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The Case for Limited Auditor Liability - The Effects of Liability Size on Risk Aversion and Ambiguity Aversion

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Should Auditors' Liability be Limited? – The Effects of Liability Size on Behavior under Risk and Ambiguity

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Abstract

Regulators in the E.U. and U.S. currently consider limiting auditors' liability in order to ensure the viability of the audit market. We set up a controlled laboratory experiment to investigate the deterrence effects of different liability regimes. Unlimited liability is modeled by extending the payoff scale by real financial losses. Our main findings are that ambiguity aversion increases with stake size and that ambiguity aversion and risk aversion are correlated if stake size is high. These findings contribute to auditing research by providing new empirical evidence that a regime of unlimited liability is likely to induce overdeterrence. We contribute to behavioral and experimental economics with our methodological innovation of introducing real losses in risk and ambiguity settings and by providing new evidence relevant for the ongoing discussion about the discrimination between different theories of behavior under ambiguity.

JEL: C91, D81, K13, M42

Keywords: *Auditor Liability, Ambiguity, Loss Aversion, Risk Aversion, Experimental Economics, Behavioral Economics*

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1. Introduction

Regulators in the E.U. and U.S. currently consider limiting auditors' liability. The European Commission has recently assigned a study and launched a public consultation to investigate whether and how auditors' liability should be limited (Directorate General for Internal Market and Services, 2007). Similarly, the Committee on Capital Markets Regulations (2006) demanded from the U.S. Congress to explore means to protect audit firms against catastrophic claims.

The primary goal of limiting auditors' liability is to reduce the risk of the bankruptcy of audit firms in order to avoid general market disruptions with potentially "adverse consequences for corporate governance in the U.S. and the rest of the world" (Committee on Capital Markets Regulation, 2006, p. 12). The threat of the bankruptcy of an audit firm seems imminent as there are currently at least 25 outstanding claims against auditors in the U.S. and in the E.U. in which the damages sought exceed 700 Mio. €: an amount that seems unbearable even for the largest national audit firms (London Economics, 2006; Talley, 2006). Market disruptions may arise in case of a further reduction of the number of big audit firms as the audit market is already highly concentrated (London Economics, 2006; US General Accounting Office, 2003). A reduction of the numbers of big audit firms from four to three would complicate the auditor choice for audited firms. The auditor choice is already difficulty today for many audited firms, because they have to find an auditor who fulfills the independence requirements (European Union, 2006; SEC, 2003), who has sufficient capacity, industry-specific expertise (Cairney and Young, 2006; Hogan and Jeter, 1999), as well as global reach and reputation (US General Accounting Office, 2003).

The effect of limiting auditors' liability on audit effort is less clear. It is feared that "a limitation on auditor liabilities […] through a cap […] eventually reduces the quality of the financial statements" (London Economics, 2006, 154). This reasoning is based on the economic rationale that reducing the threat of liability also reduces the motivation of auditors to exert effort (Melumad and Thoman, 1990; Moore and Scott, 1989). Meanwhile, a limitation of auditors' liability may also be optimal if unlimited liability induces overauditing. Overauditing is present when the marginal costs of audit effort exceed the marginal value of an audit of higher quality. The Committee on Capital Markets Regulations (2006) believes that inefficiently high levels of audit effort are currently provided in the U.S. The risk of overdeterrence in the case of liability for the full damage is also predicted by economic models (Ewert, 1999; Schwartz, 1997). A

prominent reason is that auditors do not only have to bear the liability costs when being convicted, but also suffer from a loss of reputation (Nelson et al., 1988).

It is difficult, if not impossible, to obtain robust empirical results on the effects of limited versus unlimited liability from real-world data. First, liability regimes contain many variables and a wide range of strategic interactions. Second, due to the use of proxies, the studies have to deal with the prevalence of unobserved factors, a missing counterfactual, and measurement problems due to the use of proxy information. This is especially problematic for the time-series and cross-country designs used. Consequently, existing findings remain vague: In recent studies, Lee and Mande (2003) and Geiger et al. (2006) compared the effects of the enactment of a liability reform act in the U.S. in 1995 on accounting discretion and the number of going-concern opinions. They found some support that limiting liability reduces audit quality. In contrast, the study mandated by the European Commission compared characteristics of various proxies for accounting qualities in countries with limited and unlimited liability without detecting significant differences driven by the effects of liability regime. Overall, one finds that "the empirical literature on the impact of auditor liability regimes on audit quality is scant and not conclusive" (London Economics, 2006, 154).

We set up an experiment to further investigate the effects of liability size. Specifically, since auditing decisions involve both risky and ambiguous choice situations, our experiment tests for the effects of stake size on both risk aversion and ambiguity aversion, and we also investigate the correlation of both factors. While experimental research might suffer from problems of external validity, it can directly address the problems of existing empirical research. First, the liability regime can be manipulated without the confounding effects of cross-country or cross-time comparisons. Second, audit effort as defined in the experimental setting can be measured directly, without the need to rely on noisy proxies.

Participants of the experiment are confronted with risky choices that involve a real loss with a small probability, which is either given as one specific figure (e.g. 3%) or as a probability interval (e.g. 1%-5%) to test for effects of ambiguity (Di Mauro and Maffioletti, 2004). Our experimental setting captures the underlying structure of different audit decisions (client acceptance, audit effort) by framing the decision tasks in three different ways. As our experiment focuses on the fundamentals of deterrence effects in an abstract setting, we use non-professionals as subjects.

In terms of methodology, we differ from earlier experiments on risk and ambiguity aversion by introducing real losses. Real losses are a distinct feature to ensure that our setting resembles the scenario of unlimited liability. Under unlimited liability, the danger of the bankruptcy of an audit firm caused by a single claim is present, because the potential liability can be larger than the wealth of even the largest national audit firms. Similarly, the subjects in our unlimited liability treatment face the risk of a loss that is considerably larger than their base payment. In contrast, in the limited liability treatment, participants do not face the threat of real losses as the potential loss is smaller than the base payment. This follows the notion of regulators who see limited liability as a means to ensure that one single claim cannot be "catastrophic" in the sense that it can cause the bankruptcy of an audit firm (Directorate General for Internal Market and Services, 2007, Committee on CMR 2006). The European Commission suggested four different ways of limiting auditor liability: a single monetary cap, a cap depending on the size of the audited firm, a cap depending on the audit fee and the introduction of a proportionate liability.

Our study contributes to auditing research by addressing the current regulatory issue of limiting auditor liability with the methodology of experimental economics. Specifically, through investigating decision behavior in regimes of limited and unlimited liability based on experimental settings with and without the risk of real losses, we extend earlier experimental research on auditors' liability which has mainly focused on other features of liability regimes, e.g. strict vs. negligence-based liability (Dopuch and King, 1992) or joint-and-several vs. proportionate liability (Dopuch et al., 1994; Gramling et al., 1998).

Our study also contributes to the literature on decision-making under ambiguity. Camerer and Weber (1992) emphasize that research relating to the effect of stake size on ambiguity aversion as well as on the correlation between risk and ambiguity aversion is critical to discriminating between existing theories of ambiguity aversion. Earlier experiments have not offered convincing evidence on this issue yet. Our experimental design makes a distinct methodological point concerning a better understanding of behavior under ambiguity by strengthening the experimental manipulation through the introduction of real losses.

