# LSF Research Working Paper Series

N°. 10-04

**Date:** 2010


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**JEL Classification:** C9, D7, D8, H4, I1, I3



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# Limited Liability, Moral Hazard and Risk Taking – A Safety Net Game Experiment

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Safety nets may reduce incentives to mitigate risks, and adversely affect people's behavior. We model the safety net problem as a social dilemma game involving moral hazard, risk taking and limited liability. Individuals take costly measures to avoid a likely loss which, if incurred, is collectively indemnified. The situation is compared to a situation with full liability and the deterministic benchmark, i.e. the public goods game. We report experimental results. The data show that limited liability leads to higher risk taking in comparison to full liability; however, the difference is much smaller than predicted by theory. In comparison to the deterministic benchmark, individuals take higher loss avoidance levels. We attribute this effect to social responsibility since subjects behave as if they were liable for the losses they impose on the group. With repetition, the experimental data indicate a gradual emergence of the moral hazard problem in safety nets.

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## 1 Introduction

In many parts of the industrialized world, it is believed that the more equally and widely the risks of illness, unemployment and poverty are shared, the better off is the population as a whole. A variety of social safety nets and state-sponsored insurance schemes are the result of the policies which prevent any individual from falling into misery beyond a certain level. In its core, a social safety net is a transfer of risk and liability from the citizen to society. The safety net absorbs the costs and thus assumes full liability of the misfortunes for its individual members.

Detractors of safety nets regard these risk and liability transfers not as the solution to misfortune but as the problem. It is argued that the assumption of individual liabilities by the society reduces the incentives to mitigate risks and adversely affects people's behavior. The issue of moral hazard in safety nets has also been recently raised in the context of governmental bailouts. The argument that gains are privatized but losses are socialized suggests a susceptibility to excessive risk taking of safety nets. In economic theory, the problem that insured or limited liable individuals have a propensity to take more risks than the uninsured or fully liable ones is referred to as 'moral hazard' (Pauly, 1968). Sometimes moral hazard can encourage dramatic outcomes; fire insurance can lead to arson, automobile insurance can lead to accidents, and disability insurance can lead to dismemberment. However, moral hazard does not require that people intentionally cause the misfortune to benefit from the safety net. If they simply take fewer measures to prevent the misfortune, a similar outcome can occur.[1] The moral hazard problem arises from the fact that the objective functions of the individual agents and of the social safety net are not completely aligned.

The moral hazard problem is also known as a problem of hidden action or hidden information since the agents' information or actions are generally not verifiable by third

[1] A variety of safety nets help people who suffer the misfortune of poverty. Unemployment compensation pays people who suffer the misfortune of losing their jobs. Public health care covers the ill. Deposit insurance secures private wealth. Food stamps and public housing help the poor. Aid to dependent children helps people who suffer the misfortune of having to raise children who they cannot financially support. Yet all these programs also suffer from problems of moral hazard, i.e., the mind-set that the safety net will bail you out. Thus they implicitly increase the risks of unemployment, illness, and poverty because suboptimal individual precautionary measures are taken.

parties including the indemnifying institutions. Owed to the hidden action problem it is a challenging task to collect empirical data to reliably show that higher risks are taken if individual liabilities are reduced. Therefore, there are only very few empirical studies that allow an assessment of the significance of the moral hazard problem beyond its theoretical importance. Unfortunately, the results of these empirical studies are not always conclusive. On the one hand, Grossman (1992) investigated risk taking of insured and uninsured thrifts in the times of the great depression, and found some evidence for higher risk taking among the insured ones. On the other hand, there is surprisingly little evidence for the abuse of the safety nets in health care (see e.g., Wolfe and Goddeeris, 1991; Breyer et al., 2004)[2] or unemployment (see, e.g., Pallage and Zimmermann, 2001). Likewise, the available empirical studies on private insurance data report mixed results; some studies find evidence for higher risk taking by the insured than by the uninsured (e.g., Dionne et al., 2005) and others find no difference (e.g., Abbring et al., 2003). Obviously, a drawback of the empirical data is that higher risk taking behavior in safety nets cannot be directly observed. Changes in risk taking behavior can only be indirectly estimated from the data which, for instance in the case of private insurance, also involve the problem of adverse selection. Hence, the significance of the moral hazard problem for safety nets is difficult to judge based on empirical data since the data basis for such a judgment is missing. (For a discussion of the specification problem see Abbring et al., 2003).

The same problems do not arise with experimental data. Under controlled laboratory conditions one can directly observe the effects of changes in liability on human risk taking behavior. Therefore, experimental data might be very valuable to study the problems of moral hazard and hidden action.[3] In this paper we present a safety net game experiment in which players are exposed to the risk of individual losses that are

[2] Wolfe and Goddeeris (1991) report the largest moral hazard effect in their data is in the physician expenditures.

[3] The main stream of experimental research on problems of moral hazard and hidden action focuses on the two-player sequential principal agent problem (Holmstrom 1979). Testing the subgame perfect equilibrium of the game including the incentive compatibility requirement (Berg et al. 1992, Epstein 1992, Güth et al. 1998, Keser and Willinger 2000, 2007) and reciprocity in work contracts (Anderhub et al. 2002, Fehr et al. 1997, Gächter and Königstein 2009) are the focuses of this research. The results of this research suggest that if the agent is promised a fair reward by the principal, the agent will reciprocate this fairness. The moral hazard problem turns into a threat of negative reciprocity for received unfairness.

indemnified by the group. Each player adds an independent risk of a loss to the group but is equally liable as everyone else if a loss occurs. As a benchmark to the behavior in the safety net game we consider the behavior in the absence of a safety net, i.e. the individual decision making under full liability. In section 2, we study the issue of risk taking behavior in both scenarios theoretically. For our experimental parameters, which we describe in section 3 along with the experimental design, the safety net game treatment and its control, the full liability treatment, yield opposing theoretical predictions. Given standard assumptions, the individual is predicted to choose a loss avoidance level of zero in the safety net game treatment while in the full liability treatment the individual is predicted to choose the maximally available loss avoidance level. The experimental data (reported in section 4) show that both predictions are too extreme. In both treatments, the average loss avoidance levels are chosen in the interior upper half of the action space. The choices between the two treatments are highly correlated. Subjects who choose relatively high loss avoidance levels under full liability also choose higher loss avoidance levels in the safety net game. (The experimental design controls for an order effect of treatments). Our experimental results confirm that limited liability leads to higher risk taking than full liability. The observed difference, however, is relatively small compared to the theoretical predictions.

