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Investment Behavior and the Biased Perception of Limited Loss Deduction in Income Taxation[*]

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Abstract

We use a laboratory experiment to study the extent to which investors' choices are affected by limited loss deduction in income taxation. We first compare investment behavior in the no tax baseline to a tax control setting, in which the income from investments is taxed. We find that investors significantly reduce their risk-taking as predicted by theory. Next we compare the baseline investment choices to choices under three different types of income taxation. We observe that risk-taking is significantly increased with partial and with capped loss deduction, but is unaffected by a tax system that allows no loss deduction. Since in all these treatments the after tax outcomes of the prospects were identical, we conjecture that investors have a positively biased perception of partial and capped loss deduction that promotes their willingness to take risks.

Keywords

risk-taking behavior, distorting taxation, tax perception

JEL-Classification

C91, D14, H24

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1 Introduction

Income taxation affects investments in obvious ways. Gains from the investment are generally reduced by the tax, while losses are either unaffected, partially, or fully deductable, depending on the tax scheme.[1] Income taxation, however, may also affect investment behavior in a more subtle, psychological way, if investors' perceptions of the financial consequences of taxation are biased. While a number of tax perception biases have been observed and studied in the literature, the question how the perception of loss-deduction rules in income taxation affects investment choices remains largely unexplored.[2]

In this paper, we use a laboratory experiment to study the extent to which investors' choices are affected by a biased perception of limited loss deduction in income taxation. Our research is motivated by the observation that decision-makers frequently show biased perceptions in complex risky decision tasks.[3] Income taxation, especially when it is non-linear (e.g. as in the cases without or with only partial loss deduction), can lead to risky choice situations that are sufficiently multi-level as to bias the investment decision. If, for example, the financial benefit of partial loss deduction is under-estimated by an investor, this investor may be willing to make less risky investments than she or he would be willing to with a non-biased perception of the taxation. Similarly, an overly optimistic view of the advantage of loss deduction may increase risk-taking by investors. In either case, knowledge about any type of perception bias in investment decisions enables business partners to make better judgments on each others' behavior and tax authorities to create more efficient taxation systems that foster investments and growth.

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[1] Heaton (1987) gives a detailed formal account of how income taxation without full loss deduction will bias investment decisions of an expected value maximizing investor towards less risky choices. But, other authors (see e.g. Näslund 1968 and Schneider 1980) show that whether the investor's decisions become more or less risky depends on the details of the investor's utility function.

[2] Most of the literature on tax perception is focused on the question, whether households are aware of their true tax burden and whether they base their labor supply decisions on the marginal or the average tax rate (e.g. Gensemer, Lean and Neenan 1965; Rosen 1976a and Rosen 1976b; Swenson 1988; König *et al.* 1995; Rupert and Fischer 1995). Some other tax perception issues have also been studied, e.g. the presentation of the tax schedule (De Bartolome 1995; Rupert and Wright 1998), the tax deferring effect of capital taxation (Meade 1990), the effect of tax complexity (Boylan and Frischmann 2006; Blaufus and Ortlieb 2009), the behavioral equivalence of income and consumption taxation (Blumkin, Ruffle and Ganun 2008), and the effect of tax perception on political choices (Gemmell, Morrissey and Pinar 2004) or unemployment (Riedl and van Winden 2007).

[3] Tax complexity has been found to affect behavior both in empirical (Blaufus and Ortlieb 2009) and experimental studies (Boylan and Frischmann 2006). Furthermore, Starmer and Sugden (1993) find that complexity in general affects investment decisions. A number of other settings reported in the literature demonstrate that increasing complexity in risky choice can bias outcomes. See Starmer (2000) for an overview.

Our experimental study consists of two parts. Before testing for a perception bias based on the loss deduction provision, we first check the reliability of our instrument with respect to the financial effects of income taxation on investment incentives. To this end, we compare investment behavior in a *baseline* treatment without any taxation to a *tax control* treatment, in which the investors have exactly the same choices as in the baseline treatment, but the income from their investments is taxed without a provision for loss deduction. We find that investors significantly reduce their risk-taking in the tax control treatment compared to the baseline treatment. This observation is in line with the theoretic prediction for most risk-neutral and risk-averse investors, because the tax decreases the upside opportunity of investments, without reducing the downside risk. The distortion of investment payoffs makes risky investments less attractive to investors. Given these clear and consistent results, we are confident that our experimental instrument is suited for detecting any perception bias based on the loss deduction rules.

In the second – and main – part of the experiment, we study investment behavior in three tax systems that only differ concerning the loss deduction rule. The three loss deduction provisions that we use, the partial, the capped and the no deduction rule, all have empirical and theoretical relevance, because they are either currently employed or are discussed as a possible alternative to the rule that is currently employed. To make sure that the behavioral differences we observe across the treatments of our experiment are not due to shifts in the monetary incentives, we provide the investors with investment opportunities that result in exactly the same *after tax* payoffs in every tax regime. Moreover, these payoffs are identical to the payoffs in our baseline treatment with no taxation at all. We compare the baseline investment choices to choices under three different types of income taxation. We observe that risk-taking is significantly increased with partial and capped loss deduction, but is unaffected by a tax system that allows no loss deduction. Since in all these treatments the after tax outcomes of the prospects are identical, we conjecture that investors have a positively biased perception of partial and capped loss deductions that promotes their willingness to take risks.

Our results indicate that partial and capped loss deduction rules may empirically be less obstructive to investments than a purely theoretical analysis would suggest. In fact, we surprisingly observe that with a partial or capped loss deduction, investors tend to increase their willingness to take on risk and, thus, enhance expected productivity.

The rest of the paper is organized as follows. We first give an overview of the theoretical, empirical, and experimental literature on tax perception biases. Then, in section 3, we explain the details of our experimental decision task. We describe our experimental design and setup in section 4. Finally, in section 5, we present our results, before we wrap up with a concluding discussion of these results in section 6.

2 Literature

2.1 Theoretical Contributions

There is an important body of literature analyzing the effect of taxation on risk taking in investment decisions which has been inseminated by Domar and Musgrave (1944). Based on the Keynesian model of liquidity preference, this paper models the choice between riskless cash holdings and risky interest-earning bonds in the presence of a linear income tax in which the degree of possible loss offset is varied. The investor's objective is to maximize expected yield. Risk is modeled not as standard deviation but rather as expected loss which reduces expected yield.[4] It is argued that without loss offset the effect on risk taking is ambiguous. The yield will be cut by taxation, while risk is unchanged so that the investor will want to take less risk. On the other hand the investor will want to compensate for the tax-induced reduction in income caused by increasing his risky investments. The total effect is uncertain. With complete loss offset risk-taking does not become less attractive since risk and yield are reduced by the same percentage. The investor will increase risky investments to compensate for the reduction in yield. With partial loss offset the result is uncertain again, as this is a mixed case, somewhere between the two cases discussed.[5]