2. Hypotheses development

2.1. The setting

Following the idea of replicating the decisions faced by auditors in a very stylized setting, our experiment uses three different frames for the lottery comparison: We elicit the subjects' willingness to accept risk (*risk taking frame*), their willingness to pay to avoid risk (*risk avoidance frame*) and the willingness to pay for the reduction of ambiguity (*ambiguity avoidance frame*). In the risk taking frame, subjects choose between either taking on no risk and receiving no additional compensation, or taking on a small risk of a loss and receiving compensation. This represents the auditors' decision to take on a client. In the risk avoidance frame, subjects choose between a small risk of a loss, or avoiding this risk of a loss by paying a certain amount. This represents the auditors' decision to avoid risk by performing additional costly audit procedures. In the ambiguity avoidance frame, subjects choose between an unambiguous risk of loss connected either with additional payments or additional compensation, and an ambiguous risk of loss. This represents the auditors' decision to avoid ambiguity by performing additional costly audit procedures.

2.2. Measuring risk and ambiguity aversion

The first behavioral variable that we consider in this study is relative risk aversion. In the risk taking frame, we calculate relative risk aversion by dividing the amount for which the subject is willing to accept the risk of liability by the expected liability costs. Equivalently, in the risk avoidance frame, the amount which the subject is willing to pay to avoid risk is divided by the expected liability costs.

Risk taking frame:

$$relative\ risk\ aversion = \frac{willingness\ to\ accept\ to\ take\ on\ risk\ of\ liability}{expected\ liability}$$

Risk avoidance frame:

$$relative\ risk\ aversion = \frac{willingness\ to\ pay\ to\ avoid\ risk\ of\ liability}{expected\ liability}$$

We use the ambiguity avoidance frame in order to elicit subjects' degree of ambiguity aversion. As a measure for absolute ambiguity aversion, the willingness of the subjects to pay in order to face a risk with an unambiguous, certain probability (3%, resp. 9%) instead of an ambiguous, uncertain probability (1% to 5%, resp. 7% to 11%) is used. In our experiment, absolute ambiguity aversion could also become a negative number when subjects were willing to pay for being exposed to an ambiguous risk instead of an unambiguous risk. We also calculate relative ambiguity aversion by dividing absolute ambiguity aversion by the expected liability costs.

Ambiguity avoidance frame:

absolute ambiguity aversion = willingness to pay for replacing an ambiguous risk with an unambiguous risk

$$\textit{relative ambiguity aversion} = \frac{\textit{absolute ambiguity aversion}}{\textit{expected liability}}$$

2.3. Effects of liability size on risk aversion

The diminishing utility of payoffs with wealth suggests that risk aversion should increase with stake size (Machina, 1982; Rabin, 2000). Support for this hypothesis is provided by Binswanger (1980) and Kachelmeier and Shehata (1992) who conducted large stake experiments in developing countries. Experiments with students by Bosch-Demènech and Silvestre (1999, 2006) come to the same conclusion. Recently, Holt and Laury (2002) have provided an important methodological twist to the related literature by demonstrating that it makes a difference whether choices over risky gains are hypothetical or for real money. Finally, Fehr-Duda et al. (2007) have taken up on the issue of stake-dependence based on experiments in China, confirm the findings on gains, and report that average behavior under pure loss gambles is not sensitive to stake size; in these experiments, subjects were endowed with a cash amount which served to cover their potential losses.

Our study on the effects of liability size on risk aversion extends previous studies by introducing real losses: In the unlimited liability treatments, participants are presented with mixed gambles that involve the risk of making losses that are not covered by the cash endowment.

What effect on risk aversion can we accept when increasing liability size? According to Rothschild and Stiglitz (1970), strong risk aversion holds if and only if an individual always dislikes mean-preserving spreads in risk. Consequently, and in line with the evidence provided at the beginning of this section, we infer from expected utility theory that our measure for relative risk aversion should increase with an increase in stake size.

An increase in risk aversion with stake size can also be derived from the concept of loss aversion. Loss aversion is one of the most prominent and widely confirmed violations of expected utility theory and plays a central role in Kahneman and Tversky's (1979) descriptive theory of decision-making under risk. Loss aversion captures the phenomenon that people use salient reference points and it refers to the tendency of people to be more sensitive to reductions in their current level of well-being than to increases. Relying on one specific functional representation of loss aversion for deriving conclusions on stake size effects would open the door to a range of different operational definitions of loss aversion as well as discussions about the fit and parsimony of the specification (Köbberling and Wakker, 2005). Therefore, we use here – as in the case of the definition of risk aversion – a generic behavioral description of loss aversion (Schmidt and Traub, 2002):

> *Let x and y be lottery outcomes and u(·) a strictly increasing and continuous utility function. A decision-maker is loss averse if and only if for all* $x > y \geq 0$ *it holds that* $u(x) - u(y) < u(-y) - u(-x)$.

Under the assumption of loss averse decision-makers[1], it follows immediately that our measure for relative risk aversion would be higher in the unlimited liability treatment than in the limited liability treatment. The reason is that the limited liability treatment involves only gambles in the gain domain, while the unlimited liability treatment includes mixed gambles.

[1] Many empirical studies have found strong evidence of loss aversion Barberis, N., Huang, M., Santos, T., 2001. Prospect theory and asset prices. Quarterly Journal of Economics 116, 1-53, Tversky, A., Kahneman, D., 1991. Loss aversion in riskless choice: A reference-dependent model. Quarterly Journal of Economics 106, 1039-1061.. Loss aversion can also explain a variety of field data, such as the equity premium puzzle Benartzi, S., Thaler, R., 1995. Myopic loss aversion and the equity premium puzzle. Quarterly Journal of Economics 110, 73-92. and many others Camerer, C., 2000. Prospect theory in the wild: Evidence from the field, in: D. Kahneman and A. Tversky, eds., Choices, values and frames (Cambridge University Press, New York) 288-300..

While these derivations relied on a combination of theoretical and empirical results from economics, they connect well to findings in behavioral psychology. There, it is well known, that fear effects deriving from higher stake sizes suggest higher risk aversion (Loewenstein et al., 2001; Slovic et al., 2004) as well higher loss aversion (Camerer 2005). We conclude this section with our first hypothesis:

H1: Relative risk aversion increases with higher liability size

An increase of relative risk aversion with higher liability size would imply that the size of the liability has a stronger effect than predicted by economic models of auditor liability that assume risk neutrality (e.g. Narayanan 1994; Schwartz 1997; Chan et al. 1998). That is, it would imply that auditors facing unlimited liability might be overdeterred.