Since expected utility maximization requires minimal loss avoidance levels in the safety net game experiment, but social responsibility requires maximal loss avoidance levels, the safety net game shares similarities to the linear public goods game but involves a risk component (Isaac et al., 1984). In our experimental design, which applies a loss framing, both safety net game and public goods game yield the same equilibrium predictions. By comparing these two treatments, that is, taking the public goods game as a benchmark, we address the research question if, in our setting, risk or certainty leads to more cooperation? Surprisingly, loss avoidance levels are steadily higher in the risk-involving safety net game than in the non-risky public goods game. – Surprisingly, – because the available experimental studies that consider a risk effect in the public goods game report the opposite effect. Berger and Hershey (1992) and Gangadharan and Nemes (2009) report less cooperation in experimental public goods games with risk than in the control treatment under certainty.[4] In contrast to our study, however, both experimental studies involve subjects who contribute to the decrease of the probability of a common loss (see also the related theoretical study by Lohse et al. 2007), that is, the social loss is only originated by the environment and not by the individuals. Since in our study subjects originate the social loss by choosing insufficient loss avoidance levels, they are individually responsible for this loss. This responsibility to avoid the loss could partly explain the relatively high cooperation levels in the safety net game. This point is addressed in section 5 along with the conclusions.

## 2 Theoretical considerations

This section introduces and derives the theoretical predictions of the safety net game. The safety net game involves collective risk sharing in the group. Individuals take costly loss avoidance measures, but collectively indemnify the incurred losses. Thus the originator of a social loss has limited liability as she shares the loss in the same way as everyone else. The alternative to this scenario is full liability, where, in absence of a safety net, individuals must cover their entire loss alone.

### 2.1. Individual decision problem (IND): full liability

Consider an individual $i$ who incurs a loss $L > 0$ with probability $1-F(x_i)$. $F(x_i)$ is the cumulative probability that no loss occurs and has a probability density function $f(x_i)$. The probability of the loss can be reduced by choosing a loss avoidance level $x_i \in [0;\bar{x}]$. The unit cost of loss avoidance is $c > 0$.It is assumed that if the individual chooses the zero loss avoidance level, the loss occurs with certainty. If the maximum level is chosen the loss is avoided. The individual maximizes the von Neumann-Morgenstern utility function described in equation (1), where $a > \bar{x}$ denotes the amount of owned assets, and $u_i(y)$ is the utility of payoff $y$.

$$U_i(x_i;L) = F(x_i)\ u_i(a - cx_i) + (1 - F(x_i))\ u_i(a - cx_i - L) \qquad (1)$$

It is assumed that the individual is risk averse or risk neutral and that the potential loss is significant. For our purpose of predicting the individual decisions in the experiment, a

[4] Berger and Hershey (1994) consider a step level public goods experiment in a loss framing and Gangadharan and Nemes (2009), in their treatment 7, study the differences to the linear public goods game in a gain framing design.

case of special interest is the extreme one, where utility maximization implies the choice of the maximum loss avoidance level. A sufficient assumption for such a corner solution is given by $f(x_i) \times L \geq c \; \forall \; x_i$, that is, the marginal advantage weakly exceeds the marginal costs of loss avoidance. This assumption involves all economically interesting cases, since otherwise even risk averse players would choose zero loss avoidance levels under full liability. Given standard rationality assumptions, a non-maximal loss avoidance level thus indicates risk loving attitude.

### 2.2. The safety net game (SNG): limited liability

Consider a group of $n$ individuals who face the described individual decision problem, but who decide to collectively and equally share all individual losses incurred within the group. The thus created safety net implies that each player is exposed to the same liability as everyone else for her own loss. The individual utility now depends also on the loss avoidance levels taken by the other individuals in the group. In the safety net game the individual maximizes the probability weighted utility of each possible outcome.

$$\begin{aligned} U_i(x_i;x_{-i},L) = & \prod_{k=1}^{n} F(x_k)\times u_i(a-cx_i) \\ & +\left[\sum_{j_1=1}^{n}(1-F(x_{j_1}))\times\prod_{k\neq j_1}^{n-1}F(x_k)\right]\times u_i\left(a-cx_i-\frac{L}{n}\right) \\ & +\left[\sum_{j_1=1}^{n}\sum_{j_2\neq j_1}^{n-1}(1-F(x_{j_1}))\times(1-F(x_{j_2}))\times\prod_{k\neq\{j_1,j_2\}}^{n-2}F(x_k)\right]\times u_i\left(a-cx_i-\frac{2L}{n}\right) \\ & \ldots\ldots \\ & +\left[\sum_{j_1=1}^{n}\ldots\sum_{j_{n-1}\neq\{j_1,j_2,\ldots,j_{n-2}\}}^{2}(1-F(x_{j_1}))\times\ldots\times(1-F(x_{j_{n-1}}))\times F(x_{k\neq\{j_1,\ldots,j_{n-1}\}})\right]\times u_i\left(a-cx_i-\frac{(n-1)L}{n}\right) \\ & +\prod_{j=1}^{n}(1-F(x_j))\times u_i(a-cx_i-L) \end{aligned} \tag{2}$$

Taking the loss avoidance levels of the others as given, a necessary condition for positive equilibrium levels of loss avoidance is $f(x_i) \times L/n \geq c$. If, in contrast, the marginal costs exceed the individual marginal benefit of loss avoidance, $f(x_i) \times L/n < c \; \forall \; x_i$, as we are going to assume in the experiment, expected utility maximization implies that every individual in the safety net game chooses a zero loss avoidance level. Maximization of the expected collective welfare, however, would lead to avoidance of any losses, owed to the above made assumption $f(x_i) \times L \geq c \; \forall \; x_i$. By the standard backward induction argument, the implication of zero loss avoidance equilibrium levels in the one-shot game applies also in the finitely repeated game.

### 2.3. The linear public goods game (PGG): the deterministic benchmark

The safety net game as described in the previous subsection is a social dilemma game, since individual rationality and social efficiency imply the opposing actions, maximum loss avoidance levels and collective free-riding. Similar social dilemma games have been studied in the economics literature. Closely related to the safety net game is the well-known linear public goods game (Isaac and Walker 1985) which can be understood as its deterministic pendant. In our setting, however, the linear public goods game involves a loss framing (Kahneman and Tversky 1981) and not the standard gains framing (on the latter, see surveys by Hey 1991 or Ledyard 1995).[5] An individual incurs a social loss if she takes no loss avoidance measures and she can linearly decrease the loss up to its complete avoidance. All remaining losses are shared equally by the group of *n* players. The individual maximizes the following utility function.

$$U_i(x_i; L) = u_i(a - cx_i - \sum_{j=1}^{n} \frac{L - bx_j}{n}); \quad x_j \in [0; \bar{x}] \tag{3}$$

Rearranging terms, $a - L$ is equivalent to the endowment of the individual in the standard framing of the linear public goods game (Isaac and Walker 1985), and each unit of loss avoidance increases the payoff of each group member by $b/n$, the marginal per capita return. If $b$ is bounded between one and $n$, as is the standard assumption, complete loss avoidance is collectively rational but individuals have a dominant strategy to spend nothing on loss avoidance. The zero loss avoidance level is chosen in the unique equilibrium of the finitely repeated game. In comparison to the safety net game, the loss in the linear public goods game is certain and is avoided proportionally to the chosen loss avoidance level, but the optimal individual and social choices remain the same.

