Risk Taking and the Welfare State: Some Experimental Evidence

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Abstract The welfare state can be seen as an insurance device that enables society to decrease the variance in lifetime incomes by means of redistributive taxation. The Theory of the Welfare State (Sinn, 1995, 1996) provides theoretical arguments suggesting that the welfare state not only improves allocation efficiency but also may give rise to a redistribution paradox in such a way that redistributive taxation leads to more post-tax income inequality. Here, we report experimental evidence on some constituents of the Theory of the Welfare State, namely, the Domar-Musgrave effect and the redistribution paradox. While subjects' investments increase in the way predicted by theory when redistributive taxation and lump-sum transfers are introduced, the existence of a redistribution paradox is not confirmed by our data.

Keywords: Theory of the Welfare State, Redistribution Paradox, Domar-Musgrave Effect, Income Distribution, Experiment

JEL classification: H2, D31, D8

1 Introduction

In two influential articles, Hans-Werner Sinn (Sinn, 1995, 1996) characterized the welfare state as an insurance device that enables society to decrease the variance in lifetime incomes by means of redistributive taxation. In the words of Sinn, "redistributive taxation and insurance are two sides of the same coin" (Sinn, 1995, p. 496). Of course, the basic idea behind the Theory of the Welfare State (henceforth referred to as TWS) was not new (for a survey of the prior literature, see Barr, 1992; for more recent applications see, for example, Casamatta et al., 2000; Hindriks and De Donder, 2003) but it gave a new twist to the old redistribution-and-insurance story. Against the conventional wisdom that government intervention would bring about disincentive effects that are detrimental to allocation efficiency, Sinn provided new theoretical arguments suggesting that the welfare state might in fact not only *improve* allocation efficiency. It may also give rise to a redistribution paradox in such a way that redistributive taxation leads to *more* inequality in net incomes, which is perhaps the most striking implication of TWS.

The argument for this surprising and politically controversial variant of the classical equity-efficiency-tradeoff goes as follows: First, redistributive taxation induces people to engage more in risky and productive activities. This behavioral reaction of investors is known as the Domar-Musgrave effect (Domar and Musgrave, 1944). Second, if people anticipate that the welfare state will return back the surplus from taxing their investments, they will invest even more if their preferences exhibit decreasing absolute risk aversion. Hence, the welfare state improves allocation efficiency in terms of average lifetime income. Third, if the share of resources invested increases at a greater rate than income, that is, people's preferences exhibit decreasing relative risk aversion, inequality will rise.

In this paper, we provide experimental evidence on some constituents of TWS, namely the Domar-Musgrave effect and the redistribution paradox. While some authors have already experimentally studied the Domar-Musgrave effect in a portfolio-choice context in the past (see the literature review below), we are, to the best of our knowledge, the first authors to study it in an income-distribution context. The empirical relevance of the redistribution paradox has not been tested with laboratory data so far. We introduce a simplified version of TWS from which we derive our working hypotheses. In the experiment, subjects are assigned to groups of eight and individually choose the share of their initial endowments they want to invest into a 'super lottery' (Wagner, 1958) with eight outcomes and positive expectation. We use the 'individual-choice treatment' of Traub et al. (2009) in order to create the income-distribution context: Each group member is

randomly assigned to one outcome of the lottery (corresponding to a specific position in an income distribution) and each outcome is assigned only once. The experiment involves three treatments. In the control treatment, subjects receive their personal outcomes of the lottery as payoffs. The second treatment involves a proportional tax on gains and losses and subjects' payoffs are net outcomes. The third treatment involves both the proportional tax and a lump-sum transfer which equals one eighth of the surplus from equally taxing gains and losses.

Our main findings are as follows. Subjects' investments significantly increase in the way predicted by theory if redistributive taxation and lump-sum transfers are introduced. However, if the Domar-Musgrave effect is considered separately (without the lump-sum transfer), it turns out to be insignificant at the between-subjects level. Analyzing the data at the within-subjects level, however, supports the Domar-Musgrave effect. The redistribution paradox is not confirmed by our data: Groups treated with redistributive taxation and lump-sum transfers exhibit more efficient and less unequal net income distributions than the control groups.