2.4. Effects of liability size on ambiguity aversion

Ellsberg (1961) demonstrated in a famous thought experiment that people tend to be ambiguity averse. Ambiguity can be defined as uncertainty about probability (Camerer and Weber, 1992). Ambiguity aversion is present when a lottery with a certain probability of a gain or a loss (e.g. 10%) is preferred over the same lottery with an uncertain probability (e.g. between 5% and 15%). While ambiguity aversion characterizes the tendency to prefer certain probabilities over uncertain probabilities in choices between uncertain outcomes, risk aversion characterizes the tendency to prefer certain outcomes over uncertain outcomes. Consequently, in the example above, risk aversion alone would not explain the preference for the lottery with certain probabilities over the one with uncertain probabilities,

Experiments that tested the Ellsberg hypothesis confirmed the general robustness of ambiguity aversion, but also discovered some mitigating factors (Camerer and Weber, 1992; Keren and Gerritsen, 1999). Three of these mitigating factors are especially relevant for our setting.

First, it turned out that in the gain domain, ambiguity aversion is less pronounced for small probabilities and more pronounced for high probabilities (Einhorn and Hogarth, 1986). Inversely, in the loss domain, ambiguity aversion is smaller for high probabilities and larger for small

probabilities (Di Mauro and Maffioletti, 2004; Hogarth and Kunreuther, 1989; Kahn and Sarin, 1988).

Second, Fox and Tversky (Fox and Tversky, , 585) suggest that "ambiguity aversion is produced by a comparison with less ambiguous events" (see also Fox and Weber, 2002). Consistent with their comparative ignorance hypothesis, subjects were only ambiguity averse in tasks that involve direct comparisons between events of different degrees of ambiguity. Chow and Sarin (2001) showed that while ambiguity aversion is more pronounced in direct comparison tasks, it can also be detected in non-direct comparison tasks.

Third, Camerer and Weber (1992) speculate that ambiguity aversion might be affected by the payoff size. In their review paper, they describe two studies that did not find an effect, even though stake size was varied by as much as 20 times as in Goldsmith and Salin (1983) or as much as 200 times as in an unpublished paper by Camerer and Low (cited in Camerer et al. 1992, note 16). They also refer to a study by Hogarth and Einhorn (1990) that finds some evidence that ambiguity aversion is stronger for larger payoffs, which Camerer and Weber (1992, 340) consider to be "weak evidence that ambiguity aversion increases with outcome size." Overall, Camerer and Weber (1992, 340) conclude that it is "(a)n apparent finding […] that the degree of observed ambiguity aversion is roughly independent of the consequences of the bet". However, they emphasize repeatedly the importance – both from a theoretical and practical perspective – of investigating the outcome dependency of observed ambiguity aversion. For example, the finding that payoff size affects ambiguity aversion would weaken the validity of outcome independent theories of ambiguity aversion.

Following the theories that view ambiguity aversion as being dependent on stake size (Hazen, 1987; Hogarth and Einhorn, 1990; Sarin and Winkler, 1992), we put up the following hypothesis:

H2: Ambiguity aversion increases with liability size

This hypothesis is directly connected to arguments raised in the auditing literature: For example, one can infer that the Committee on Capital Market Regulations (Committee on Capital Markets Regulation) implicitly assumes that ambiguity aversion is especially high in settings with a high liability. They state that overauditing might be "motivated by the auditors' fear of

liability, especially given their new obligations under Section 404 of the Sarbanes-Oxley Act" (p. 86), and characterize these new obligations as being of high "vagueness", referring to the ambiguity of the task (p. 127).

2.5. Correlation of ambiguity aversion and risk aversion

Cogent evidence for a correlation between risk aversion and ambiguity aversion has not been shown yet. Curley, Yates and Abrams (1986) found minimal support for a modest correlation between risk aversion and ambiguity avoidance, while Hogarth and Einhorn (1990) found no such effects. These mixed results of prior research were questioned by Camerer and Weber (1992) on grounds of measurement errors due to "the failure to induce or establish a sharp equivalence between unambiguous and ambiguous probabilities". Overall, they state that "the correlation between risk attitudes and ambiguity attitudes appears to be low" (p. 341). They call for further research on this question, in order to evaluate the validity of theories assuming such a link by integrating ambiguity aversion in utility models (Hazen, 1987; Sarin and Winkler, 1992).

Recent literature suggests that the concepts of risk or loss aversion and ambiguity aversion are connected, as both phenomena are linked to fear effects. With respect to ambiguity aversion, Viscusi and Chesson (1999, 153) conclude that "people exhibit 'fear' effects of ambiguity for small probabilities" in the loss domain. Similarly, Camerer (2005, 132) links loss aversion to fear stating that his "intuition is that loss aversion is often an exaggerated emotional reaction of fear".

Our hypotheses follow theories that predict a correlation between risk aversion and ambiguity aversion. Since feelings of fear or anxiety increase with stake size (Inder and O'Brien, 2003), we separate our hypothesis by liability treatment:

H3a: Risk aversion is correlated with ambiguity aversion in the limited liability treatment.

H3b: Risk aversion is correlated with ambiguity aversion in the unlimited liability treatment.

A particularly high correlation between risk and ambiguity aversion would suggest that some auditors might be especially overdeterred. These auditors might consider leaving the profession when facing unlimited liability (London Economics, 2006, 176). Those auditors who remain in the profession might have difficulty conducting audits properly due to fear of liability. Interestingly, this concern was already brought forth by the German legislator when auditor liability was introduced in 1931 (Gietzmann and Quick, 1998; Schmölder, 1930).

3. Experimental design

3.1. Experimental procedure and payoffs

Our experiment reconstructs a setting consisting of auditors who face a small risk of liability, and our goal is to investigate their decision behavior under limited and unlimited liability. Conceptually, we rely on an established instrument for risk elicitation, the so called price list mechanism (Holt and Laury, 2002), which involves comparisons between lotteries and sure payoffs. This task involves a number of choices between paired lotteries as described in Appendix 1. Depending on the treatment, these lotteries might involve a small risk of a real loss. The relative attractiveness of the lotteries on the price list is manipulated by systematically varying the amount of additional costs or compensation for only one of the lotteries over the rows of the list.We use a 3% and a 9% risk level to resemble the litigation risk which the auditor faces in an audit; these risk levels are in reasonable bounds for our specific purpose.[2]

As we have already outlined, in order to replicate the decisions faced by auditors in a very stylized setting our design uses three different frames for the lottery comparison: We elicit the subjects' willingness to accept risk (risk taking frame, 4 periods), their willingness to pay to avoid risk (risk avoidance frame, 4 periods) and the willingness to pay for the reduction of ambiguity (ambiguity avoidance frame, 2 periods). To exclude order effects, the order of the

[2] A rough estimate provides a 2% litigation risk for each audit. This number can be derived when dividing the average number of 300 litigation filings each year in the U.S. by the 15,000 SEC registered companies Talley, E. L., 2006. Cataclysmic liability risk among big 4 auditors. Columbia Law Review 106, 1641-1697.. These risk levels are also in line with Talley's (2006)Talley, E. L., 2006. Cataclysmic liability risk among big 4 auditors. Columbia Law Review 106, 1641-1697. estimates for a catastrophic claim against a Big 4 audit firm over a one to five year time horizon. Note also that the 3% probability level is regularly used in experimental studies as the lowest probability level Di Mauro, C., Maffioletti, A., 1996. An experimental investigation of the impact of ambiguity on the valuation of self-insurance and self-protection. Journal of Risk & Uncertainty 13, 53-71, Di Mauro, C., Maffioletti, A., 2004. Attitudes to risk and attitudes to uncertainty: Experimental evidence. Applied Economics 36, 357-372..

three different frames was randomly varied across the different sessions in a latin-square design, while the order of the different tasks within each frame was randomized for each subject.