[5] Shanley and Grossman (2007) use a negative framing what they called *public bad game* and, indeed, find differences to the public goods game in a positive framing. Contributions are significantly higher under positive framing. However, their setting is different from ours in several respects.

## 3. Experimental design & testable hypothesis

The experiment includes three treatments. The first one is the safety net game as described in section 2.2 (hereafter, SNG), where the individual is only partially liable for her losses since they are collectively indemnified. The second one is an individual control treatment as described in section 2.1 in which the individual is fully liable for her incurred losses (hereafter IND).[6] The third one, the linear public goods game as described in section 2.3 (hereafter, PGG) is a deterministic control treatment.

Subjects interacted during the experiment with exactly three other subjects; the SNG and the PGG involved $n = 4$ in a partners setting. The other parameters were chosen as follows; subjects faced a (gross) endowment of $a = 150$, loss avoidance costs $c = 1$, a potential loss of $L = 100$, and $\bar{x} = 50$ as a maximum loss avoidance level. Subjects were asked to choose a level $x_i = \{0,1,...,50\}$ to avoid the potential loss. All amounts referred to Eurocent. In the treatments SNG and IND, independent random draws of individual threshold levels $s_i$ from a uniform distribution on the interval $\{1,...,50\}$ determined if the individual loss was incurred or if it was avoided. If the chosen loss avoidance level weakly exceeded the threshold level, the subject avoided the loss; otherwise, i.e. if the subjects' loss avoidance level was lower than the threshold level, the subject incurred the loss. Extreme decisions were riskless, i.e. if the subject assigned $x_i = 0$ the loss was incurred, and if the subject assigned $x_i = 50$ no loss was incurred.

Table 1 records the resulting payoff functions in the three treatments along with the theoretical prediction on loss avoidance levels and payoffs. The loss avoidance and thus the payoff in the IND and SNG treatments depends on the individual choices and the realizations of the independently drawn threshold levels, and is indicated through the binary variable $I_i$ in Table 1, which takes the value one if the loss occurs and zero otherwise. The expected payoffs in the SNG are equivalent to the ones in the PGG for any given action profile. Thus, each Eurocent spent on loss avoidance reduces the

[6] DiMauro (2002) investigates a related experiment, where subjects make an individual decision under risk or uncertainty by choosing a loss avoidance level to decrease the probability of the loss. She compares the effect of risk and uncertainty, and reports higher average loss avoidance levels under uncertainty than under risk.

expected group loss by two Eurocents. This parameterization has been used in the standard gain framing design for the linear public goods game, for instance, by Croson et al. (2005).[7]

Each treatment involved ten periods (i.e., repetitions) with feedback information. In the SNG, subjects received private feedback information on their loss avoidance levels, their individual threshold levels and the resulted loss, the sum of all losses in the group, and their payoff. This information was permanently available in a table for each past period. In the IND and the PGG treatments, the received information was equivalent to the one of the SNG treatment. Indeed, no information about other subjects' losses was available in the IND treatment, and no chance moves were reported in the PGG treatment. Note, however, the feedback information in the SNG is less transparent than in the PGG, since the sum of all losses in the PGG treatment implicitly reveals the loss avoidance levels of the others while, in the SNG, only the insufficient actions of others are revealed. This lack of transparency represents the hidden action problem highlighted in the literature. In our setting this problem has two dimensions. On one hand, free-riders have an advantage as they are able to cover their low cooperation levels without fearing immediate punishment; on the other hand, cooperators have a disadvantage as they have higher costs to signal their cooperation. If the free-rider advantage effect is greater [smaller] than the cooperators disadvantage effect, loss avoidance levels will be lower [higher].

Each subject participated in the SNG and in one of the other treatments, either the IND or the PGG. Treatments were conducted in different orders, thus we controlled for an order effect. Half the subjects played the SNG in the first run and the other half played the SNG in the second run. In total, we had four sessions which can be identified by the order of the treatments: IND-SNG, SNG-IND, PGG-SNG, and SNG-PGG. The comparison of the two first sessions informs us about an order effect with respect to risk taking when being switched from limited to full liability, and the comparison of the latter two sessions informs us about a behavioral change when being switched from the deterministic to the risky environment and vice versa. Note again, groups stayed the same

[7] In an earlier version of the paper, a gain framing was used for the treatments. The results were qualitatively equal. But there were some subject pool differences. Therefore, we do not report the results here. The data, however, can be obtained upon request from the authors.

in the first and the second treatment of a session. In the first treatment, subjects were uninformed about the second treatment.

| Treatment | Payoff function | Predicted loss avoidance level | Predicted payoff |
|---|---|---|---|
| IND | $150 - x_i - 100 I_i, I_i = \begin{cases} 0, if\ x_i \geq s_i, s_i \sim U\{1,2,...,50\} \\ 1, otherwise \end{cases}$ | 50 | 100 |
| SNG | $150 - x_i - \sum_{j=1}^{4} \frac{100}{4} I_j, I_j = \begin{cases} 0, if\ x_j \geq s_j, s_j \sim U\{1,2,...,50\} \\ 1, otherwise \end{cases}$ | 0 | 50 |
| PGG | $150 - x_i - \sum_{j=1}^{4} \frac{100 - 2x_j}{4}$ | 0 | 50 |

**Table 1: Experimental setting and prediction**

The sessions were conducted at the Magdeburg Experimental Laboratory (MaXLab), subjects were undergraduate students of the Otto-von-Guericke University Magdeburg in Germany. The subjects had not participated in any public goods or group decision experiment before. The experimental software was programmed using z-Tree (Fischbacher, 2007); participants were recruited via ORSEE (Greiner, 2004). At the beginning of each treatment, the instructions were read aloud. Prior to interacting, subjects ran through a stand-alone computerized comprehension test.[8] At the end of the session, we debriefed subjects in an onscreen questionnaire. Given that all subjects passed the test and given their replies in the debriefings, we are confident that the instructions were understood.

## 4 Experimental results

In total, 112 subjects participated in four sessions, each subject in exactly one session. In each session, we collected seven independent observations on four-subject groups. Since every subject participated in the SNG treatment and one of the other two treatments, the

[8] The translated instructions and a description of the onscreen-test are appended to the paper.

data consist of 28 independent observations for the SNG treatment, and 14 independent observations for the PGG and IND treatments. The experimental design involves thus both a within-subjects component (as each subject participated in two different treatments) and a between-subjects component (as each subject participated in one session of the SNG). Each experimental session took about an hour to run and subjects earned 17.44 Euro on average in the sessions with the IND treatment and 14.83 in the sessions with the PGG treatment; no show-up fee was paid. Based on the following result, the subsequent analysis is conducted on the pooled data regardless of the treatment order.

**Observation 1**:

We observe no order effect. There are no significant differences between the first-run and second-run loss avoidance levels for any treatment (SNG, PGG and IND).