Richter (1960) shows that the assumption on the investor's behavior is not necessarily Bernoulli rational. Nevertheless, his and other subsequent contributions confirm the main results of Domar and Musgrave (1944) using different optimization frameworks like the μ-σ-criterion (Tobin 1958), expected utility with different utility functions (Mossin 1968, Stiglitz 1969, Allingham 1972 and Sandmo 1989), mathematical optimization (Näslund 1968) or stochastic dominance (Russell and Smith 1970): Under a proportional income tax with complete loss offset, a risk averse investor will tend to invest a bigger share of his wealth in risky assets than without taxation provided that relative risk aversion is increasing. Likewise,

4 Domar and Musgrave (1944, p. 396).

5 Domar and Musgrave (1944, p. 388–390).

risk-taking increases with the tax rate as taxation not only reduces positive returns to the investor, but also risk through tax loss compensation. With incomplete loss offset, the effect is ambiguous.[6]

A progressive income tax with full or with limited loss offset will reduce risk taking by a risk neutral investor. For a risk-averse investor the effect is ambiguous even with full loss offset. Provided that the utility function is nonlinear and concave it is always possible to find a tax schedule which increases risk taking with respect to a specific risky investment and another tax schedule which decreases risk taking with respect to another specific risky investment (Bamberg and Richter 1984, p. 96–100)

2.2 Experimental Contributions

To our knowledge, this paper presents the first experimental investigation of the effects of the biased perception of loss deduction provisions of taxation. While there are a few other papers that examine the effect of taxation on investment decisions, they all focus on other aspects of taxation. Anderson and Butler (1997) investigate the effect of a differential tax treatment on financial markets. They compare assets that are subject to regular capital gains taxation to assets that are subject to a preferential treatment, either an unlimited capital loss deduction or a low tax rate. They find that – as expected – the assets with a preferential tax treatment generally achieve higher market prices than those without. The price difference, however, is stronger for high risk assets than for low risk assets. This asymmetric bias is reflected in the significantly lower risk premiums that are observed with a preferential tax treatment than without. They conclude that while the preferential tax treatment can increase the propensity of investors to take risks, some (or all) of the momentum may be lost due to the increase of the market prices for the high risk assets. Note, however, that this result is driven by the fact that the supply of high risk investment opportunities in the studied market is fixed. It seems plausible that preferential tax treatment will not only lead to an increase of the asset price, but also to an increase in the supply of preferred type of asset.

Meade (1990) studies a different aspect of capital gains taxation. She reports laboratory experiments on the tax deferring effect of capital gains taxation on investment decisions and

[6] Bamberg and Richter (1984, p. 93). Seemingly opposite results are not in contradiction to this: Tobin (1958, p. 81–82) assumes a tax on interest paid without loss offset for capital losses, but there is also no tax on capital gains. Mintz (1981) produces ambiguous results by assuming discrimatory taxation of (1st) economic rents and the cost of capital or (2nd) returns to equity and bond holders. Feldstein (1969, p. 761–763) shows that a proportional tax has no effect on risk-taking with decreasing absolute risk aversion.

finds that taxing capital gains only at the time of realization may lock investors into inefficient investments. Furthermore, she shows that the inefficient lock-in effect is mitigated by preferential rates, deferred tax interest charges, and/or a tax-free re-investment provision.

King and Wallin (1990) conduct experiments comparing investment behavior in the presence of a proportional and a progressive tax to a benchmark case without taxation. They find that the progressive tax reduces, but the proportional tax does not increase risk-taking compared to the benchmark. De Bartolome (1995) conducts a related experiment to find out, whether investors base their decisions on the average or on the marginal tax rate. He finds that the answer to the question depends on the presentation of the tax schedule. Subjects using an aggregate income tax table tend to base their decision on the average tax, while those using a tax rate schedule seem to be much more aware of the marginal tax. Rupert and Wright (1998) conduct a similar experiment showing that the higher the visibility of the marginal tax rate was for the subjects, the more efficient the decisions.

Boylan and Frischmann (2006) study the effect of tax complexity on price decisions in an experimental market and find complexity to drive up prices. They show that market competition can mitigate the negative effects of tax complexity on investments, but cannot fully eliminate the bias. Note that while our tax setting is simpler than their "complex" tax, it is clearly more complex than their "simple" flat tax.

3 Decision task

In each treatment, participants face 20 decision situations with two investment alternatives to choose from. Each investment consists of a lottery with three equally probable outcomes, where the lowest and highest payoffs are symmetrically set in the positive and the negative domain, but can be different in each investment pair. The mid payoff lies between the extreme payoffs, but is equal for both investment alternatives in each pair. Hence, the pairs of investment alternatives can be presented as follows:

$$(x \quad , \quad z \quad , \quad -x) \quad \text{and} \quad (y \quad , \quad z \quad , \quad -y)$$

where $x > y > 0$ and z is the identical mid payoff. Since all three states of nature are equally probable (with $p = 1/3$), the expected values of both investment alternatives are identical. Note, however, that the variance of the right investment is smaller, since x is strictly larger than y. We refer to right investment alternative as the *low-risk investment* and to the left investment alternative as the *high-risk investment*. Assuming risk aversion, we should generally observe the following preference in the experiment:

$$(x \quad , \quad z \quad , \quad -x) \quad \prec \quad (y \quad , \quad z \quad , \quad -y)$$

The first treatment (without taxation) measures the risk attitude of each participant and serves as a benchmark to analyze the effect of the different tax regimes in the other treatments. Since all participants go through all treatments and since after-tax payoffs are identical in all treatments (except the tax control treatment), switching from the low-risk to the high-risk investment or vice versa indicates a perception effect of the tax rule.

3.1 Income taxation without loss deduction

The first question we ask is: Do taxes matter at all? In particular: Do participants integrate fiscal facts in their decision process? To test this, the same pairs of investments as in the baseline treatment are used as gross income investments in the *tax control treatment*. In other words, the choices in the baseline and the tax control treatment are equivalent before tax. After tax, however, the payoffs in the two treatments differ substantially. While there is no tax in the baseline treatment, there is a proportional tax without loss deduction in the tax control treatment. The tax rate for gains is t and losses are not deductible. Consequently, while the investments are symmetric pre-tax (just as in the baseline treatment), they are asymmetric post-tax. Hence, the expected value of the low-risk investment exceeds the value of the high-risk investment, as following transformation shows:

$$\begin{aligned} E(\text{low-risk investment}) &> E(\text{high-risk investment}) \\ \frac{1}{3}\cdot\left[(1-t)\cdot y+(1-t)\cdot z-y\right] &> \frac{1}{3}\cdot\left[(1-t)\cdot x+(1-t)\cdot z-x\right] \\ (1-t)\cdot z-t\cdot y &> (1-t)\cdot z-t\cdot x \\ y &< x \end{aligned}$$

As a consequence, we expect participants to choose the low-risk investments more often in the tax control treatment as compared to the baseline treatment, where both investments have the same expected value. The following hypothesis results:

Hypothesis 1: *In the tax control treatment the preference for low-risk investment is higher as compared to the baseline treatment.*

Hypothesis 1 only sets the groundwork for our study. If we find that it does not hold, we must generally doubt that our subjects integrate fiscal effects in their decision processes the way a rational decision-maker who maximizes expected value and minimizes risk would. Hence, this first part of our study is only meant as a robustness check for the rest of the investigation, in which we examine the tax perception hypotheses.