We ensured that the subjects understood the experimental setting by providing extensive instructions with examples, administering and checking control questions, and having five trial periods before the incentivized rounds. Subjects rated the experiment to be simple (mean = 5.25, SD = 1.50) on a scale from 1 (difficult) to 7 (easy), and claimed to have understood the experiment very well (mean = 6.62, SD = 0.75, on a scale from 1 to 7).

Payoffs were determined by drawing numbered balls from urns. For each participant, we randomly selected one row of one randomly drawn period and then played the selected lottery at the end of the experiment. Additionally, each participant received a base compensation of 12.00 Euro (15.60 $).

The study was conducted in December 2006 in the experimental laboratory of the University in Mannheim, Germany. In 7 sessions, each of which lasted between 50 and 60 minutes, a total of 101 subjects participated in the study. All subjects were recruited from the general student population. The experiment was computerized using zTree (Fischbacher 1999), and involved 4 sessions with an unlimited liability treatment and 3 limited liability treatments. The payouts ranged from -8.00 Euro (-10.40 $) to 21.00 Euro (27.30 $), and the average payoff was 12.18 Euro (15.80 $).

3.2. Between-subject manipulation: liability size

Our main manipulation is the size of the potential loss. We multiply the potential loss of 4.00 Euro (5.20 $) for the limited liability treatment fivefold to create the unlimited liability treatment with a potential loss of 20.00 Euro (26.00 $). These stake sizes and a base compensation of 12.00 Euro (15.60 $) ensure that total payments are still positive in the setting of limited liability, but negative in the setting of unlimited liability. While subjects still receive a positive payment of about 8.00 € (10.40 $) in the case of a loss in the setting of limited liability, they have to pay about 8.00 € (10.40 $) in the case of a loss in the setting of unlimited liability.[3]

There are two main reasons for choosing this manipulation. First, and most importantly, we believe that this manipulation effectively captures a major characteristic of limited versus

[3] The positive and negative 8.00 € payment are average values and can differ due to the minor additional compensations and costs used to elicit the difference in the valuation of the two lotteries.

unlimited liability. According to the first criterion for evaluating the different potential models about limiting auditor liability (London Economics 2006) limiting liability shall lower the liability risk to such an amount that audit firms can bear through the buffer provided by the network captive, commercial insurers and funds from partners' income (p. xxi). These criteria are also cited by the E.U. (Directorate General for Internal Market and Services, 2007) and by the Committee on Capital Market Regulation (2006) in the U.S.

Second, we think that exposing subjects to the risk of a real loss exerts a much stronger behavioral impact than merely enlarging the stake size and is in itself a methodological innovation in the field of experimental and behavioral economics. In accordance with standard procedures of the laboratory, all participants were informed about the expected average payoff and the duration of the experiment when signing in over the internet. Upon entering the experimental laboratory, they were informed about the risk of a real loss and were asked to give their written consent that they would be willing to make a payment in case of a negative payoff. We also pointed out that they are free to choose whether to participate in the experiment or not. All of them chose to participate.[4]

3.3. Within-subject manipulation: ambiguity

Auditors are regularly confronted with ambiguity (Zebda 1991), since their responsibilities are ambiguously defined. For example, the vagueness of the materiality definition established by SOX 404 in the audit of internal controls has recently been criticized by the Committee on Capital Market Regulations (2006, 115-117). The U.S. Chamber of Commerce (2006, 14) states that the auditing standard on internal controls "doesn't provide much guidance as to when 'enough is enough'. Further areas of ambiguity are, for example, risk assessment and audit planning (Guess et al., 2000), the judgment of the probability of contingent events (Hackenbrack and Nelson, 1996; Nelson and Kinney Jr, 1997), and materiality judgments (Messier et al., 2005). Ambiguity is also present in the strategic interaction between the auditor and the auditee (Zimbelman and Waller, 1999).

[4] One participant had not enough money with her to cover the potential loss. We told her privately before the experiment started that she could choose to either participate in the regular experiment by promising to deposit a pledge in the case of a loss or to participate for a lower, but fixed amount of payoff. She decided to participate in the regular experiment.

Therefore, the second important variable manipulated in our experiment is ambiguity. We use an interval of probability representation to construct ambiguous probabilities (Di Mauro and Maffioletti, 2004), such that the ambiguous probability interval corresponding to the probability of 3% is the interval from 1% to 5%, and for the probability of 9%, the corresponding interval is from 7% to 11%. Subjects were told that in the case of ambiguous probabilities, the specific probability would be determined by drawing a ball from an urn that contained balls with integer numbers spanning the interval of probabilities.[5]

In our experiment, subjects compare ambiguous and unambiguous probabilities both directly and indirectly. Following Fox and Tversky (1995) we focus on the direct comparison tasks of the ambiguity avoidance frame. In this frame, subjects compare a lottery with a 3% risk to a lottery with a 1% to 5% risk, and a lottery with a 9% risk to a lottery with a 7% to 11% risk. We also manipulate the ambiguity of the tasks within-subject in the risk taking and the risk avoidance frame. We do so in order to establish the robustness of our results over various settings.

3.4. Statistical method

Each of the 101 subjects was exposed to 10 different decision tasks (4 for the risk taking task, 4 for the risk avoidance tasks and 2 for the ambiguity avoidance frame), from which we can derive 1010 different decision parameters. In line with other experimental work, we aggregate observations on a subject level. For example, when reporting the observations for the risk taking task, we calculate for each subject the arithmetic mean of the 4 observations in this frame. In 24 out of the 1010 decision tasks subjects behaved inconsistently within the task; these observations were deleted from the sample. In all cases, individual decision parameters were calculated from the remaining observations on that task.[6]

[5] For example, the urn contained five balls numbered from 1 to 5 when the interval ranged from 1% to 5%. If the ball with the number 2 was drawn, the subjects would face a 2% risk of liability. This method is well-suited to establish equivalence between ambiguous and unambiguous probabilities (e.g. Camerer and Weber 1992, 339 seq.)Camerer, C., Weber, M., 1992. Recent developments in modeling preferences: Uncertainty and ambiguity. Journal of Risk & Uncertainty 5, 325-370..

[6] This rate is somewhat lower than the inconsistency rate found in Holt and Laury (2002). All presented results of this paper do not change, if we eliminate all decisions of subjects that behave inconsistently from the analysis, or if we include the inconsistent decisions in the analysis.