The observation is supported by the outcomes of the random effects dummy regression of group loss avoidance levels on a time trend.[9] The results are recorded in Table 2 for each treatment; and in the appendix the results are detailed for the SNG treatment. The binary variable *Run2Dummy* takes the value zero for the first run and one for the second run of a session. This variable is interacted on the intercept and slope, thus we test for order effects on initial levels and dynamics. The data show that both of these coefficients are not significant at the 10% level. In favor of higher statistical power, we focus, hence, on the pooled data per treatment.[10]

**Table 2: Order effect: random effects regression of loss avoidance levels**

| Independent Variables | (1) SNG | (2) PGG | (3) IND |
|---|---|---|---|
| *Run2Dummy* | 5.813 | -0.452 | 1.243 |
| | (3.793) | (7.065) | (2.155) |
| $Run2Dummy \times Period$ | -0.249 | -0.009 | 0.165 |
| | (0.245) | (0.387) | (0.167) |

[9] Our panel data regression results are in line with the outcomes of the Hausman test; that is, unless the coefficients of the fixed effects model and the random effects model are significantly different, the random effects regression results are reported.

[10] Nevertheless, the subsequently reported observations also represent each treatment order.

| | | | |
|---|---|---|---|
| *Period* | -1.334*** | -1.164*** | 0.216* |
| | (0.173) | (0.274) | (0.118) |
| *Constant* | 33.43*** | 27.60*** | 41.82*** |
| | (2.682) | (4.996) | (1.524) |
| Observations | 280 | 140 | 140 |
| Independent groups | 28 | 14 | 14 |
| Wald test | 144.1 | 36.49 | 15.06 |

Standard errors in parentheses, *** p<0.01, ** p<0.05, * p<0.1

**Observation 2**:

Loss avoidance levels decline in the SNG and the PGG treatments.

The period variable in Table 2 reveals the dynamics of the treatments. The coefficient is significantly negative for the SNG and the PGG. The positive coefficient for the IND is only marginally significant. The effects are obvious in Figure 1 which displays the average loss avoidance levels. From this figure we also see how the loss avoidance levels differ between treatments.[11]

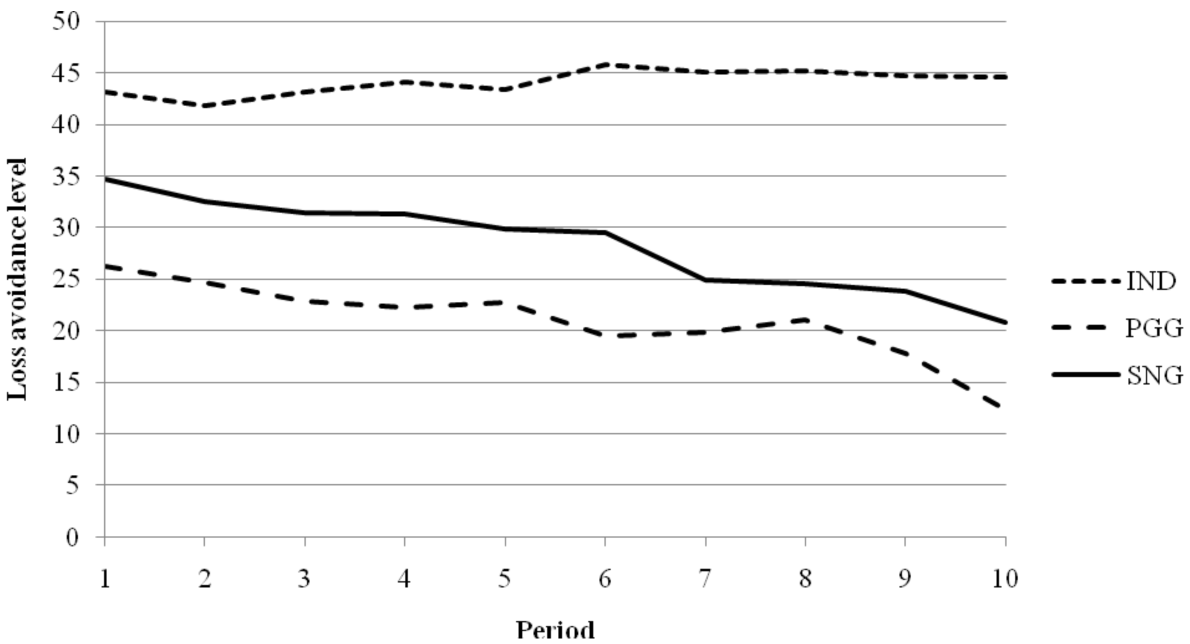


**Figure 1. Average loss avoidance levels**

[11] Over all periods, the average loss avoidance levels were 57%, 42%, and 88% of the endowment in the SNG, PGG, and IND treatments (see Table 5).

**Observation 3**:

Loss avoidance levels in the SNG treatment are lower than in the IND treatment and higher than in the PGG treatment.

Statistical support for this observation is given by the random effects dummy regression of group loss avoidance levels on a time trend, which is recorded in Table 3. The regression involves a binary treatment variable which takes the value one for the treatment SNG and zero otherwise. In column (5) of Table 3, the significant positive effect of this treatment variable indicates the absolutely higher loss avoidance levels in the SNG compared to the PGG. We also interact this treatment variable with the time trend. The coefficient, however, indicates no difference in the decline of loss avoidance levels. In Figure 1 we see that the loss avoidance levels of these two treatments decline in parallel. Relative to the IND treatment, on the other hand, we observe a negative treatment effect of the SNG in both level and dynamics as indicated in column (6). The loss avoidance levels of the IND are both absolutely higher and non-decreasing over periods.

**Table 3. Treatment effect: random effects regression of loss avoidance levels**

| Independent Variables | (5) PGG | (6) IND |
|---|---|---|
| *SNG* | 7.296*** | -4.451*** |
| | (1.574) | (1.467) |
| *SNG* $\times$ *Period* | -0.290 | -1.757*** |
| | (0.245) | (0.229) |
| *Period* | -1.168*** | 0.299 |
| | (0.200) | (0.187) |
| *Constant* | 29.04*** | 40.79*** |
| | (2.192) | (1.927) |
| Observations | 420 | 420 |
| Independent groups | 28 | 28 |
| Wald test | 189.5 | 475.7 |

Standard errors in parentheses, *** p<0.01, ** p<0.05, * p<0.1

Having made these observations, the question arises why subjects in the SNG exert higher loss avoidance levels than in the PGG? In reply to this question note that the loss avoidance levels in the SNG are halfway between the PGG and the IND throughout the experiment from the first period.[12] Loss avoidance levels are higher in the SNG than in the PGG because the risk exposure influences behaviour. Subjects behave 'as if' they play two games simultaneously; the *n* players PGG contribution game and the IND decision making game against nature. This statement is backed by the following two observations on individual behavior in the SNG treatment.

**Observation 4A**:

Individual loss avoidance levels of the SNG treatment positively correlate with the ones in the IND and the PGG treatments.