3.2 Perception of no, partial, and capped loss deduction

The main part of our study is concerned with the perception of loss deduction rules in income taxation. We test the effect of three different methods of loss compensation (or loss deduction) on the propensity to choose risky investments. Accordingly, we have three treatments with different loss deduction rules (the three *perception treatments*). The payoff structure in each of the perception treatments is constructed in such a way that the after tax payoffs of the alternative investments are equivalent to the payoffs from the investments in the baseline treatment. This means that in terms of *net* payoffs the participants face exactly the same choices in all three perception treatments as in the baseline treatment. Hence, the only treatment difference is due to the fact that the investment alternatives are presented in different *gross* payoffs (i.e. in before tax payoffs) and the participants are informed about the taxation rules.[7] If participants integrate the fiscal effects of taxation correctly into their decisions, they should report exactly the same preference in every single one of these treatments and this preference should be the same as in the baseline treatment. Thus, following hypothesis results:

Hypothesis 2: *The preferences for the low-risk investments observed in the perception treatments do not differ from each other and from the preferences observed in the baseline treatment.*

In each perception-treatment, gains are subject to taxation at a rate of t but loss deduction is limited. To achieve the gross payoffs in each perception-treatment, the investment payoffs of the baseline-treatment (x, y, z) are grossed up as follows.

$$\left(\frac{x}{1-t} \quad , \quad \frac{z}{1-t} \quad , \quad -x+T(x)\right) \quad \text{and} \quad \left(\frac{y}{1-t} \quad , \quad \frac{z}{1-t} \quad , \quad -y+T(y)\right)$$

[7] When calculating the gross payments that equalized the net payments, in some cases we rounded the gross payoffs to the second decimal in the perception treatments. This, however, did not result in any substantial differences of the net values across treatments.

T denotes the tax payment which is a tax refund in the loss cases $T(\bullet) \leq 0$. The three perception-treatments differ in the tax refund T:

- *no deduction treatment*: Losses are not deductible: $T(\bullet) = 0$,
- *partial deduction treatment:* 50 % of losses are deductible:

$$T(x) = \frac{-x \cdot t}{2-t} \quad ; \quad T(y) = \frac{-y \cdot t}{2-t},$$

- *capped deduction treatment:* Up to a limit L losses are completely deductible; losses above L are not deductible:

$$T(x) = \begin{cases} \dfrac{-x \cdot t}{1-t} & \text{for} \quad -x - T \geq -L \\ -L \cdot t & \text{for} \quad -x - T < -L \end{cases} \quad ; \quad T(y) = \begin{cases} \dfrac{-y \cdot t}{1-t} & \text{for} \quad -y - T \geq -L \\ -L \cdot t & \text{for} \quad -y - T < -L \end{cases}.$$

Contrary to hypothesis 2, participants may not integrate all fiscal facts into their calculus of returns. They may base their decisions on gross payoffs, apply some kind of choice heuristic, or make biased guesses on their after tax payoffs. In these cases, participants may over- or underestimate the effect of taxation, making choices that are different across treatments and when compared to the baseline treatment. We can formalize the effect of a biased perception of taxation by comparing choices in a model with gross payoffs to the choices in the baseline model (i.e. the case with net payoffs). For example, in the no deduction treatment ($T(\bullet) = 0$), investment pairs have the following gross payoffs:

$$\left(\frac{x}{1-t} \quad , \quad \frac{z}{1-t} \quad , \quad -x \right) \quad \text{and} \quad \left(\frac{y}{1-t} \quad , \quad \frac{z}{1-t} \quad , \quad -y \right)$$

Gross positive payoffs are higher than those in the baseline treatment, because if they are realized they will be taxed down to a net value that is equal to that in the baseline treatment. The gross negative payoffs are exactly the same as in the baseline treatment, because taxation does not affect these outcomes when loss deduction is fully excluded ($T(\bullet) = 0$). Those who base their choice on gross payoffs will find the expected value of the low-risk investment smaller than the expected value of the high-risk investment, because:

$$
\begin{aligned}
E\left(\text{low-risk investment}\right) &< E\left(\text{high-risk investment}\right) \\
\frac{1}{3}\cdot\left[\frac{y}{1-t}+\frac{z}{1-t}-y\right] &< \frac{1}{3}\cdot\left[\frac{x}{1-t}+\frac{z}{1-t}-x\right] \\
y\cdot\left(\frac{1}{1-t}-1\right) &< x\cdot\left(\frac{1}{1-t}-1\right) \\
y &< x
\end{aligned}
$$

Hence, such participants will tend to choose the high-risk investment when losses are not deductible and we will observe more high-risk choices in the no loss deduction treatment than in the baseline treatment. Similar considerations apply to the other two perception treatments.

If participants' decisions are based on heuristics or biased guesses, we cannot predict in which way the decision will be affected without knowing details of the bias. However, we can show that an underestimation of the tax effect on positive payoffs decreases the perceived expected value of the low-risk investment compared to that of the high-risk investment. This might induce some participants to prefer the high-risk investment more often than in the baseline treatment. The opposite holds participants overestimate the effect of taxation on their positive payoffs. Similarly, an overly optimistic perception of the effect of loss deduction should lead to a greater preference for the high-risk investment than in the unbiased case, while a pessimistic perception will lead to a greater preference for the low-risk investment.

4 Experimental design and setup

4.1 The hill climbing task

Our laboratory experiment consists of two parts. In the first part of the experiment, the subjects perform a real-effort task to "earn" their initial endowment. To avoid out-of-pocket payments, participants needed an initial endowment that covers potential losses from their risky investments. We decided to let the participants "earn" their endowments in a real-effort task, instead of simply providing them with cash. The real-effort task has the advantage that it eliminates the *house money effect*, i.e. the phenomenon that participants tend to be more risk-averse when betting with an "earned" endowment than with an endowment that comes as a windfall (the latter is often referred to as "house money").[8]

[8] For an overview of the literature on the *house money effect* see Clark (2002) and Weber and Zuchel (2005), both of whom only find mixed evidence for the existence of the effect.