4. Results

Our data underline the importance of stake size, and emphasize the behavioral effects of unlimited liability: We find that risk aversion and ambiguity aversion are higher as soon as stakes increase. Similarly, we find significant stake effects when we analyze the correlation between risk and ambiguity aversion. These findings suggest that auditors are overdeterred in a setting of unlimited liability. With our data, we can also confirm various existing findings from research on individual decision behavior, e.g. probability weighting or framing.[7]

4.1. Higher relative risk aversion with higher liability size

We hypothesized that the relative risk aversion will increase with liability size (H1). Overall, we find that subjects display a high degree of relative risk aversion (mean = 4.55, SD = 2.95). Focusing at the treatment effects, our data confirm indeed that relative risk aversion is larger in the unlimited liability treatment than in the limited liability treatment (4.82 vs. 4.26). In absolute numbers, the average willingness to pay to avoid a 3% risk of a 4.00 € loss is 0.51 €, while the willingness to avoid a 3% risk of a 20.00 € loss is 2.89 €. This means that the multiplication of liability size by 5.00 induced a multiplication of the willingness to pay by 5.66.

While the differences in relative risk aversion between the setting of limited and unlimited liability are not statistically significant on an aggregate level, this finding is robust, since it holds in all considered cases, as figure 1 shows: In the risk taking frame (5.34 for unlimited liability vs. 4.67 for limited liability), in the risk avoidance frame (4.29 vs. 3.88), for the 3% (5.34 vs. 4.96) and the 9% risk level (4.29 vs. 3.60), as well as for ambiguous (5.04 vs. 4.41) and unambiguous probabilities (4.41 vs. 3.60).

--- Insert figure 1 here ---

[7] E.g., we find evidence for probability weighting, as relative risk aversion is higher for the 3% compared to the 9% level Abdellaoui, M., Vossmann, F., Weber, M., 2005. Choice-based elicitation and decomposition of decision weights for gains and losses under uncertainty. Management Science 51, 1384-1399, Prelec, D., 1998. The probability weighting function. Econometrica 66, 497-527.. Similarly, we find evidence for the presence of framing effects, since relative risk aversion is higher in the risk avoidance frame compared to the risk taking frame Kahneman, D., Knetsch, J. L., Thaler, R. H., 1990. Experimental tests of the endowment effect and the coase theorem. Journal of Political Economy 98, 1325-1348..

In another robustness check that follows the example of Holt and Laury (2002), we plot the proportion of participants choosing the safe choice for each cost level. We find that the proportion of participants choosing the safe choice is lower in the setting of unlimited liability for almost all cost levels.

--- Insert figure 2 here ---

Overall, our findings indicate that inherent features of the audit environment make it likely that auditors are highly risk averse. The overproportional increase in risk aversion with liability size suggests that auditors facing unlimited liability might be overdeterred. This is all the more the case since our results can be considered only a lower bound to the true deterrence effect.[8]

4.2. Higher ambiguity aversion with higher liability size

We strongly confirm our second hypothesis that ambiguity aversion increases with stake size (H2). While subjects in the ambiguity avoidance frame are willing to pay on average 0.42 € to avoid ambiguity under unlimited liability, they are rather ambiguity neutral for this task under limited liability (-0.05 €). This difference in absolute ambiguity aversion is significant ($p = 0.042$). It is still significant when considering only the 3% risk level ($p = 0.030$), and marginally significant when considering only the 9% risk level ($p = 0.068$).

When adjusting absolute ambiguity aversion for the size of expected liability, the results become even stronger. Subjects in the unlimited liability treatment are willing to pay 0.41 € to avoid ambiguity for each 1.00 € of expected liability, while subjects in the limited liability setting even show some degree of ambiguity seeking and demand 0.20 € in order to avoid ambiguity. This difference in relative ambiguity aversion is highly significant ($p = 0.006$) overall, and it remains highly significant, if we disaggregate the findings by risk levels (3% risk level: $p = 0.011$; 9% risk level: $p=0.013$).

[8] Upon entering the laboratory, subjects had to sign a consent form in which they stated that they would pay in the event of a loss, i.e. w e communicated very clearly at the beginning of the experiment that the potential amount that subjects had to pay in the setting of unlimited liability would be enforced. Assuming that some participants still believed that the payment would not be fully enforced would further strengthen our conclusion that risk aversion increases overproportionally with stake size. In that sense, our results constitute only a lower bound on the increase of risk aversion due to the increase in stakes.

--- Insert table 1 here ---

--- Insert figure 3 here ---

In addition to a comparison of population averages, we utilize a type-classification approach. Type-classification has proven to be a powerful procedure for discerning economic relationships that might not be apparent in pooled analyses (e.g. Houser et al., 2004). We therefore classify the subjects in our experiment into ambiguity seeking, ambiguity neutral and ambiguity averse types. We find that only 4 subjects are ambiguity averse in the limited liability setting, while 15 subjects are ambiguity averse in the unlimited liability setting. The difference of the distribution of the ambiguity types in the two liability settings is statistically significant in a chi-square test ($p = 0.041$).

--- Insert figure 4 here ---

Our results suggest that unlimited liability might induce costly overauditing when the task is ambiguous. The evidence that ambiguity aversion increases with liability size supports the statement of the Committee on Capital Markets Regulation (Committee on Capital Markets Regulation, , p. 86) that overauditing might occur in the vaguely defined task of internal control audits.

4.3. Correlation of risk aversion and ambiguity aversion for high liability size

Following a regularly debated question in ambiguity research, we hypothesized that risk aversion and ambiguity aversion are positively correlated (H3a & H3b).

Contrary to our hypothesis (H3a), but consistent with existing research, we cannot find evidence for a positive correlation between risk aversion and ambiguity aversion in the setting of limited liability (Spearman's $\rho = 0.010$, $p = 0.948$).

However, in line with (H3b), we confirm a positive correlation for the unlimited liability setting (Spearman's $\rho = 0.366$, $p = 0.008$).

These findings constitute evidence that the concepts of risk aversion and ambiguity aversion are indeed correlated as soon as stakes or high enough, or – to be more precise – as soon as real losses are involved. We speculate that earlier research failed to show this link, because the manipulation of stake sizes was too weak as it only happened in the gain domain. Our finding is also in line with research that emphasizes the behavioral importance of salient losses (Camerer, 2005; Rabin, 2000), and it applies existing findings regarding the impact of losses on behavior under risk to behavior under ambiguity.

--- Insert table 2 here ---

--- Insert figure 5 here ---

The observed correlation between risk aversion and ambiguity aversion underlines the possibility that some auditors might be especially overdeterred by unlimited liability. These auditors might consider leaving the profession when facing unlimited liability, a fear expressed in the study commissioned by the European Union (London Economics, 2006, 176).

5. Conclusions

In both the E.U. and U.S., the concern has been expressed that a potential failure of one of the Big 4 audit firms might cause severe market disruptions. While limited liability is currently considered to be one potential means of ensuring the viability of the market, it is feared that it comes along with a lower motivation of auditors to exert high effort.

In order to address several issues of existing empirical research on this topic, we use a controlled laboratory experiment to test for the deterrence effects of limited and unlimited liability. In our context, limited liability describes the scenario in which the potential loss can be covered by the base payment, capturing the fact that limited liability prevents the risk that an audit firm will be forced by a single catastrophic claim to declare bankruptcy. In contrast, this risk of bankruptcy is present under unlimited liability, which we capture in our experiment by introducing the risk of making real financial losses.