The paper is organized as follows. The next section gives a brief review of the literature. Section 3 introduces the model and derives working hypotheses. In Section 4, we explain the details of the experiment that was conducted in order to test TWS. Section 5 presents the results. The paper concludes with Section 6.

2 Literature Review

We begin with our literature review with a 'historical' classification of TWS and then summarize the existing experimental literature on risk taking and taxation. The idea that the distribution of lifetime incomes is generated by individual choices under risk can be traced back to Friedman (1953), who held that it follows from expected utility maximization (Friedman and Savage, 1948) that "...the inequality of income in a society may be regarded [...] as [...] a reflection of deliberate choice in accordance with the tastes and preferences of the members of society rather than simply and 'act of God'." (Friedman 1953, p. 278). Though Kanbur (1979) later showed in a general equilibrium framework that the relationship between risk taking and inequality neither has to be monotonic nor does greater diversity in risk preferences necessarily has to contribute to more societal inequality, the individualistic approach to social welfare proposed by Friedman has influenced scores of authors.

An important contribution to this literature was made by Harsanyi (1953,

1955, 1978), who proved the equivalence between expected utility maximization and welfare maximization with interpersonally comparable cardinal utility. Harsanyi's utilitarianism postulates that people maximize their utility from under a veil of ignorance under the assumption that all future income positions are equally likely ('equiprobability model'). Hence, though they are personally involved in the society, people act *ethically* in terms of being impartial welfare maximizers.[1] Consequently, the concepts of individual risk aversion and societal inequality aversion completely amalgamate in the Friedman-Harsanyi framework.

Gibrat (1931) already modelled the distribution of personal incomes as the outcome of a multiplicative stochastic process that creates a positively skewed income distribution under the assumption of the 'law of proportional effect'[2]. The positively-skewed shape is well in line with empirical observations (see, for example, Mincer, 1970; Castañeda et al., 2003; and Atkinson and Bourguignon, 2015) and has been made a core element of many income-redistribution models in political economy, for instance, the Meltzer-Richard model (Meltzer and Richard, 1981; for a literature overview, see Moene and Wallerstein, 2001).

Other strands of the literature analyze the role of taxation under uncertainty in various microeconomic contexts such as asset choice (see, for example, Feldstein, 1969; and Alan et al., 2010), or in the context of optimum taxation (for example, Diamond et al., 1980). In this paper, we focus on the aspect of taxation-induced risk taking. That equally taxing gains and losses of risky investments can induce more risk-taking in investors via the reduction of the variance of outcomes was discovered by Domar and Musgrave (1944): "If losses can be offset [. . .] [t]he investor's income [. . .] has been reduced, and to restore it, he will take more risk [. . .]" (p. 390). Mossin (1968) integrated their theory into the expected utility framework.

The first experimental study on the Domar-Musgrave effect was conducted by Swenson (1989). His experiment used a double-auction design. Subjects were either in a seller or a buyer role. Sellers were endowed with risky assets ('certificates') and buyers with cash. At the end of each period, certificates were redeemed at a high value resulting in a gain, or at a low value resulting in a loss. Both gains and losses were subject to taxation. Subjects went through four different taxation schemes, but in a within-subjects-design: no tax (control treatment), proportional tax, progressive tax and proportional tax with tax credit. The author found the demand for risky assets to

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[1]The model has provoked a lot of criticism. See, for example, Diamond (1967), Rawls (1971, 1974) and Harsanyi's reply (Harsanyi, 1975a, 1975b).

[2]The law means that relative income change is a time-independent random variable.

increase under a proportional tax with tax credit. Conversely, a progressive tax decreased risk taking. Surprisingly, the proportional tax scheme did not significantly increase the demand for the risky certificate as compared to the control treatment. This finding contradicts the insurance effect of a taxation scheme that enables investors to fully deduct losses discovered by Domar and Musgrave (1944).

Similar results were reported by King and Wallin (1990) in an individual choice experimental design. Subjects had to allocate their endowments between a risky and a safe asset. Gains and losses were taxed using three taxation schemes: no tax (control treatment), proportional tax, and progressive tax. They used a within-subjects design, too. The data confirmed the authors' prediction that a progressive tax would decrease holdings of the risky asset. In line with Swenson (1989), they did not find a significant effect of the proportional tax scheme on risk-taking.