The real-effort task that the participants performed consisted of searching the maximum point in a monotonous two-dimensional grid on a computer screen.[9] This "hill climbing" task has the advantage that – on the one hand – it can be performed without any specific knowledge, but – on the other hand – it cannot be performed adequately without exerting at least some effort.[10] While the payoffs from this task theoretically spread between 0 and 15 Euros, most participants earned the maximum initial endowment by performing the simple but tedious task very well. Hence, we have avoided any confounding effects that may be due to varied initial endowments.[11]

4.2 The investment task

In the second part of the experiment, the participants face a series of decision situations such as those described in section 3. Depending on the treatment, the income from the investments is taxed with different methods of loss deduction in place. Using a within-subject design, we put all participants through all five treatments. In each treatment, each participant has 20 pairs of investment alternatives to choose from.[12] Hence, each participant makes 100 investment decisions in total. In the four tax treatments, the payoffs are subject to an income tax with a flat rate of 35 % and one of the three loss deduction possibilities, "no deduction," "partial deduction," or "capped deduction." In the "tax control" and the "no deduction" treatment, the participants are rewarded no tax benefits for losses that they incur. In the "partial deduction" treatment, subjects are rewarded tax credits on 50 percent of their incurred losses. In the "capped deduction" treatment, subjects are rewarded tax credits on 100 percent of the first 12 currency units that they lose and 0 percent on the rest.

The experiment is framed as an investment situation with taxes. The investment alternatives are referred to as "business opportunities" and the terms "tax," "tax rate," and "loss deduction" are used to refer to the tax related elements of the design in the instructions and on-screen.[13] Table 1 gives an overview of our five treatments. The treatments, the pairs of

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9 The instructions for the "hill climbing" task are available in the appendix A1.

10 A number of other authors have used similar hill climbing tasks to induce real effort exertion. The software we used was a slightly modified version of the software also used by van Dijk, Sonnemans and van Winden (2001, p. 190–194). A demo version of the game can be downloaded from http://www1.fee.uva.nl/CREED/effort.htm. We are very thankful to Jos Theelen (University of Amsterdam) for making the hill climbing task software available to us.

11 The size of the initial endowments may affect behavior. Torgler, for example, finds that a higher initial endowment leads to a higher tax morale Torgler (2002, p. 21).

12 All pairs of investment alternatives are shown in appendix A2.

13 The instructions for the investment task are available in the appendix A3.

investments, and the positions of the investment alternatives on the screen (right or left hand side) were all randomized across participants.

4.3 The questionnaires

After reading the instructions, participants were asked to fill out a questionnaire testing their comprehension of the mathematics of the investment and tax situation. The answers were checked by an experimenter. Participants, who had not calculated the solutions correctly, were briefed by the experimenter until all misunderstandings were dissolved.

After the experiment, the participants were asked to fill out a second questionnaire, in which they were asked about their age, gender, major, and their level of knowledge of tax laws. Additionally, we asked (1) which loss deduction method was regarded as fairest among the methods offered in the different treatments and (2) whether participants had based their decisions rather on net or on gross payoffs.

Table 1: Overview of the experimental treatments

<table>
<tr><th>treatment</th><th>tax characteristics</th><th>presentation</th></tr>
<tr><td>baseline</td><td>no tax</td><td>pre-tax and post-tax payoffs are equivalent</td></tr>
<tr><td>tax control</td><td>positive payoffs are taxed at a rate of 35 %
losses are not deductible</td><td>pre-tax investment alternatives are equal to the baseline investment alternatives</td></tr>
<tr><td>no deduction</td><td>positive payoffs are taxed at a rate of 35 %
losses are not deductible</td><td rowspan="3">post-tax investment alternatives are equal to the baseline investment alternatives</td></tr>
<tr><td>partial deduction</td><td>positive payoffs are taxed at a rate of 35 %
50 % of losses may be deducted</td></tr>
<tr><td>capped deduction</td><td>positive payoffs are taxed at a rate of 35 %
100 % of losses up to a limit of -12 may be deducted</td></tr>
</table>

4.4 Experimental setup

The experiment was conducted at the computerized experimental laboratory of the University of Magdeburg (MaXLab) with 91 student participants (37 female and 54 male subjects).[14] Most participants majored in Economics and Management. The participants completed the tasks at individual speeds, but no session lasted less than 1.5 hours and no session lasted longer than 2 hours. After the session, the participants were paid their earnings in cash. To avoid income effects, we paid the amount earned in the hill climbing task plus (minus) the profit (loss) from only one randomly drawn and played out investment choice.[15] Participants earned between 1 and 29 Euros, with an average of 13.64 Euros.

5 Results

5.1 Do taxes matter?

To analyze whether participants took taxes into account when making their investment decisions, we compare the number of low-risk choices in the baseline treatment to the number in the tax control treatment. If participants integrate the effects of taxation in their decisions, we expect to observe a difference in the number of low-risk investment choices (Hypothesis 1). Note that the participants make 20 decisions in each treatment and, therefore, the maximum number of low-risk choices is 20. Table 2 depicts the mean and the median number of low-risk investment choices over all 91 participants.

Table 2: Number of low-risk choices (baseline- and tax control treatments)

	baseline	tax control
mean	9.45	12.69
median	9	16

As expected, we observe both a higher mean and a higher median in the number of low-risk choices when comparing the tax control treatment to the baseline treatment. The difference is highly significant ($p < 0.001$, Wilcoxon signed-ranks test, two tailed). Apparently, our participants integrate fiscal facts in their decision process.

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[14] For the first part of the experiment, we used a modified version of the “Hill Climbing” software also used by (van Dijk, Sonnemans and van Winden 2001). The investment tasks were programmed using z-Tree (Fischbacher 2007).

[15] This is common practice in experiments involving risky choices. See Starmer and Sugden (1991).

To gain a better understanding of the participants' risk attitudes and choice behavior, we categorize participants in three categories: risk seeking, risk averse, and unclassified. We define classes using a two-tailed binomial test at a 0.05 significance level applied to the number of low-risk versus high-risk choices that each participant made in each treatment. Participants making significantly more high-risk than low-risk choices are called "risk seeking," while those making significantly more low-risk than high-risk choices are called "risk averse." We categorize all others as "unclassified," because we do not have the necessary statistical evidence to categorize them.[16] Since participants made 20 choices in each treatment, using our binomial test criterion, we could classify a participant as risk seeking (risk averse), if he/she chose the low-risk investment at most in 5 (at least in 15) cases.

Table 3 shows the distribution of types for the baseline and tax control treatments. In the baseline treatment without taxation, more participants are categorized as risk seeking than as risk averse. This difference, however, is not statistically significant on any standard level. (The *p*-value of the binomial test is reported in the bottom row of Table 3.) Hence, we must assume that the participants in our baseline treatment are essentially neither biased towards the high-risk nor towards the low-risk investment. In the tax control treatment, we observe substantially fewer participants in the risk seeking than in the risk averse category. In this case, the binomial test reveals a significant difference. Using the Fisher exact test, we can show that the difference between the two treatments is significant (with $p < 0.001$, two-tailed). These results confirm hypothesis 1. Participants do not seem to base their decision on the gross payoffs, because introducing an income tax leads to the predicted shift of choices from the high-risk to the low-risk investments.