Our main results are that ambiguity aversion is higher under unlimited liability, and that ambiguity aversion and risk aversion are correlated under unlimited liability. These effects occur

only in treatments that involve the possibility to make real financial losses. Earlier experiments have not detected these effects; we believe that the reason is that in contrast to our experimental design, their manipulation of stake size happened only in the gain domain and was, therefore, much weaker than ours. While the introduction of real loss payoffs into risky and ambiguous decision situations is a methodological innovation in experimental economics in itself, the obtained results are also of substantial interest from the viewpoint of behavioral economics: They contribute to ongoing discussions – initially started in the review of Camerer and Weber (1992) – about the relationship between ambiguity, risk aversion, and stake size effects, and have implications for the development of theory that captures these key ingredients of human decision behavior.

Finally, our results have implications for the current debate about limiting auditor liability. Our experiment provides new evidence why unlimited liability might induce overdeterrence. First, under unlimited liability, auditors might show a high degree of risk aversion, since risk aversion increases with stake size. Second, auditors in this setting might show a high degree of ambiguity aversion, since ambiguity aversion also increases with stake size. Third, some auditors might be deterred in a particularly strong way and might consider leaving the profession as risk aversion and ambiguity aversion coincide under unlimited liability. Overall, we find striking evidence that under unlimited liability, the effects of fear from risk and ambiguity causes decision behavior to deviate considerably stronger from risk-neutral optimal decision behavior than under limited liability. This provides first empirical support for the rationale that unlimited liability makes it difficult for auditors to perform their duties properly which was expressed by the German legislator already in the 1930s.

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Table 1
Ambiguity aversion by liability level
(ambiguity avoidance frame)

absolute ambiguity aversion = willingness to pay for replacing an ambiguous risk with an unambiguous risk

$$\textit{relative ambiguity aversion} = \frac{\textit{absolute ambiguity aversion}}{\textit{expected liability}}$$

		Limited Liability		**Unlimited Liability**				
		Mean	SD	Mean	SD	Diff (Means)	p-value	
Absolute Ambiguity Aversion	Overall	-5.06	(16.99)	42.13	(176.93)	47.19	0.042	**
	3%	-2.17	(7.97)	32.50	(109.47)	34.67	0.030	**
	9%	-8.21	(22.88)	51.75	(226.00)	59.96	0.068	*
Relative Ambiguity Aversion	Overall	-0.20	(0.65)	0.41	(1.56)	0.61	0.006	***
	3%	-0.18	(0.66)	0.54	(1.82)	0.72	0.011	**
	9%	-0.23	(0.64)	0.29	(1.26)	0.52	0.013	**

Table 2

Correlation between risk aversion and ambiguity aversion on a subject level

		Correlation	Spearman's ρ	p-value	
Limited Liability	Overall	-0.200	0.010	0.948	
	3%	0.075	0.133	0.383	
	9%	-0.248	-0.042	0.790	
Unlimited Liability	Overall	0.405	0.366	0.008	***
	3%	0.311	0.299	0.035	**
	9%	0.355	0.473	0.001	***

Figure 1

Relative risk aversion by liability level over different treatments (risk taking and risk avoidance frame)

Risk taking frame:

$$relative\ risk\ aversion = \frac{willingness\ to\ accept\ to\ take\ on\ risk\ of\ liability}{expected\ liability}$$

Risk avoidance frame:

$$relative\ risk\ aversion = \frac{willingness\ to\ pay\ to\ avoid\ risk\ of\ liability}{expected\ liability}$$

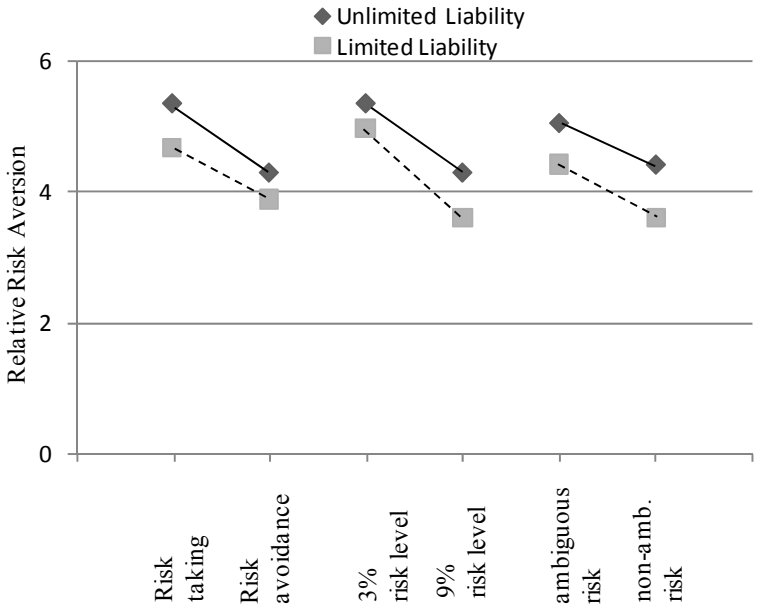


Figure 2

Proportion of safe choices by cost level
(risk taking and risk avoidance frame)

As described in the method section, we use a price list mechanism to elicit risk aversion. Choices in which subjects choose to avoid the risk are safe choices. A higher proportion of safe choices indicates higher relative risk aversion.

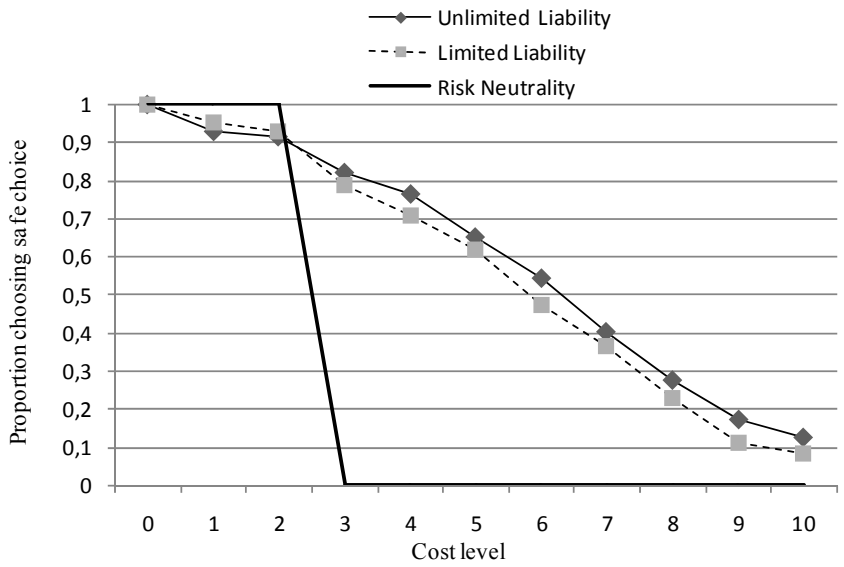


Figure 3
Absolute ambiguity aversion by liability level
(ambiguity avoidance task)

The descriptive statistics and test statistics for this figure are reported in table 1.

absolute ambiguity aversion = willingness to pay for replacing an ambiguous risk with an unambiguous risk