In support of the observation we report the outcomes of a random effects dummy regression of the individual loss avoidance levels on the individual average allocations in the control treatments. Thus, we use as instruments for individual cooperation attitudes and for risk aversion the average loss avoidance levels of the PGG and the IND, respectively. These instruments are represented by the variable *AverageControl* in Table 4. To separate the effects of the cooperation and risk attitudes, this variable is interacted with the binary variable *PGG* which takes the value one if the individual participated in the PGG treatment and zero for the IND treatment (we remind the reader that each individual participated either in the PGG or the IND treatment). As recorded in Table 4, we find that the average loss avoidance levels in both control treatment positively correlate with those in the SNG treatment. Therefore, we conclude that both effects, the attitude to cooperate and risk aversion, play a role for the behaviour in the SNG

[12] As the figure A1 in the appendix shows the order is observable already in the first period. The charts of figures A2-A3 show the evolution of distributions over the periods for the three treatments. Statistical support is given by the two-tailed Wilcoxon signed ranks test that rejects the null-hypothesis of equal loss avoidance levels in the SNG and the PGG treatments at the 5%-level (p = .016). The p-values for the equivalent one-tailed Wilcoxon signed ranks test between the IND and the SNG is also significant (p = .037).

treatment. We caution the reader that the significant PGG effect is no indication for a greater cooperation effect since the loss avoidance levels in PGG are significantly lower than in IND. Our data show no effect of these instruments on the time trend. Thus, subjects who contribute more in the SNG treatment contribute more in the PGG and IND treatments, too.

**Table 4. Cooperation and risk attitudes in the SNG: random effects regression of loss avoidance levels**

| Independent Variables | (7) |
|---|---|
| AverageControl | 0.394***<br>(0.0747) |
| AverageControl × PGG | 0.394***<br>(0.0791) |
| AverageControl × Period | -0.00677<br>(0.00896) |
| AverageControl × PGG × Period | 0.000182<br>(0.00022) |
| Period | -1.302***<br>(0.325) |
| Constant | 20.87***<br>(2.745) |
| Observations | 1120 |
| Independent groups | 28 |
| Wald test | 269.1 |

Standard errors in parentheses, *** p<0.01, ** p<0.05, * p<0.1

**Observation 4B**:

Individual loss avoidance levels of the SNG treatment are negatively correlated to the lagged losses of the other group members (conditional cooperation effect), and positively correlated to an experienced loss (social responsibility effect).

Table 5 reports fixed effects regression results on the determinants of the individual loss avoidance levels. The results for the SNG treatment are reported jointly with the PGG treatment in column (8) and with the IND treatment in column (9). From column (8) (line g) we find that the loss avoidance levels depend negatively on the lagged losses of the others. This *conditional cooperation* effect (see Neugebauer et al. 2009 and references therein) appears to be similar in both treatments since the coefficient of the interacted variable indicates no significant differences between the SNG and the PGG (line b). The experienced loss effect in the SNG treatment is evidenced from the significance of the interacted variable in line a).[13] If subjects experience a loss, they tend to increase their loss avoidance levels in the next period. Note that this effect is even more significant in the IND treatment, see lines a) and g) of column (9). For the IND treatment this effect is in line with ex-post rational adjustment behavior (Selten and Stöcker 1986; Selten and Buchta 1994) owed to subjects' full liability. Owed to the limited liability of the SNG, however, this behaviour cannot be explained by expost rational adjustments. We may want to refer to this reaction as a *social responsibility* effect. Subjects act as if they take care for their losses they impose on the group, and avoid further losses by increasing their avoidance levels.

**Table 5. Dynamics of the loss effect: fixed effects regression of loss avoidance levels**

| Independent Variables | (8) PGG | (9) IND |
|---|---|---|
| a) SNG × LaggedLoss | 0.0250** | -0.0379* |
| | (0.0114) | (0.0201) |
| b) SNG × LaggedOthers'Loss | 0.0120 | |
| | (0.00862) | |
| c) SNG × LaggedLossAvoidanceLevel | 0.0974** | -0.0943 |
| | (0.0454) | (0.0779) |
| d) SNG × Period | -0.0783 | -0.895*** |
| | (0.254) | (0.216) |
| e) SNG | -2.210 | 1.621 |
| | (2.736) | (3.682) |
| f) LaggedLoss | | 0.0609*** |
| | | (0.0175) |

[13] Note that the lagged loss avoidance level corresponds to the lagged own loss in the PGG treatment, but in the SNG treatment this equivalence is not given, owed to the stochastic component. Therefore, we check the effect of the lagged loss through the lines a), c), and h) of column (8). Line h) indicates a path dependence effect; the loss avoidance level positively correlates with the loss avoidance level in the previous period.

| | | |
|---|---|---|
| g) LaggedOthers'Loss | -0.0310*** | |
| | (0.00832) | |
| h) LaggedLossAvoidanceLevel | 0.334*** | 0.644*** |
| | (0.0342) | (0.0716) |
| i) Period | -0.702*** | 0.103 |
| | (0.206) | (0.174) |
| j) Constant | 22.99*** | 14.00*** |
| | (2.105) | (3.332) |
| Observations | 1512 | 1512 |
| Independent groups | 112 | 112 |
| R-squared | 0.238 | 0.455 |

Standard errors in parentheses, *** $p<0.01$, ** $p<0.05$, * $p<0.1$

Revisiting the distributions of loss avoidance levels, we close this section by comparing the experimental data to the theoretical predictions. As pointed out in Table 1, the standard theory predicts a zero loss avoidance level for the SNG and the PGG, and a full loss avoidance level for the IND. We observe that the zero loss avoidance level is only exerted in 18% of the decisions in the SNG (see Table 6). In the first and last period the relative frequencies are 10% and 27%.[14] The increase in the number of free riders occurs gradually from one period to the next in the SNG. This fact is evident from the cumulative distributions of loss avoidance levels by period, shown in Figure A2 of the appendix. Note that the shape of the distributions stays the same across periods, but the support on the zero level increases between the periods. The Spearman rank correlation coefficient of the number of free riders and periods is r =. 901.[15] On the other hand, the relative frequency of full loss avoidance levels is 20% in the SNG, that is, about the same size than in the PGG. For the IND treatment we observe that most loss avoidance levels are above half of the endowment (94.64%, see Figure A4), but only 51% involve full loss

[14] These numbers are not only much smaller than the predicted ones, but also half the size compared to the PGG treatment. According to the Wilcoxon signed ranks test, we find that the relative frequencies of zero contributions are significantly different between the SNG treatment and the PGG treatment (p=.023). The one-tailed test between SNG and IND is also significant (p=.000).

[15] The correlation coefficients for the other two treatments are r =.979 (PGG) and r =-.058 (IND). The distributions of loss avoidance levels for these treatments are recorded in figures A3 and A4.

avoidance. Subjects take significant risks in the situation where risk aversion requires no risk taking at all, and this risk taking does not vanish throughout the experiment. Given the relatively high avoidance levels in the SNG and PGG treatments, it seems surprising that the IND treatment where the individual is fully liable for her losses involves such a high amount of risk taking.