Table 3: Risk classification based on low-risk choices (baseline- and tax control treatments)

	baseline	tax control
risk seeking	38	19
unclassified	23	23
risk averse	30	49
binomial test, two tailed H0: risk seeking = risk averse	$p = 0.396$	$p = 0.004$

[16] Obviously, our classification method does not guarantee that the participants we call "risk seeking" are risk seeking in absolute terms (or vice versa). It may be that they are only "less risk averse" than others. Analogously, we do not claim that those individuals we classify as risk averse are risk averse in absolute terms. Note also that the remaining "unclassified" participants should not be considered to be risk neutral, because they may in fact be risk seeking or averse, but we simply do not have enough evidence to reject risk neutrality.

5.2 Perception of income taxation and loss deduction

Remember that the setup of the three perception treatments is such that the after-tax payoffs of the investment alternatives are equal to the payoffs of the investment alternatives in the baseline treatment. Thus, participants with stable and unbiased preferences will choose those investments in these treatments that are equivalent to the investment they chose in the baseline treatment (hypothesis 2). Table 4 shows the mean and the median number of low-risk choices in the baseline treatment and in each of the perception treatments.

Table 4: Number of low-risk choices (baseline- and perception treatments)

	baseline	no deduction	partial deduction	capped deduction
mean	9.45	10.00	6.91	7.54
median	9	11	5	5

We again classify the participants in risk classes, just as we did in section 5.1. Table 5 shows the distribution of subjects across classes for the baseline without taxation and the perception treatments with taxes and different methods of loss deduction. The p-value of the binomial test comparing the distribution to an equal distribution of risk seeking and risk averse decision-makers is reported in the bottom row.

Table 5: Risk classification (baseline- and perception treatments)

	baseline	no deduction	partial deduction	capped deduction
risk seeking	38	32	46	48
unclassified	23	27	26	24
risk averse	30	32	19	19
binomial test, two tailed H0: risk seeking = risk averse	$p = 0.396$	$p = 1.000$	$p < 0.001$	$p < 0.001$

Table 4 and Table 5 show that there are no obvious differences between the baseline and the no-deduction treatments. In both treatments, we find no significant difference between an equal distribution and the observed distribution of risk seeking and risk averse participants. Furthermore, using the Fisher's Exact Test, we find no difference between the distributions of decision-maker types across these two treatments. In contrast, we find the distribution of participant types significantly biased in the partial and the capped deduction treatments (as the binomial test results in the bottom row show.) The method of loss deduction in these two latter treatments, evidently leads to a biased response by the participants, who tend to be risk seeking to a significantly larger extent than risk averse. The Fisher Exact Test results support the finding that the distributions of decision-maker types in the latter two treatments are significantly different from the distributions of types in the baseline and the no deduction treatments (both at 0.05 significance level, one-tailed). The observed distributions in the two latter treatments, the partial and the capped deduction, however, are not significantly different when compared to each other.

Figure 1 depicts the ratio of low-risk choices in each pair of investments in the baseline- and in the perception treatments. There are twenty data points for each treatment, because each treatment consisted of 20 pairs of investments. The distribution of the data points in Figure 1 is informative because it shows that the effects we have observed so far do not pertain to a limited set of investment alternatives, but have a broad relevance. Comparing the distribution of data points of the two treatments to the left (baseline and no deduction) with those of the two treatments to the right (partial and capped deduction), we find that the almost every data point in the former is above the median of the latter and vice versa. In the case of the partial deduction treatment, it is even more extreme, because all but two of the data points are below the minimum data point of the baseline treatment. While we find a clear distinction between the two treatments to the left and the two to the right, there are apparently no differences within each of these subsets.

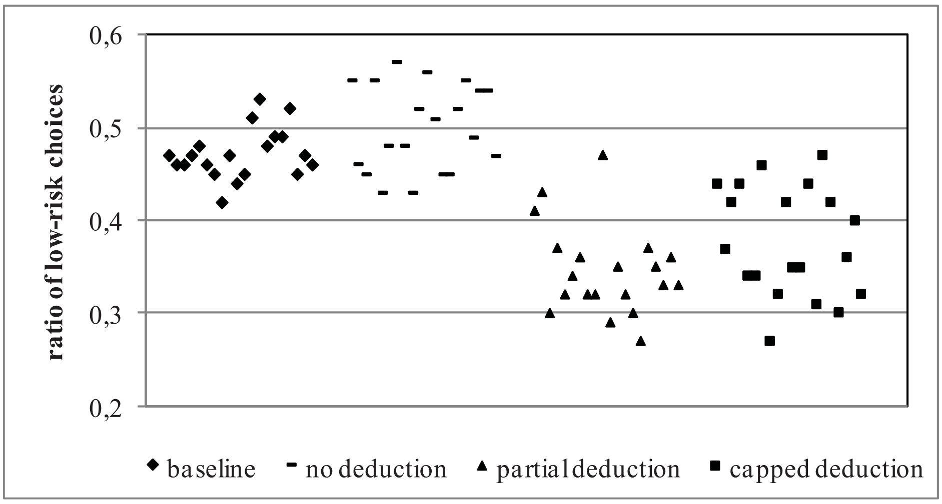


Figure 1: Relative number of low-risk choices

To assess the quantitative differences between the treatments we run logit regressions, where the choice of the low-risk investment alternative is the endogenous variable. Since we have a within subject design, we use fixed effects regressions to deal with the participants' idiosyncratic biases. Table 6 shows the results of our logit regressions.

In the first regression (Model 1), we include all data from the four treatments with the same after-tax investment payoffs (i.e. the benchmark treatment and the three perception treatments). To analyze the treatment effects, we regress on three treatment dummies (the benchmark treatment is the default) as well as on the spread between the extreme values of the investment alternatives and on their common component. The regression clearly shows that all three treatments significantly influence the participants' choices, but none of the payoff related variables does. Taking the payoff related variables out of the regression in Model 2, we find the treatment coefficients of the first model basically unchanged.

The regression models 1 and 2 support our finding that introducing partial and capped loss deduction decreases the participants' tendency to choose the less risky investment alternatives. In fact, the regressions neatly demonstrate that the effect of partial loss deduction is even somewhat greater than the effect of a capped deduction.

Interestingly, however, the regressions in Table 6 also show that the "no deduction" treatment has a significant positive effect on the participants' tendency to choose the less risky investment alternative. This supports our visual impression from figure 1, which hints at the participants' slightly greater willingness to take risks without taxes than with an income tax and no loss deduction. This effect goes in the opposite direction and is much smaller than the negative effect that the partial and the capped loss deduction have on risk-taking.