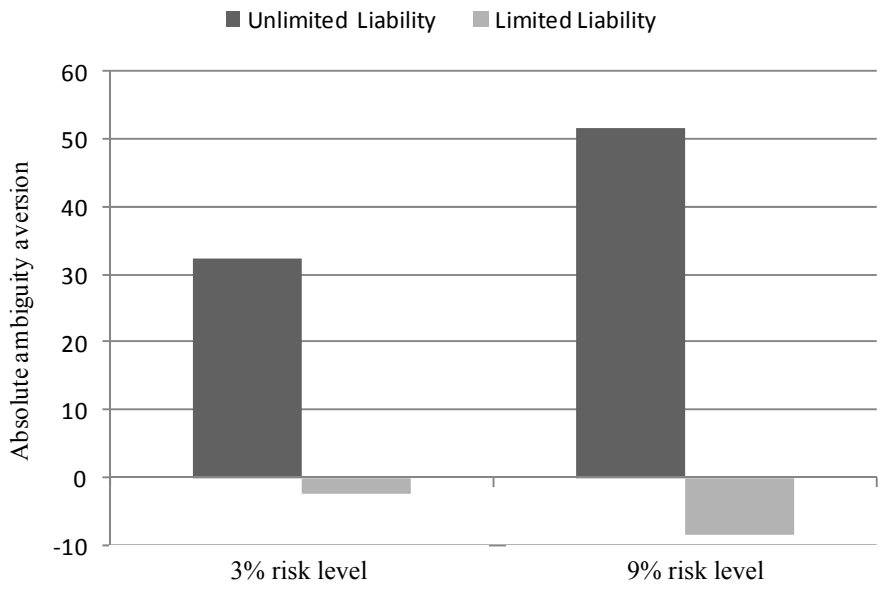
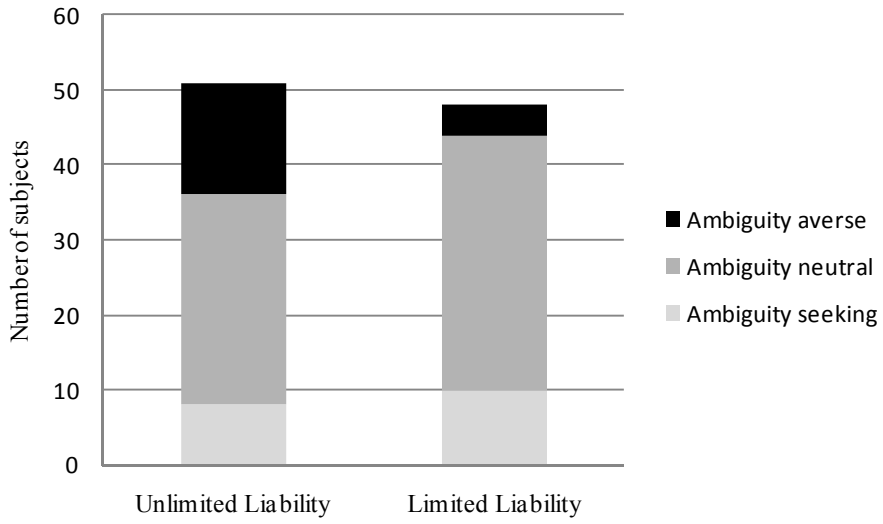


Figure 4
Ambiguity type by liability level
(ambiguity avoidance frame)

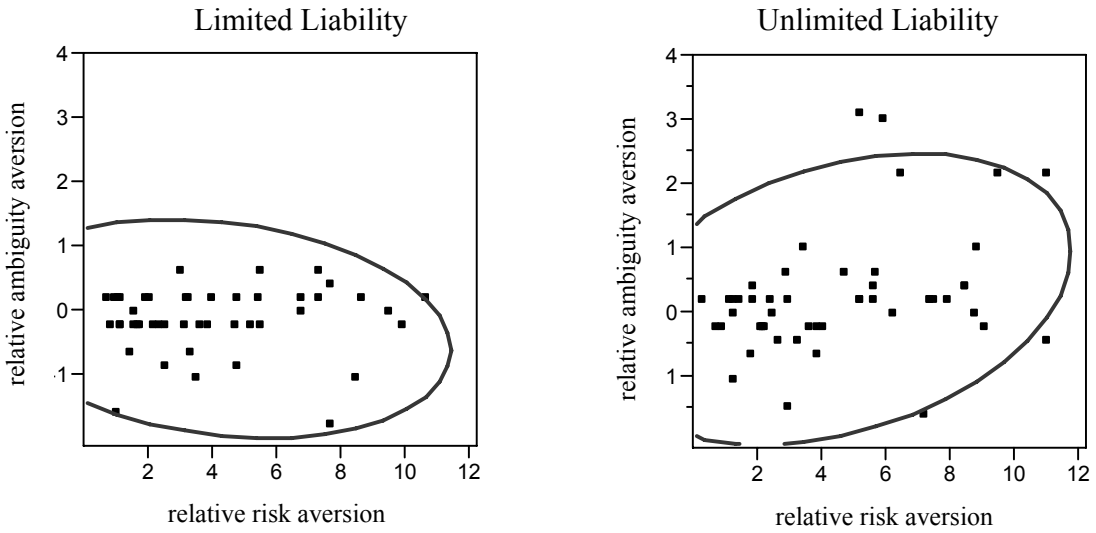
As described in the method section, we use a price list mechanism for eliciting ambiguity aversion. Subjects are classified as ambiguity neutral when they make five or six unambiguous choices. They are classified as ambiguity averse when they make seven or more unambiguous choices and are classified as ambiguity seeking when they make four or less unambiguous choices.



p(chi-square) = 0.041

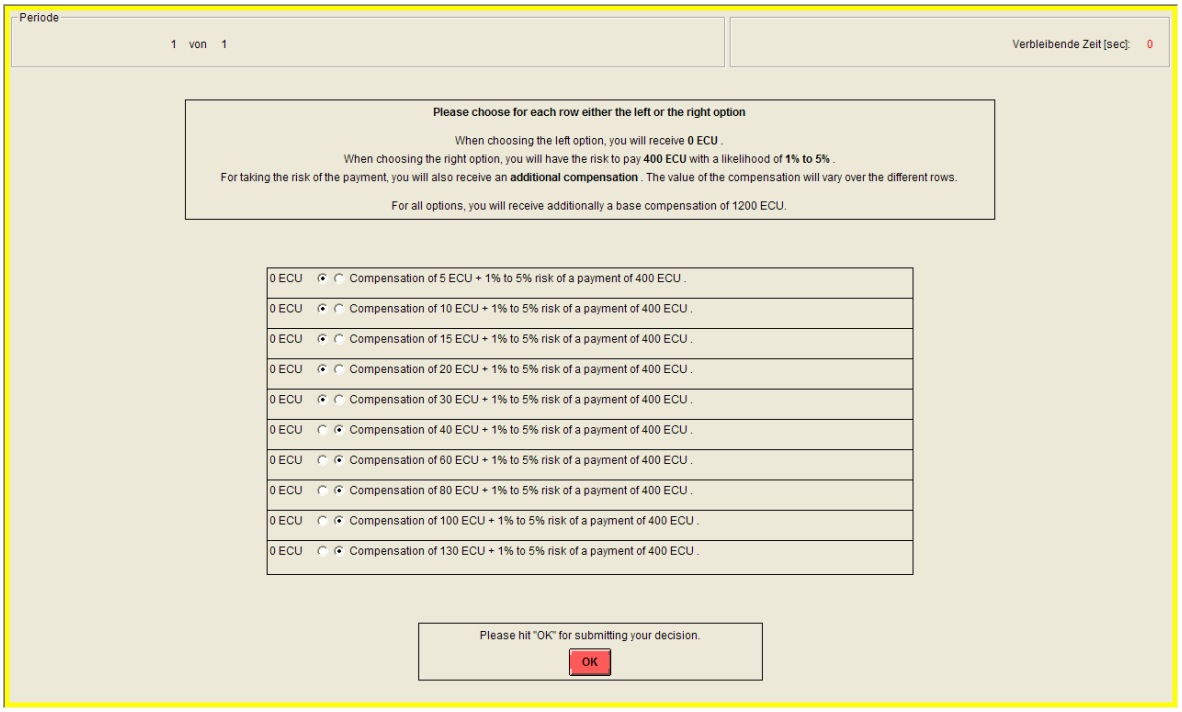
Figure 5
Correlation between risk aversion and ambiguity aversion on a subject level