**Table 6. Loss avoidance levels: descriptive statistics**

| | | IND | SNG | PGG |
|---|---|---|---|---|
| Relative frequency x=0 | First period | 0.00% | 9.82% | 25.00% |
| | Last period | 0.36% | 26.79% | 53.57% |
| | Average | 0.36% | 18.13% | 35.36% |
| Relative frequency x=50 | First period | 42.86% | 33.04% | 32.14% |
| | Last period | 50.00% | 10.71% | 3.57% |
| | Average | 51.25% | 20.80% | 21.79% |
| Average absolute level | First period | 43.09 | 34.68 | 26.23 |
| | Last period | 44.61 | 20.75 | 12.38 |
| | Average | 44.08 | 28.31 | 20.94 |
| N | | 56 | 112 | 56 |

## 5 Summary and conclusions

This paper introduces the *safety net game* in which members of a group choose avoidance levels to prevent a likely individual loss which is socially indemnified within the group. The safety net game involves the problem of moral hazard since the group members are limited liable for any loss they impose on the group and since the individual actions are unobservable. If a loss occurs, it is hard to prove, in hindsight, that it occurred due to the lack of loss avoidance measures or due to chance. We discussed the safety net game theoretically and reported experimental results and compared it to two control treatments; the full liability individual decision task and the linear public goods game. For the safety net game and for the public goods game, standard theory predicts free-riding; under full liability, in contrast, theory predicts the choice of the maximal loss avoidance level. As for the full liability control treatment, the experimental data support the theoretical prediction that the loss avoidance levels are lower in the safety net game than under full liability. Although this result is not surprising, the difference between the two treatments is surprising as it is far smaller than predicted. There are two reasons for this deviation from the theoretical prediction. On one hand, the full liability treatment elicited higher risk taking as only 88% of the disposable resources were employed on loss avoidance rather than the predicted 100%. On the other hand, the safety net game treatment elicited lower risk taking as 56% of the resources were employed rather than the predicted 0%. Thus, and against the theoretical prediction, the observed avoidance levels were also significantly greater than the 42% average observed in the public goods game.

Our observations suggest that the higher loss avoidance levels compared to the public goods game result from the risk exposure of cooperative individuals. To show cooperation under hidden action the individual loss avoidance level must be sufficiently high to weather the move of nature. If a subject fails to avoid the loss in one period, our data show that the loss avoidance level is increased in response to this loss in the following period. This effect can be interpreted as socially responsible behavior. Subjects behave as if responsible for imposing a loss on the group even though they are only limited liable. However, we also observe in line with the theory that some subjects ride free on the others, the predicted zero loss avoidance level is chosen in 18% of all decisions. The number of free-riders increases with repetition, however, following a similar pattern as in the public goods game. The loss avoidance levels evolve inversely to the observed losses incurred by the other group members. So, risk taking increases gradually.

This observation is consistent with the findings of Grossman (1992); in his empirical study on the effect of federal deposit insurance on thrift risk taking he writes (p. 819): "While newly insured thrifts undertook less risk than their uninsured counterparts, moral hazard emerged gradually. The results […] indicate that after having been insured for approximately five years an insured institution's risk-taking surpassed that of its uninsured counterpart […]. Once insured, however, thrift managers felt free to undertake more risk."

Although the moral hazard problem observed in the data is not as serious as expected in theory, the increase of risk taking suggests a gradual erosion of social responsibility. There are at least two political measures that can be taken to mitigate this erosion which have also been discussed in the literature (Holmstrom 1979). First, the insurance literature suggests that the inclusion of a deductible upon a realized loss can enhance moral standards as participants' liability is increased. The crucial question in this context, indeed, is on the size of the deductible that would lead to the desirable outcome. Second, the literature on agency problems suggests a monitoring of the agent's actions. Here the question arises how probable a monitoring must be owed to the costs of monitoring in safety nets. A sensible policy might be the introduction of monitoring in the frame of an alert system. Upon a realized loss and increasingly with every further loss, monitoring efforts must be increased. Monitoring must be accompanied by a reasonable sanction of defectors who -in the worst case- might face exclusion from the safety net. Such measures do not only discipline defectors but also serve as a general moral support for social responsibility. These relevant questions on sensible political measures to support the maintenance of moral standards, which can also be addressed within the safety net game experiment, obviously call for further research.

**Acknowledgements**

We wish to thank Abdolkarim Sadrieh and the Faculty of Economics and Management of University of Magdeburg for using their MaXLab and Marina Schröder and Harald Wypior for professional lab assistance.

## Appendix

## Table A1. Random effects regression: absence of order effect in the SNG

| Independent variables | SNG_PGG vs SNG_IND | SNG1 vs SNG2_PGG | SNG1 vs SNG2_IND | SNG2_PGG vs SNG2_IND | SNG1_PGG vs SNG1_IND |
|---|---|---|---|---|---|
| Run2Dummy | 5.377 | 3.733 | 7.893 | 4.160 | 6.595 |
| | (3.829) | (4.907) | (5.024) | (4.390) | (6.325) |
| Run2Dummy × Period | -0.338 | -0.0496 | -0.449 | -0.399 | -0.277 |
| | (0.245) | (0.287) | (0.298) | (0.371) | (0.321) |
| Period | -1.289*** | -1.334*** | -1.334*** | -1.383*** | -1.195*** |
| | (0.173) | (0.166) | (0.172) | (0.262) | (0.227) |
| Constant | 33.65*** | 33.43*** | 33.43*** | 37.16*** | 30.13*** |
| | (2.708) | (2.833) | (2.901) | (3.104) | (4.472) |
| Observations | 280 | 210 | 210 | 140 | 140 |
| Independent groups | 28 | 21 | 21 | 14 | 14 |
| Wald test | 144.9 | 99.88 | 115.1 | 74.25 | 70.59 |