Fochmann et al. (2012a, b), Ackermann et al. (2013) and Fochmann and Hemmerich (2014) investigated whether risk perception can explain the findings of Swenson (1989) and King and Wallin (1990). Fochmann et al. (2012a) analyzed whether varying loss offsetting methods may lead to different investment behaviors. Subjects went through several decision tasks in which they had to choose between a low risk asset and a high risk asset. The expected value of both investment alternatives was the same, but their variance differed accordingly. While gains were always subject to the same tax rate, there were three treatment for losses: losses were non-deductible, up to 50% deductible, or completely deductible with a cap. Net payoffs were the same in all treatments. Hence, the only treatment difference was the *framing* of gross payoffs and deduction rules. The investment in the high risk asset increased significantly with partial and capped loss deduction when compared to no loss deduction.

Fochmann et al. (2012b) and Ackermann et al. (2013) used similar framing designs. The former study showed that risk taking increased if a proportional income tax with a full loss offset was applied. Interestingly, the latter study found that participants invested a lower amount in the risky asset when they had to pay a tax or when they received a subsidy and the effect intensified if both were combined. Fochmann and Hemmerich (2014) therefore drew the conclusion that the framing of the decision problem plays an important role in the investment decision. Based on their previous studies they argued that, if framing effects were controlled for, investments would actually increase, thus providing evidence on behalf the existence of the Domar-Musgrave effect. Fochmann and Hemmerich (2014, p. 28) issued a warning that due to these behavioral effects "[. . .] politicians should be aware that governmental interventions could bias risk taking behavior" and

produce very negative consequences.

The following theoretical model (Section 3) and experimental design (Section 4) are based on the individualistic approach to social welfare pioneered by Friedman and Harsanyi. Individual decision makers maximize their expected utility by optimally choosing the share of their wealth they want to place into a risky and profitable investment. The resulting distribution of wealth therefore reflects people's attitudes towards risk (and inequality). Note that, since we are in an individual choice framework without strategic interaction between group members, the model does not account for attitudes towards inequality and efficiency in terms of social preferences. Nevertheless, we assess social preferences in the experiment and control for their impact on individual investments in the regression analysis.

Along the lines of TWS, the welfare state is introduced in two steps. First, we apply a proportional tax on gains and losses (that is, we assume fully deductability), which is expected to give rise to the Domar-Musgrave effect. Second, we additionally pay a lump-sum transfer, which is expected to cause an income effect and may give rise to the redistribution paradox. In order to avoid the framing effect discovered by Fochmann and Hemmerich (2014), we use a neutral framing.

3   The Model

In this section, we introduce our model. It is a simplified version of TWS that enables us to focus on the risk-taking-and-taxation aspect. In particular, we stripped off the optimum taxation part. The presentation of the model was also inspired by the easily accessible textbook version of TWS from Breyer and Buchholz (2009).

An investor's initial endowment is given by $Y_0 \in \mathbf{R}_+$. At $t = 0$ she decides on the amount V_0 to be invested in a risky asset, where $0 \leq V_0 \leq Y_0$. The asset is a 'super lottery' (Wagner, 1958) that consists of a sequence of T independent Bernoulli trials with success probability p. Let $z_t = \{0 \,(\text{failure}), 1 \,(\text{success})\}$ denote the outcome of the tth lottery. The total number of successful investments $x = \sum_{t=0}^{T} z_t$ is a random variable X exhibiting a binomial distribution with $T + 1$ distinct outcomes $x \in X = \{0, 1, \ldots, T\}$. The probability density function of X is given by

$$f_X(x) = \left(\begin{array}{c} T \\ x \end{array} \right) p^x (1 - p)^{T-x} I_{\{0,1,\ldots,T\}}(x) \,, \tag{1}$$

where $I_\Omega(\omega)$ is an indicator function that equals one if $\omega \in \Omega$ and zero otherwise.