Table 6: Logit regression results for the perception treatments

	Model 1 all	Model 2 all	Model 3 males	Model 4 females
no deduction	.185 * (.086)	.185 * (.086)	.127 (.113)	.267 * (.134)
partial deduction	-.866 *** (.088)	-.866 *** (.088)	- 1.070 *** (.116)	-.580 *** (.136)
capped deduction	-.646 *** (.087)	-.646 *** (.087)	-.759 *** (.114)	-.487 *** (.135)
spread difference $x - y$	-.004 (.063)			
common outcome z	-.002 (.011)			
n[#]	82	82	49	33
[#] We could not use the full sample for the regressions, because some participants exhibit absolutely no variation in their behavior.		*** $\alpha = 0.001$ two-tailed	** $\alpha = 0.01$ two-tailed	* $\alpha = 0.05$ two-tailed

Table 6 also displays the results of logit regressions that we ran for the data separated by gender. Some authors have reported that females react more sensitively to losses than males.[17] To check for gender differences, we ran the separate regressions and find two interesting differences. First, the strong risk enhancing effect of the partial and the capped loss reduction rules can be observed in both genders. Women, however, seem to be affected less strongly, because the two corresponding coefficients in the Model 4 are about half the size of the coefficients in Model 3. The second gender difference that we observe pertains to the behavior in the no deduction case. The coefficient in the regression with the data from our female participants (model 4) is significantly positive, while the corresponding coefficient in the regression with our male participants (model 3) is not. For one thing, this indicates that the significant coefficient in the regression over all data (model 2) results from the females' propensity to avoid risk-taking in the no deduction case. Furthermore, the fact that this coefficient is almost double the size of the coefficient we derive from the decisions of the males, seems in line with the general picture. The sign of the coefficients is the same for both genders, but women tend to be somewhat more hesitant to take on risks.

[17] See e.g. Brooks and Zank (2005, p. 317) and Schmidt and Traub (2002, p. 245).

6 Conclusions

We introduce a simple experimental setup to investigate the effect of income taxation with various loss deduction rules on investment behavior. Our decision-makers choose between two investment alternatives that have the same expected value, but differ in variance. In the three tax perception treatments, we use investment alternatives with equal post-tax payoffs in all treatments. Hence, if the participants in our experiment are rational, payoff maximizing, and have stable preferences, we should observe identical choices in all treatments, both with and without taxation and no matter which loss deduction rule is used.

When there is no taxation, the number of risk seeking investors is not significantly greater than the number of risk averse investors. The same is true in the case of proportional income taxation without loss deduction. However, when there is taxation and a partial or capped loss deduction rule, we find a surprisingly strong and significant bias towards risk seeking. Our regression results show that this effect is even slightly stronger in the case of partial loss deduction than in the case of capped loss deduction.

We conjecture that the value of the loss deduction is overestimated when there is either a partial or a capped loss deduction rule. Since losses are optimistically assumed to weigh less in these situations, the decision makers feel safe to take on greater risks. It almost seems as if the investors believe that losses will be overcompensated by the tax refunds. This may explain why some “tax haven” regulations lead to exaggerated investments.[18]

Interestingly, we find that while women exhibit exactly the same type of tax perception bias, the effect on their risk-taking behavior is substantially smaller. In fact, in the case of no deduction, women actually tend to make significantly more risk averse choices than without taxes, presumably because they are slightly biased to overestimate the negative effect of taxation for the high risk investment.

All in all, our study shows that the legal provision concerning the taxation of losses can cause a significant perception bias and affect the risk-taking behavior of individuals. This opens a door for a “behavioral design” of the tax policy. For example, if the degree of risk-taking seems too low, e.g. due to a financial or political crisis, improving loss deduction rules may

[18] A prominent case in the Geman tax code is the full loss deduction that was provided for investments in ship ownership. This tax haven is generally believed to be the reason for an exaggerated investment of wealthy Germans in the shipping business. In 2006, German citizens owned by far more ships than any other nationals worldwide (Schulz 2007).

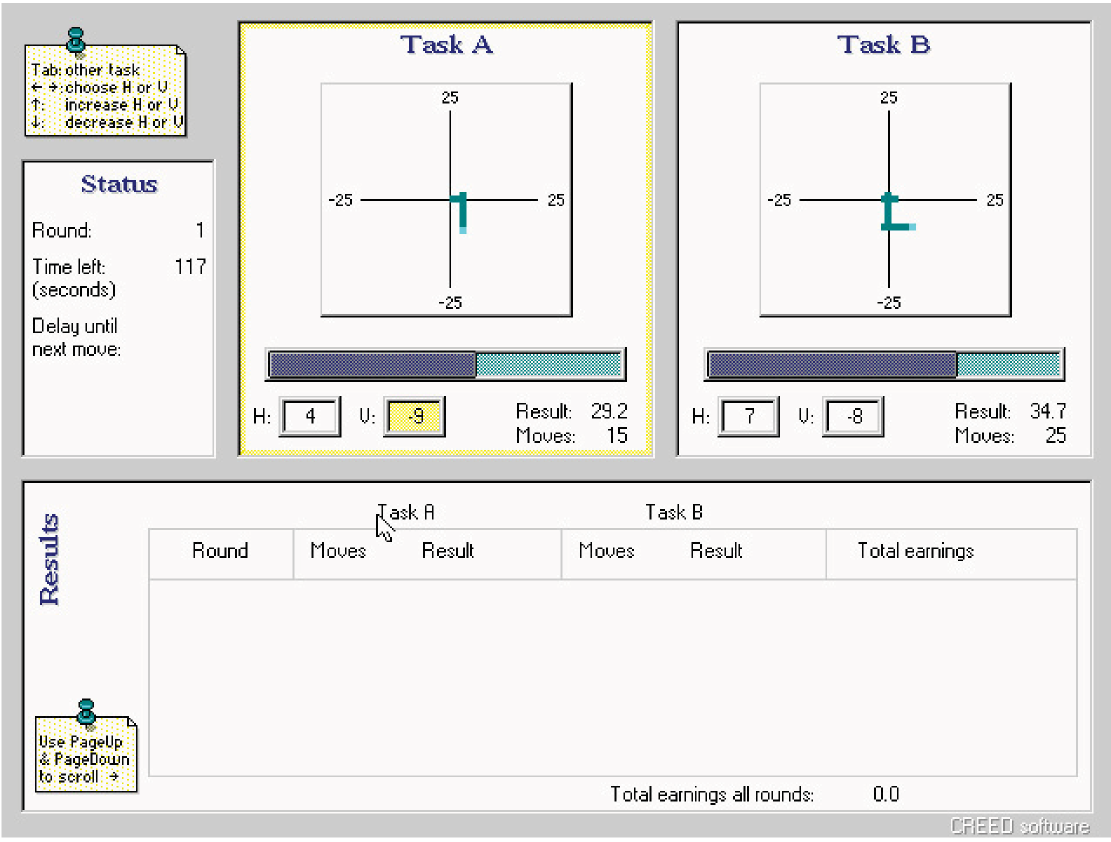
help induce more risk-taking. On the other hand, if the economic situation seems too risky, it may be sensible to switch to a taxation policy without loss deduction.

Obviously, our conclusions must also contain a caveat concerning the implications of our findings for the decision-making of firms. We do not claim that we can easily draw conclusions from this study for corporate decision-making. It is well known that most firms consult their tax departments or tax consultants to back up important investment decisions. In such cases, we do not expect to observe a strong perception bias. A large part of the capital investments, however, are personal savings that are invested with scant expert advice. Our study suggests that these small and dispersed investments – that in total are a substantial part of an economies total investments – may be strongly affected by the loss deduction rule. Perhaps this bias is the difference between the individual and the institutional investors that has induced legislators to create the different loss deduction rules that (in many countries) apply to personal income taxation versus corporate income taxation. Legislators seem to be taking advantage of the biased perception of loss deduction extensively.