**Standard errors in parentheses, *** p<0.01, ** p<0.05, * p<0.1**

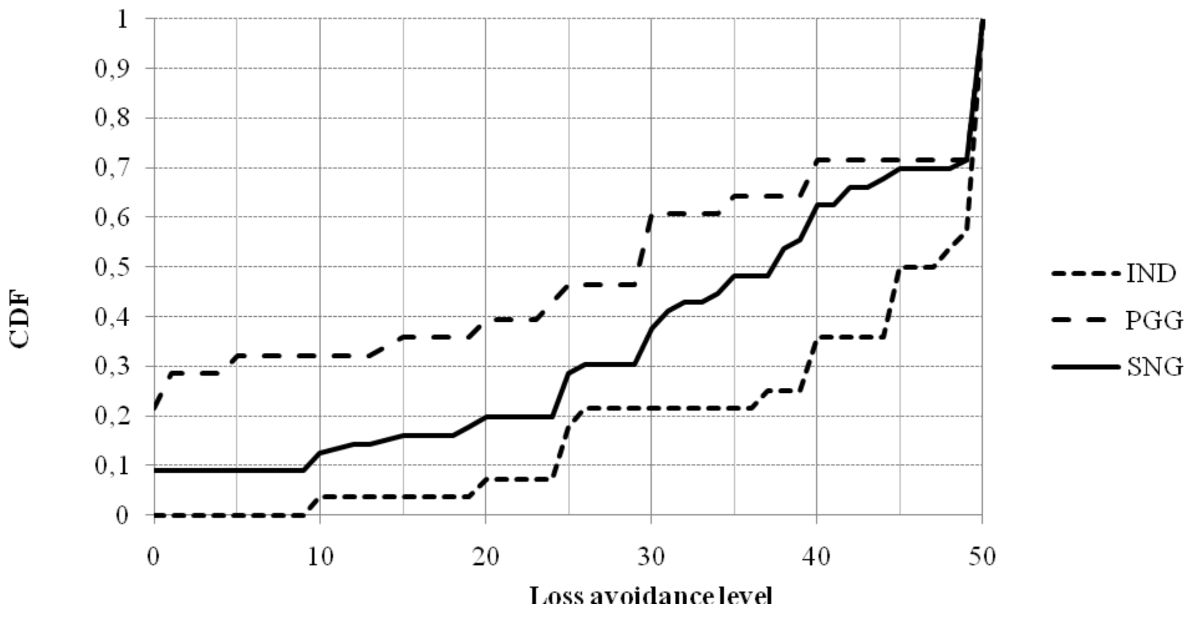


**Figure A1. Cumulative distribution of loss avoidance levels in the first period**

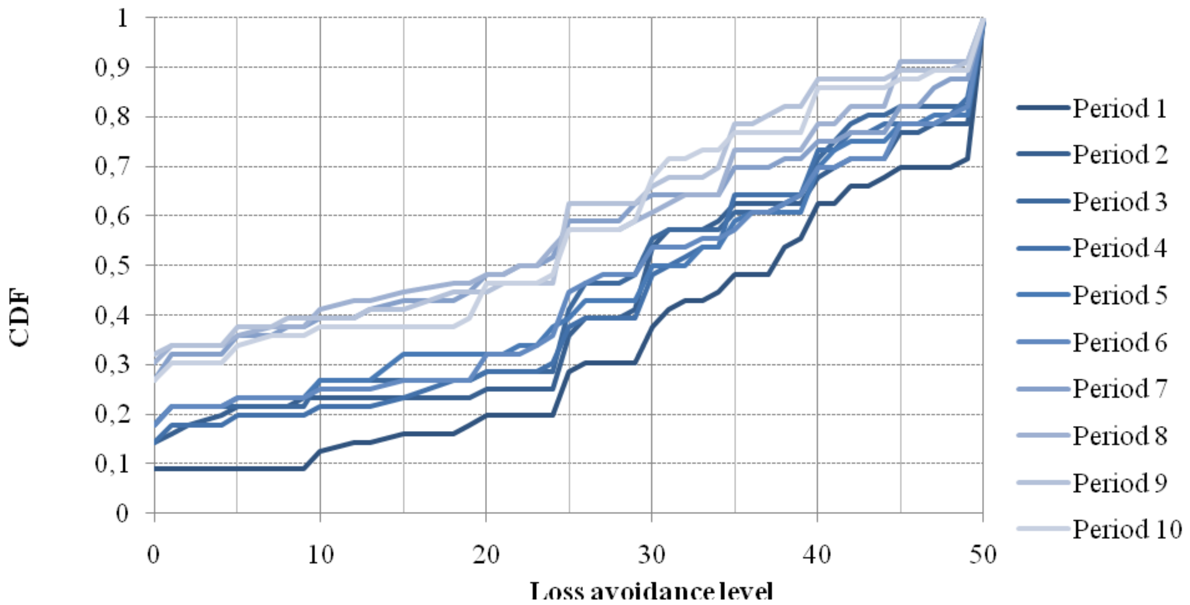


**Figure A2. Cumulative distribution of loss avoidance levels by periods in SNG**

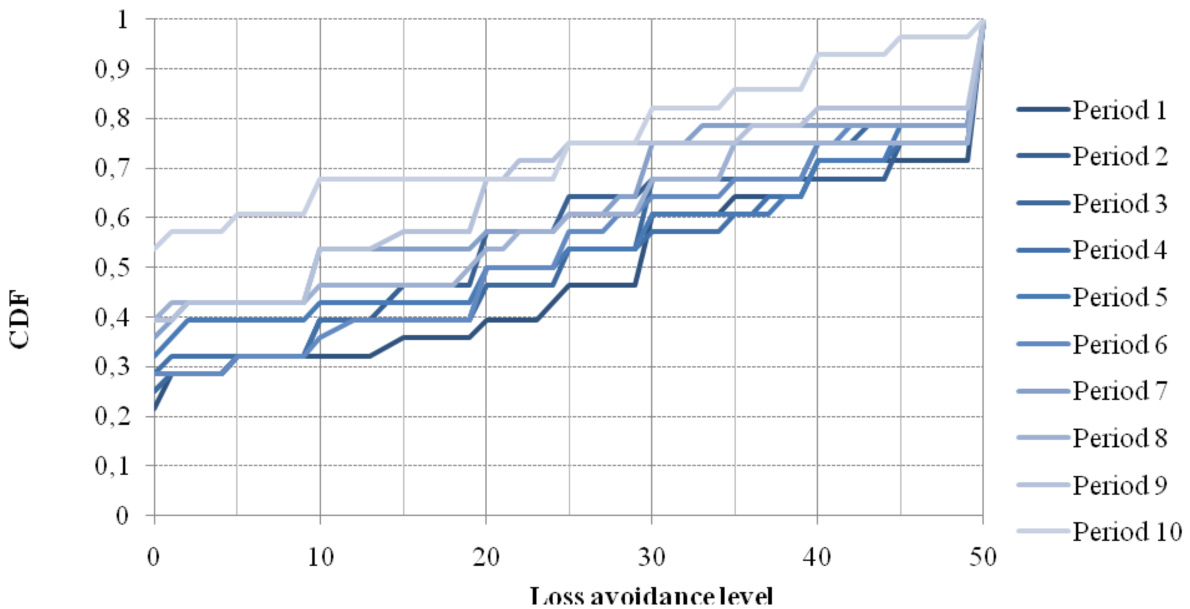


**Figure A3. Cumulative distribution of loss avoidance levels by periods in PGG**

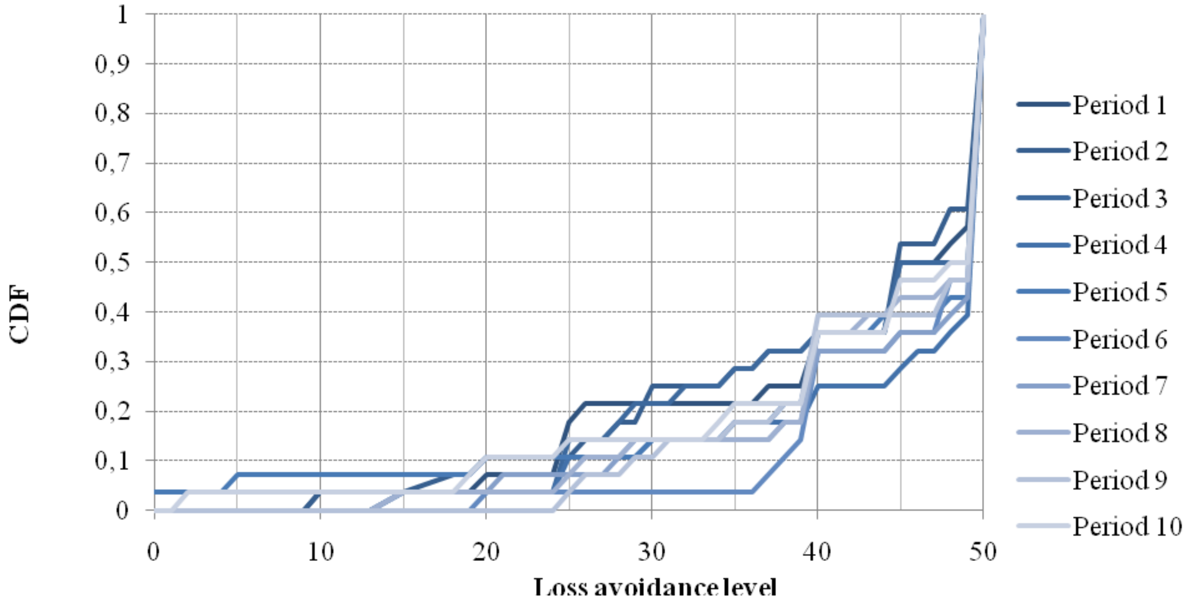


**Figure A4. Cumulative distribution of loss avoidance levels by periods in IND**

**INSTRUCTIONS (TRANSLATION)**

(Any treatment) Welcome to the experiment! Please switch off your mobile telephone! Please pay attention to the following instructions and inform the instructor in case you experience problems in understanding. During the entire experiment you are not allowed to communicate with any other participant. If you do communicate with other participants you will have to abandon the experiment immediately and you lose all claims regarding payment. By participating in the experiment you contribute to the experimental research on individual decision making. Therefore, it is important that you make all your decisions on your own!

*Instructions independent of the order*

**The IND treatment**

In the experiment you are going to make individual decisions in ten periods.
In every period, you will receive an endowment of 150 Eurocent. You can spend up to 50 Eurocents in order to avoid a personal loss of 100 Eurocents. Your spending has to be an integer of 0,1,…,50. With every Eurocent you spend, you reduce the likelihood of the loss. The occurrence of the loss is determined by chance and by your spending. For each period the computer randomly determines a personal threshold. The threshold is an integer of 1,2,…,50.. If your spending is greater or equal to the threshold your loss is avoided. If your spending is lower a loss of 100 Eurocents occurs.
Note: The threshold exceeds 0 always, and never exceeds 50. Hence, you will have a sure loss if you spend 0 and no loss if you spend 50 Eurocents. Hence, your payoff in any period equals

150 (*your endowment*) – your spending to prevent the loss – 100 (*in case of an occurred loss*)

You take all your decisions on the computer. After each period the following information in the form of a table are displayed: period, spending, threshold, loss, period payoff.

**The SNG treatment**

In the following you are going to interact with three other participants in a group of four for ten periods. The composition of the group will stay the same throughout the entire experiment. The identity of the group members will be randomly determined at the beginning and will not be revealed to you at any time.
In every period, you will receive an endowment of 150 Eurocent. You can spend up to 50 Eurocents in order to avoid a personal loss of 100 Eurocents. Your spending has to be an integer of 0,1,…,50.
With every Eurocent you spend, you reduce the likelihood of the loss. The occurrence of the loss is determined by chance and by your spending. For each period the computer randomly determines a personal threshold. The threshold is an integer of 1,2,…,50. . If your spending is greater or equal to the threshold your loss is avoided. If your spending is lower a loss of 100 Eurocents occurs.