After each lottery, V_t yields an interest of r^+ in the case of a success and r^- in the case of a failure, where $r^+ > 0 > r^-$. The interest factor $R_t = V_t/V_{t-1}$ is a random variable with constant expected value $E(R_t) = 1 + pr^+ + (1-p)r^-$ and variance $Var(R_t) = p(1-p)(r^+ - r^-)^2$. Henceforth, we assume that the asset on average yields a positive return, that is, $E(R_t) > 1$.

After T lotteries and x cases of success, the investor's wealth is given by

$$Y_T(x) = Y_0 + \left((1+r^+)^x(1+r^-)^{T-x} - 1\right) V_0 . \tag{2}$$

We assume that the investor's optimum choice $V_0^\star$ is consistent with maximizing expected utility

$$EU = \sum_{x=0}^{T} f_X(x) u\left(Y_T(x)\right) , \tag{3}$$

where $u(\cdot)$ is a von Neumann-Morgenstern utility function. The necessary condition for $V_0^\star$ to be expected utility maximizing is given by

$$\sum_{x=0}^{T} f_X(x) u'\left(Y_T(x)\right) \left((1+r^+)^x(1+r^-)^{T-x} - 1\right) = 0 . \tag{4}$$

It requires the expected positive return on the last unit of wealth invested to exactly balance its potential negative return.

Now, we impose a proportional tax with rate $0 \le \tau \le 1$ on all gains and losses, that is, we assume full deductability. The investor's final net wealth is then given by

$$Y_T^\tau(x) = Y_0 + \left((1+r^+)^x(1+r^-)^{T-x} - 1\right) V_0 (1-\tau) . \tag{5}$$

Hence, we have to replace equation (2) by (5) in the maximization of (3). Let V_0^τ denote the optimum investment in presence of the tax. The expression $(1-\tau)$ drops out of the necessary condition (4) because τ is imposed both on gains and losses.[3] Yet, the tax decreases the investor's final net wealth in case of an overall gain $(Y_T^\tau(x) > Y_0)$ and therefore increases the marginal utility of wealth $u'(\cdot)$. Analogously, it increases the investor's final net wealth in case of an overall loss $(Y_T^\tau(x) < Y_0)$ and therefore decreases the marginal utility of wealth. Consequently, the investor must increase V_0, where the increase is inversely proportional to $(1-\tau)$:

$$V_0^\tau = \frac{V_0^\star}{1-\tau} . \tag{6}$$

This is the insurance effect or *Domar-Musgrave effect* of the tax:

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[3]With $\tau = 1$, the investor would receive exactly Y_0 irrespective of whether she wins or loses.

Hypothesis 1 (Domar-Musgrave effect). *The investor increases her investment if gains and losses are taxed equally.*

Next, we assume that there are n identical investors. At each point of time exactly pn of them are successful while $(1-p)n$ fail. Let $\tilde{V}_0$ denote the level of investment that arises under the assumption that each investor takes the investment of the other investors as given (Cournot-Nash equilibrium). Since the expected return of the asset is positive, the taxes collected from the 'winners' exceed the subsidies to be paid in order to partly compensates the 'losers' for their losses:

$$\Gamma(\tilde{V}_0) = n\tau\tilde{V}_0 \sum_{x=0}^{T} f_X(x) \left((1+r^+)^x(1+t^-)^{T-x} - 1\right) > 0 \ . \tag{7}$$

The surplus $\Gamma(\tilde{V}_0)$ is equally distributed among all investors by means of a lump-sum transfer $\gamma = \Gamma(\tilde{V}_0)/n$. The transfer increases each investor's final wealth[4] irrespective of the number of successful investments x:

$$Y_T^\gamma(x) = Y_0 + \left((1+r^+)^x(1+r^-)^{T-x} - 1\right) V_0 (1 - \tau) + \gamma \ . \tag{8}$$

Replacing equation (5) by (8) in the maximization (3) yields the same optimum condition as before, except that $u'(\cdot)$ includes $\gamma > 0$ now. If the investor correctly anticipates γ, her optimum investment V_0^γ thus increases (stays constant, decreases) as compared to V_0^τ if $u(\cdot)$ exhibits decreasing (constant, increasing) absolute risk aversion. Taking into account that decreasing absolute risk aversion (DARA) is considered to be the standard case in the literature (see Friend and Blume, 1975; Paravisini et al., 2016), we arrive at the following hypothesis:

Hypothesis 2 (Income Effect). *The lump-sum transfer induces investors to take more risk.*

In the following two equations, we express the optimum solution of the investment problem in terms of the expected value and the coefficient of variation of net wealth:

$$\mu = \sum_{x=0}^{T} f_X(x) Y_T(x) \tag{9}$$

$$\nu = \frac{\sqrt{\sum_{x=0}^{T} f_X(x) (Y_T(x) - \mu)^2}}{\mu} \ . \tag{10}$$

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[4]For a given investment, expected net wealth is identical in the situations without tax and with tax and lump-sum transfer. Expected net wealth is lower in the situation with tax but without transfer.

Obviously, the proportional tax τ does neither change μ nor ν because net income does not change. With DARA, the additional lump-sum transfer γ increases μ. Whether ν decreases, stays constant or increases depends on whether $u(\cdot)$ exhibits increasing, constant, or decreasing relative risk aversion. We formulate the latter case as a hypothesis and call it 'redistribution paradox':

Hypothesis 3 (Redistribution Paradox). *Redistribution in the welfare state leads to both greater efficiency and more inequality.*

4 The Experiment

The experiment was implemented with z-Tree (Fischbacher, 2007). Subject recruitment was done using hroot (Bock et al., 2014). The experiment involved three separate parts: (i) an elicitation task for distributional preferences, (ii) a decision on an investment in a risky asset, and (iii) a risk-preference elicitation task. After reading the experiment's instructions, subjects had to answer five control questions and were subsequently informed about the right answers. After the end of the experiment, participants completed a questionnaire. We start our description of the experiment with the main task, the investment in a risky asset.

4.1 The Investment Task

The investment task resembles the decision problem presented in Section 3. We use three different treatments: NO TAX, TAX and LUMP SUM. Each subject is assigned only once to one of the three treatments. The task is repeated four times (rounds). At the beginning of each round, subjects receive monetary endowments of $Y_0 = 100$ points and are randomly matched to groups of eight within their treatment. Subjects simultaneously and anonymously select their preferred investments V_0, where $0 \leq V_0 \leq 100$. 100 points are later on converted into 2 Euros. They receive the outcome of the investment plus the residual amount $Y_0 - V_0$ as payoff. The total payoff of the investment task is the sum of the payoffs of all four rounds. Round outcomes are not revealed before after the end of the entire experiment in order to avoid hedging or wealth effects.

As described in Section 3, the investment involves a sequence of $T = 3$ independent Bernoulli trials with success probability $p = 0.5$. V_t yields an interest rate of r^+ in case of success and r^- in case of failure. Hence, the investment generates $2^3 = 8$ possible outcomes that all have an individual probability of 1/8. The outcomes are referred to as positions $\{A, B, C, D, E, F, G, H\}$,

respectively. When all eight group members have submitted their investment V_0, each group member is assigned to one of the eight positions A to H. Positions are assigned only once within each group. Hence, each group member has an ex ante probability of 1/8th to be assigned to one of the eight positions and to receive the outcome assigned to the respective position, based on her own V_0, as her payoff.

Friedman's (1953) and Harsanyi's (1955) individual-choice approach to social welfare underlying TWS assumes that the decision maker becomes a member of the respective society after having made her choice. This requirement is incorporated into the experimental design by assigning subjects randomly to the eight possible positions and paying them out together, instead of paying out them separately as in a standard individual-choice experiment (the group assignment procedure is adopted from the 'individual-choice treatment' of Traub et al., 2009). Hence, though subjects have to make individual investment decisions that do neither affect the payoff nor the decision space of their group mates, they make their decisions in a group context that could be interpreted as a small stylized society in which the outcomes of the lottery represent an income distribution (this aspect of the experiment was also highlighted in the instructions). We should like to emphasize that this central feature of the individual-choice approach (and the model outlined above) could neither be preserved in a pure individual choice experimental setting without such a group context, nor in a game theoretic experimental setting where subjects actually interact and create utility externalities by their investment choices.