Appendix

A1 Instructions for the *Hill Climbing* game (original in German)

In the first part of the experiment, you will have the opportunity to earn money. Your payment will depend on your own actions only. To this end, you will find a screen image similar to the following on your computer screen after the program has started:



The objective of this part of the experiment is to find the maximum value in a grid. This value depends on two variables H (horizontal) and V (vertical) and can be found by adapting the variables H and/or V. In each grid, there is only **one** maximum value that is fixed at **50**. The slope towards the maximum value is always positive. Accordingly, the value increases if you move towards the maximum value and decreases if you move away from the maximum value.

The values (*Result*) of the tasks that you have achieved by the end of the first part of the experiment provide the basis for your first payment. The number of steps is irrelevant for the size of the payoff. Your payoff (in Euros) from the first part of the experiment is computed as follows:

$$\text{Payoff} = 0.15 \cdot \text{Result (TaskA)} + 0.15 \cdot \text{Result} \cdot \text{(TaskB)}$$

Accordingly, the maximum payoff that you can achieve is 15 Euros, if you can find the highest possible value of 50 both in Task A and Task B.

Moving inside the grid: At the start of this part of the experiment, the variables are set to their preset values of H = 0 and V = 0. You can read the value resulting from this point in the field "Result." By pressing the arrow buttons *right/left* you can switch between the variables. By pressing the buttons *up/down* you can change the value of the variables. In the *Task A* example in the figure above, the variables are H = 4 and V = – 9. The resulting value from the parameters in this example is 29.2 (*Result*). Using the Tab-Button you can switch between the tasks A and B.

After one practice round that is irrelevant for your payoff, you will have 3 minutes to search for the maximum values of task A **and** B. After the given time is over, the first part of the experiment ends. It is **very important** that you write down the final values of the variables H and V of the corresponding tasks on the memo sheet that is provided. At the beginning of the second part of the experiment, you will be asked to enter these values. These data will be used to calculate your final payoff at the end of the experiment.

After reading these instructions, please, raise your hand. An assistant will start the software for the first part of the experiment on your computer.

A2 Investment alternatives in the investment experiment

The table below exhibits all pre-tax investment alternatives in the investment experiment. The left investment is the high-risk and the right investment is the low-risk investment. Note that in the perception treatments the after-tax payoffs were exactly the same as in baseline treatment. Note also that the choice pairs were not displayed in this order, but randomly.

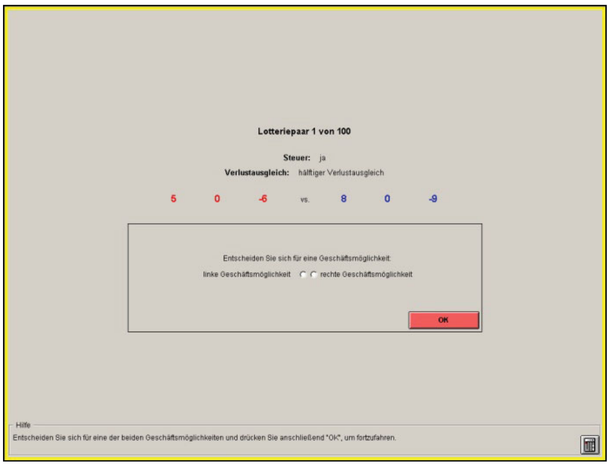
	investment number	left investment			right investment		
baseline treatment	1	14.00	0.00	-14.00	13.00	0.00	-13.00
	2	12.00	0.00	-12.00	11.00	0.00	-11.00
	3	10.00	0.00	-10.00	9.00	0.00	-9.00
	4	14.00	3.00	-14.00	13.00	3.00	-13.00
	5	12.00	3.00	-12.00	11.00	3.00	-11.00
	6	10.00	3.00	-10.00	9.00	3.00	-9.00
	7	14.00	6.00	-14.00	13.00	6.00	-13.00
	8	12.00	6.00	-12.00	11.00	6.00	-11.00
	9	10.00	6.00	-10.00	9.00	6.00	-9.00
	10	14.00	9.00	-14.00	13.00	9.00	-13.00
	11	12.00	9.00	-12.00	11.00	9.00	-11.00
	12	14.00	0.00	-14.00	11.00	0.00	-11.00
	13	12.00	0.00	-12.00	9.00	0.00	-9.00
	14	10.00	0.00	-10.00	7.00	0.00	-7.00
	15	14.00	3.00	-14.00	11.00	3.00	-11.00
	16	12.00	3.00	-12.00	9.00	3.00	-9.00
	17	10.00	3.00	-10.00	7.00	3.00	-7.00
	18	14.00	6.00	-14.00	11.00	6.00	-11.00
	19	12.00	6.00	-12.00	9.00	6.00	-9.00
	20	10.00	6.00	-10.00	7.00	6.00	-7.00
tax control treatment	21	14.00	0.00	-14.00	13.00	0.00	-13.00
	22	12.00	0.00	-12.00	11.00	0.00	-11.00
	23	10.00	0.00	-10.00	9.00	0.00	-9.00
	24	14.00	3.00	-14.00	13.00	3.00	-13.00
	25	12.00	3.00	-12.00	11.00	3.00	-11.00
	26	10.00	3.00	-10.00	9.00	3.00	-9.00
	27	14.00	6.00	-14.00	13.00	6.00	-13.00
	28	12.00	6.00	-12.00	11.00	6.00	-11.00
	29	10.00	6.00	-10.00	9.00	6.00	-9.00
	30	14.00	9.00	-14.00	13.00	9.00	-13.00
	31	12.00	9.00	-12.00	11.00	9.00	-11.00
	32	14.00	0.00	-14.00	11.00	0.00	-11.00
	33	12.00	0.00	-12.00	9.00	0.00	-9.00
	34	10.00	0.00	-10.00	7.00	0.00	-7.00
	35	14.00	3.00	-14.00	11.00	3.00	-11.00
	36	12.00	3.00	-12.00	9.00	3.00	-9.00
	37	10.00	3.00	-10.00	7.00	3.00	-7.00
	38	14.00	6.00	-14.00	11.00	6.00	-11.00
	39	12.00	6.00	-12.00	9.00	6.00	-9.00
	40	10.00	6.00	-10.00	7.00	6.00	-7.00