Note: The threshold exceeds 0 always, and never exceeds 50. Hence, you will have a sure loss if you spend 0 and no loss if you spend 50 Eurocents. Hence, your payoff in any period equals
When a loss occurs, the amount is divided in equal shares between the members of your group (in other words, the not prevented loss will be divided by 4). You likewise have to share the losses that have von been prevented by other group members. Hence, your payoff in any period equals

150 (*your endowment*) – your spending to prevent the loss – 100/4 (*in case of an occurred loss*)
– 100/4 (*times the number of not prevented losses of other group members*)
[In short: 150 – spending – (sum of all losses)/4]

You take all your decisions on the computer. After each period the following information in the form of a table are displayed: period, spending, threshold, loss, sum of all losses, your share of the group loss, period payoff.

**The PGG treatment**

In the following you are going to interact with three other participants in a group of four for ten periods. The composition of the group will stay the same throughout the entire experiment. The identity of the group members will be randomly determined at the beginning and will not be revealed to you at any time.

In every period, you will receive an endowment of 150 Eurocent. You can spend up to 50 Eurocents in order to avoid a personal loss of 100 Eurocents. Your spending has to be an integer of 0,1,…,50..
With every cent you spend, you reduce the maximum loss by 2 Eurocents. The remaining loss is divided in equal shares between the members of your group (in other words, the not prevented loss will be divided by 4). You likewise have to share the losses that have von been prevented by other group members. Hence, your payoff in any period equals

150 (*your endowment*) – your spending to prevent the loss – [100 (*loss*) – 2 times your spending]/4
– 3* [100 (*loss*) – 2 times spending of other group members]/4
[In short: 150 – spending – (200 – spending of all group members)/4]

You take all your decisions on the computer. After each period the following information in the form of a table are displayed: period, spending, loss, sum of all losses, your share of the group loss, period payoff.

*Additional instructions if played at second order*

The instructions are the same if played at first. There is an additional remark that the groups are going to be the same as in the first treatment. Finally, we also state
At the end of the experiments you will receive all payments from experiment 1 and experiment 2 against a receipt.

COMPUTER SUPPORTED TEST

Before each treatment the subjects have to fulfill a comprehension test. The test involves two screens. On the first screen, subjects were prompted to insert 8 (4 in PGG) integers between 1 and 50. On the second screen, the subjects faced these numbers in a different order, indicating the spending of fictitious players in a group to prevent the loss and indicating the thresholds (not in PGG). The subjects were informed that they had to take the comprehension test on the basis of the introduced numbers. Given the arrangement of the numbers on the screen, subjects had to compute the payoff for each fictitious player. Subjects confirmed their computations by a press on a button. However, only if they had passed the test they could continue the experiment. The treatment started when all subjects had passed.

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