Table 1 illustrates the decision task by means of a coin toss which is repeated three times. Heads wins ('success') and tails loses ('failure'). We set $r^+ = 0.6$ and $r^- = -0.4$. All eight possible outcomes as well as their corresponding positions and payoffs per point are shown at the bottom of the table.[5] A glance at the payoffs shows that the sequence of three coin tosses gives rise to the positively skewed income distribution, which is typical for OECD countries and predicted by stochastic theories of income distribution.

In the No Tax treatment, the payoff per point is multiplied with V_0. In the Tax treatment, a proportional tax rate τ is imposed on both gains and losses. Hence the payoff per point is multiplied with $V_0(1-\tau)$. In the Lump Sum treatment, the payoff per point is also multiplied with $V_0(1-\tau)$ and each position receives an additional lump-sum transfer of

$$\gamma = \tau V_0 \sum_{x=0}^{3} f_X(x) \left((1+r^+)^x (1+t^-)^{3-x} - 1 \right) ,$$

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[5]Strictly speaking, there are only four *different* outcomes.

Table 1: Coin Toss and Position

1st coin toss		H					T	
2nd coin toss		HH		HT		TH		TT
3rd coin toss	HHH	HHT	HTH	HTT	THH	THT	TTH	TTT
Position	A	B	C	D	E	F	G	H
Payoff per point	4.096	1.536	1.536	0.576	1.536	0.576	0.576	0.216

Notes: 'H': heads (success) means a multiplication with 1.6 ($r^+ = 0.6$); 'T': tails (failure) means a multiplication with 0.6 ($r^- = -0.4$).

see equation (7). For example, given the parameters $r^+ = 0.6$, $r^- = -0.4$ and $\tau = 0.4$, γ amounts to 13.2% of the investment V_0. Table 2 shows the calculation of payoffs in the different treatments.

Table 2: Payoff Function by Treatment

Treatment	Calculation of payoff
No Tax	$Y_3(x) = 100 + \left((1+r^+)^x(1+r^-)^{3-x} - 1\right) V_0$
Tax	$Y_3^\tau(x) = 100 + \left((1+r^+)^x(1+r^-)^{3-x} - 1\right) V_0 (1-\tau)$
Lump Sum	$Y_3^\gamma(x) = 100 + \left((1+r^+)^x(1+r^-)^{3-x} - 1\right) V_0 (1-\tau) + \gamma$

Notes: There is 1 subject with $x = 0$ successes, 3 with $x = 1$, 3 with $x = 2$ and 1 with $x = 3$.

The values of r^+, r^- and τ change in every round. There are four different variations, which we call *Basic*, *High Inequality*, *High Efficiency* and *High Tax* (see Table 3). The variations are the same in all treatments. One of the four variations is randomly assigned to each round in a stranger design. We ensure that each variation is only used once in a session. The values for r^+ and r^- are higher in *High Inequality* as compared to *Basic*, which gives a higher standard deviation of outcomes. In *High Efficiency*, the value for r^+ changes from 0.6 to 0.7 as compared to *Basic*, thus increasing the mean profitability of the asset. Finally, in *High Tax* τ is increased to 0.5.[6]

Table 3: Round-Variation of Parameter Values

	Basic	High Inequality	High Efficiency	High Tax
r^+	0.6	0.9	0.7	0.6
r^-	-0.4	-0.7	-0.4	-0.4
τ	0.4	0.4	0.4	0.5

Since Fochmann and coauthors (see Section 2) reported a negative tax perception effect, we frame the experiment as a neutral investment choice rather than in terms of a 'welfare state' and avoid any terms like 'tax' or

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[6]In No Tax, there is no tax rate and we therefore aggregate *Basic* and *High Tax*.

'transfer'.[7] In the instructions (see Appendix A), subjects are simply told that they are randomly assigned to a group which consists of eight people at the beginning of each round. Each group member receives an initial amount of 100 points and has to decide individually on her investment between 0 and 100 points. They receive the amount that they do not invest for sure. For the invested amount, there are eight possible outcomes that have the same probability. The outcomes are referred to as positions A to H. Each group member is assigned to one of the positions after all participants have submitted their investment and each position is assigned only once within a group. Every group member receives the outcome belonging to the position based on his or her own investment. The payoff in each round consists of the sure amount plus the outcome of the investment. Subjects are told that they can check the outcome of different investments for each position by moving a slider on the screen from left to right. The program then automatically calculates the outcomes, given the respective treatment and round-specific parameter variation. In the example of Figure 3 in the Appendix, the subject is in the LUMP SUM treatment with the *Basic* variation. She tries the investment $V_0 = 50$, leading to potential payoffs of 200, 123, 94 or 83, depending on her final position.