In the figure, we plot the 90% density ellipse which indicates the positive correlation between relative risk aversion and relative ambiguity aversion in the unlimited liability setting.
The descriptive statistics and test statistics for this figure are reported in table 2.

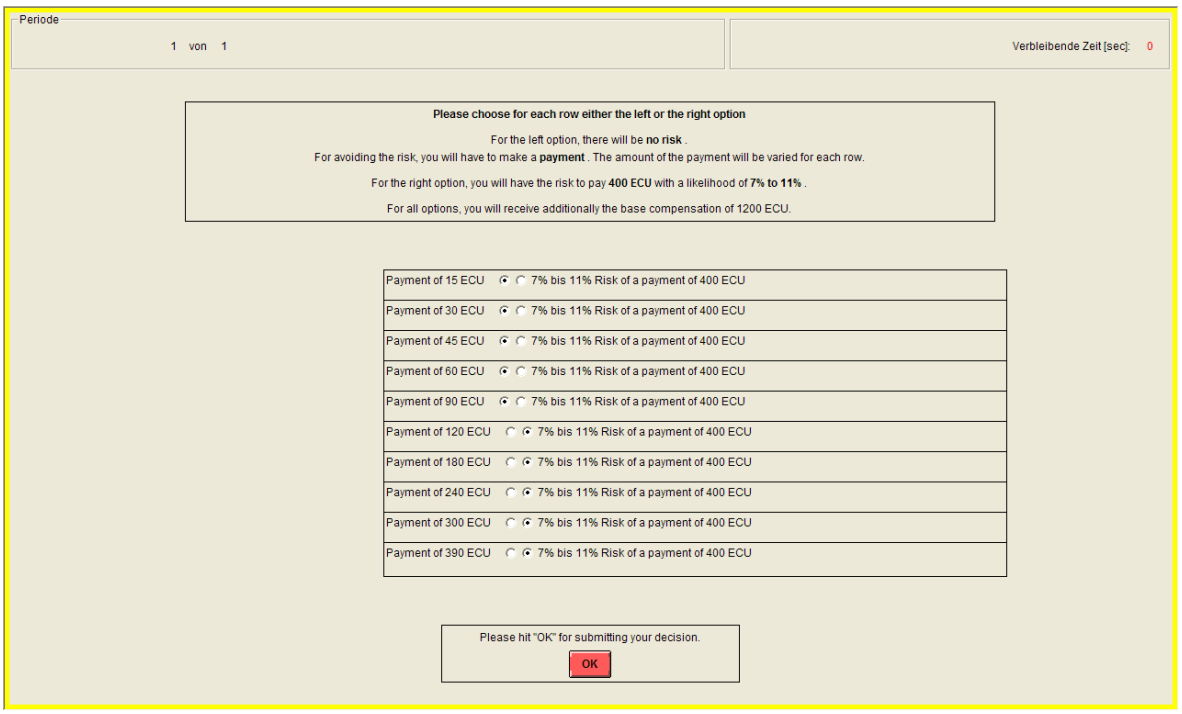


Appendix: Research Instrument

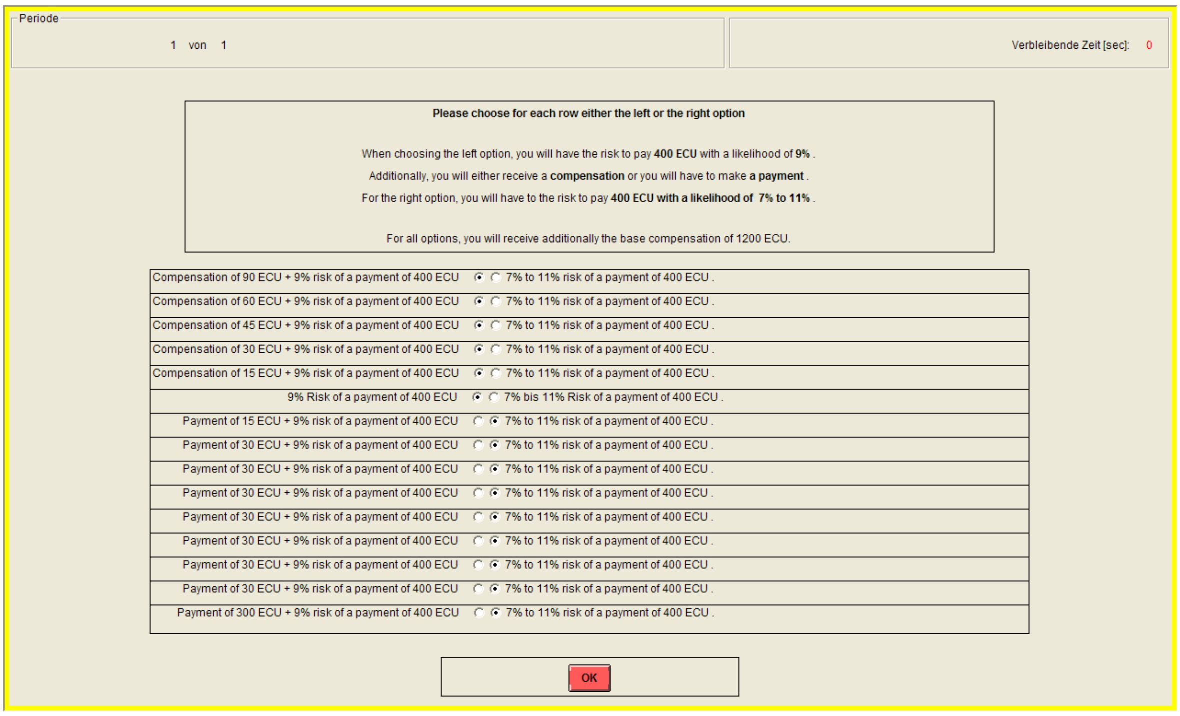
Screen Shot 1: Risk taking frame



Screen Shot 2: Risk avoidance frame



Screen Shot 3: Ambiguity avoidance frame



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