no deduction treatment	41	21.55	0.00	-14.00	20.00	0.00	-13.00
	42	18.45	0.00	-12.00	16.90	0.00	-11.00
	43	15.40	0.00	-10.00	13.85	0.00	-9.00
	44	21.55	4.60	-14.00	20.00	4.60	-13.00
	45	18.45	4.60	-12.00	16.90	4.60	-11.00
	46	15.40	4.60	-10.00	13.85	4.60	-9.00
	47	21.55	9.25	-14.00	20.00	9.25	-13.00
	48	18.45	9.25	-12.00	16.90	9.25	-11.00
	49	15.40	9.25	-10.00	13.85	9.25	-9.00
	50	21.55	13.85	-14.00	20.00	13.85	-13.00
	51	18.45	13.85	-12.00	16.90	13.85	-11.00
	52	21.55	0.00	-14.00	16.90	0.00	-11.00
	53	18.45	0.00	-12.00	13.85	0.00	-9.00
	54	15.40	0.00	-10.00	10.75	0.00	-7.00
	55	21.55	4.60	-14.00	16.90	4.60	-11.00
	56	18.45	4.60	-12.00	13.85	4.60	-9.00
	57	15.40	4.60	-10.00	10.75	4.60	-7.00
	58	21.55	9.25	-14.00	16.90	9.25	-11.00
	59	18.45	9.25	-12.00	13.85	9.25	-9.00
	60	15.40	9.25	-10.00	10.75	9.25	-7.00
partial deduction treatment	61	21.55	0.00	-16.95	20.00	0.00	-15.75
	62	18.45	0.00	-14.55	16.90	0.00	-13.35
	63	15.40	0.00	-12.10	13.85	0.00	-10.90
	64	21.55	4.60	-16.95	20.00	4.60	-15.75
	65	18.45	4.60	-14.55	16.90	4.60	-13.35
	66	15.40	4.60	-12.10	13.85	4.60	-10.90
	67	21.55	9.25	-16.95	20.00	9.25	-15.75
	68	18.45	9.25	-14.55	16.90	9.25	-13.35
	69	15.40	9.25	-12.10	13.85	9.25	-10.90
	70	21.55	13.85	-16.95	20.00	13.85	-15.75
	71	18.45	13.85	-14.55	16.90	13.85	-13.35
	72	21.55	0.00	-16.95	16.90	0.00	-13.35
	73	18.45	0.00	-14.55	13.85	0.00	-10.90
	74	15.40	0.00	-12.10	10.75	0.00	-8.50
	75	21.55	4.60	-16.95	16.90	4.60	-13.35
	76	18.45	4.60	-14.55	13.85	4.60	-10.90
	77	15.40	4.60	-12.10	10.75	4.60	-8.50
	78	21.55	9.25	-16.95	16.90	9.25	-13.35
	79	18.45	9.25	-14.55	13.85	9.25	-10.90
	80	15.40	9.25	-12.10	10.75	9.25	-8.50
capped deduction treatment	81	21.55	0.00	-18.20	20.00	0.00	-17.20
	82	18.45	0.00	-16.20	16.90	0.00	-15.20
	83	15.40	0.00	-14.20	13.85	0.00	-13.20
	84	21.55	4.60	-18.20	20.00	4.60	-17.20
	85	18.45	4.60	-16.20	16.90	4.60	-15.20
	86	15.40	4.60	-14.20	13.85	4.60	-13.20
	87	21.55	9.25	-18.20	20.00	9.25	-17.20
	88	18.45	9.25	-16.20	16.90	9.25	-15.20
	89	15.40	9.25	-14.20	13.85	9.25	-13.20
	90	21.55	13.85	-18.20	20.00	13.85	-17.20
	91	18.45	13.85	-16.20	16.90	13.85	-15.20
	92	21.55	0.00	-18.20	16.90	0.00	-15.20
	93	18.45	0.00	-16.20	13.85	0.00	-13.20
	94	15.40	0.00	-14.20	10.75	0.00	-10.75
	95	21.55	4.60	-18.20	16.90	4.60	-15.20
	96	18.45	4.60	-16.20	13.85	4.60	-13.20
	97	15.40	4.60	-14.20	10.75	4.60	-10.75
	98	21.55	9.25	-18.20	16.90	9.25	-15.20
	99	18.45	9.25	-16.20	13.85	9.25	-13.20
	100	15.40	9.25	-14.20	10.75	9.25	-10.75

A3 **Instructions of the investment experiment** (original in German)

Imagine you are an entrepreneur and have to decide, which business opportunities you may want to realize in the future. You will have the choice between two alternative business opportunities with different payoffs. Your task is to decide which one of the two you prefer.

In the course of this part of the experiment, there are 100 such decision situations that will all be represented as follows:



Each business opportunity is specified by **three payoffs**. Each of the three payoffs may realize with a **probability of 1/3**. This means for the red business opportunity (left business opportunity), that it will pay 5 with a probability of 1/3, 0 with a probability of 1/3, and the (negative) payoff – 6 with a probability of 1/3. After you have made all your decisions in the 100 situations, one of the situations will be selected at random to determine your payoff for the second part of the experiment. Hence, your result depends on one of your 100 decisions.

There are **four** different taxation methods for dealing with your payoffs. Positive payoffs may be taxable and negative payoffs may be tax-deductible (loss deduction). Loss deduction means that you receive a tax refund from tax authority in the case of a loss, i.e. your actual loss is reduced. The currently valid method, which always affects both business opportunities, is shown above the presentation of the two business opportunities. For example, in the figure above, the 3rd method (50 % loss deduction) is presented as:

tax: yes
loss deduction: 50 % loss deduction

In the following, the consequences of the four different taxation methods are specified:

1. Tax exemption

No taxation exists, i.e. none of the presented payoffs of the business opportunities are subject to taxation. Consequently, there is no necessity for loss deduction. All positive and negative payoffs remain unchanged.

2. No loss deduction (no l.d.)

The payoffs are taxed a rate of 35 %. But, there is no loss deduction. Hence, **all** positive payoffs are subject to taxation, while negative payoffs are not reduced.

3. 50 % loss deduction (50 % l.d.)

The payoffs are taxed a rate of 35 %. Half of the negative payoffs are eligible for tax deduction.

4. Capped loss deduction (capped l.d.)

The payoffs are taxed a rate of 35 %. Negative payoffs are eligible for full loss deduction up to a value of –12. Hence, negative payoffs between 0 and –12 are subject to a full loss deduction, but higher losses, i.e. values smaller than –12, are not eligible for any loss deduction.

Example:

		tax exemption		**no l.d.**		**50 % l.d.**		**capped l.d.**		
(1)	payoff (pre-tax)	5	-6	5	-6	5	-6	5	-6	-14
(2)	taxable part of the payoff	0	0	5	0	5	-3	5	-6	-12
(3)	resulting tax = (2) · 0.35	0	0	1.75	0	1.75	-1.05	1.75	-2.10	-4.20
	after-tax payoff = (1) - (3)	**5**	**-6**	**3.25**	**-6**	**3.25**	**-4.95**	**3.25**	**-3.90**	**-9.80**

- You can use the Windows-calculator during the experiment to calculate your after-tax payoffs. If required, press the calculator-symbol at the lower right corner.
- If you have any questions, please raise your hand and an assistant will help you.
- Please, complete the questionnaire and then let us know that you are ready, before the experiment starts.

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