4.2   Preference Elicitation Tasks

As subjects might differ with respect to their social preferences and risk attitudes, we conduct Kerschbamer's equity equality test (Kerschbamer, 2015) in part (i) of the experiment and we elicit their risk attitudes using the standard lottery selection design by Holt and Laury (2002) in the slightly modified version by Balafoutas et al. (2012) in part (iii).

In the equity equality test, subjects are faced with a series of ten binary choices, split into two blocks. Within each block of five choices, subjects have to allocate points to themselves and a 'passive person'. The choices involve a trade-off between efficiency (number of points in total) and advantageous inequality (first block) or disadvantageous (second block) inequality. In order to save space, we omit details and refer to the original description of the double price-list technique by Kerschbamer (2015). The instructions can be found in Appendix A. At the end of the task, subjects receive a combined payoff of one of their ten choices as a decision maker and as a 'passive person'. It is not possible to be matched with the same person twice.

The disadvantageous inequality block provides a measure of efficiency

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[7]Indeed, a pilot study with a tax framing generated more variance in the data, mainly caused by some subjects choosing low investments in the tax and lump sum treatments.

preferences, the willingness-to-pay for disadvantageous inequality, $WTP^d \in [-0.667, 0.667]$. It is calibrated to the allocation where a subject switches from the more-efficient-self-disadvantageous to the more equal allocation. A negative WTP^d means that the subject is willing to sacrifice efficiency for a more equal allocation, while positive values mean a preference for efficiency in spite of getting a lower payoff than the 'passive person'. Analogously, the advantageous inequality block provides a measure of inequality aversion, the willingness-to-pay for advantageous inequality $WTP^a \in [-0.667, 0.667]$. It is calibrated to the allocation where a subject switches from the more-efficient-self-advantageous to the more equal allocation. A negative WTP^a means that the subject is willing to sacrifice equality for a more efficient allocation, while positive values mean a preference for equality in spite of sacrificing own payoff.

In the lottery-selection task, subject are assigned a score $R \in [0, 1]$, where $R = 0.5$ marks risk neutrality. Lower (higher) values indicate risk aversion (risk seeking). At the end of the task, one decision is randomly chosen for payoff. Instructions are provided in the Appendix.

5   Results

The experiment was conducted in 2016 at the experimental lab of the University of Hamburg with 96 subjects. 59 (61%) of them were female. 32 subjects participated in each treatment. One session lasted for 60 minutes. The lowest payoff was 7.86 Euros, the highest payoff 21.84 Euros and the average payoff 12.84 Euros.

Figure 1 gives a first graphical impression of the investment behavior aggregated over all three (No Tax) or four (Tax, Lump Sum) parameter variations per subject. The bars in the left panel of the figure represent the mean investment by treatment. Subjects on average invested least in No Tax (48 points), they invested more in Tax (56), and they placed most in Lump Sum (65). Note that we obtained 30 left censored ($V_0 = 0$) observations (15, 10, 5 in Tax, No Tax, Lump Sum) and 101 right censored ($V_0 = 100$) observations (26, 32, 43). The right panel of the figure therefore additionally shows the cumulative probability distribution of V_0 by treatment. The graph of No Tax visibly and distinctly dominates the graphs of Tax and Lump Sum; the graph of Tax dominates Lump Sum for investments of more than 20 points. The medians are 45, 55.5, and 75 points. Hence, the first descriptive inspection of the data indicates that the tax and the lump-sum transfer have altered subjects' behavior in the hypothesized direction.
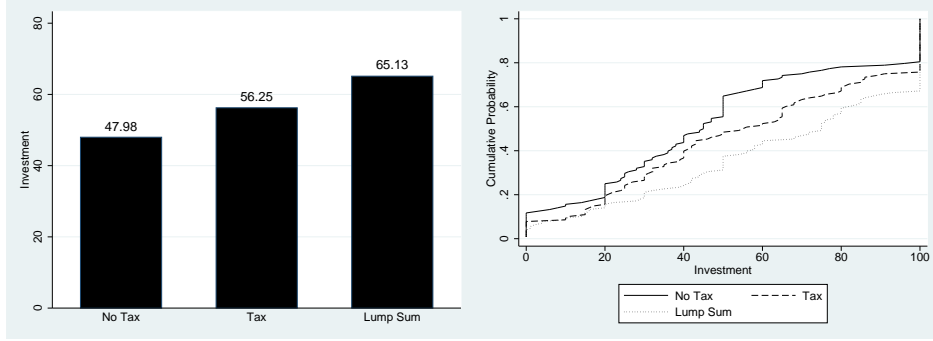
Figure 1: Mean Investment and Cumulative Probability by Treatment

In order to check whether these indications are statistically supported, we perform a regression analysis. Table 4 reports the results of a random-effects panel Tobit estimation with the investment, V_0, as the dependent variable. The regression model takes into account that we have four observations per subject, fixed covariates (such as gender), and a dependent variable that is censored from below (0) and above (100). Model I tests for the significance of the main treatment effects at the between-subjects level. Model II checks for the impact of parameter variations on investment behavior at the within-subjects level. Model III additionally controls for subjects' risk attitude (R), efficiency preference (WTP^d), inequality aversion (WTP^a) and gender (with 'female' as the benchmark category).

Altogether, 384 observations from 96 subjects entered each regression. The treatment effect of TAX is positive as expected, but it is insignificant in all three models. Subjects invested significantly more points (20-24) in LUMP SUM than in NO TAX. The difference between the coefficients of TAX and LUMP SUM is insignificant (mean difference in model III: 11.540, $p = 0.184$). In the strict sense, Hypotheses 1 and 2 have to be rejected in the light of these results, as neither the tax nor the lump-sum transfer alone are able to significantly raise subjects' investments. However, the joint impact of the two elements of the 'welfare state' is strong enough to significantly boost the amount placed in the 'super lottery'.

Models II and III show that more risk in terms of higher inequality of outcomes led to significantly lower investments (roughly -23 points) as expected. Increasing group efficiency in terms of the expected return of the investment made it significantly more attractive ($+18$ points). Moreover, in the *High Tax* parameter variation subjects invested significantly more (about $+12$ points). In model III, where we control for subjects' heterogeneity with respect to risk attitude, efficiency preference, inequality aversion and gen-

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Table 4: Estimation Results

	I	II	III
TAX	10.625	7.766	12.540
	(9.172)	(9.231)	(8.823)
LUMP SUM	23.439**	20.586**	24.081***
	(9.201)	(9.254)	(8.712)
High Inequality	—	-22.971***	-22.842***
		(4.743)	(4.739)
High Efficiency	—	18.239***	18.261***
		(4.790)	(4.790)
High Tax	—	12.427**	12.458**
		(5.751)	(5.748)
R	—	—	61.620**
			(27.665)
WTP^a	—	—	-5.782
			(12.444)
WTP^d	—	—	16.744
			(12.041)
Male	—	—	13.427*
			(7.626)
Constant	51.286***	52.049***	12.717
	(6.485)	(6.737)	(16.529)
Wald-χ^2	6.506**	78.649***	91.306***

Table notes. Random-effects Tobit panel model. Dependent variable: investment in points, V_0. $n = 384$.
*$p \leq 0.1$, **$p \leq 0.05$,***$p \leq 0.01$.

der, we see that risk aversion in subjects has a strong negative impact on their investment behavior (remember that positive values of R stand for risk seeking). Efficiency preferences and inequality aversion do not seem to have affected investment behavior. Male subject invested a significantly greater share of their initial endowments (+13 points).

Table 5 gives the predicted mean investment by treatment and parametrization. All figures are based on regression model III. Comparing predicted means between NO TAX and TAX provides us with a test of equation (6), according to which the optimum investment in TAX multiplied with $(1 - \tau)$ should equal the investment in NO TAX.[8] T-tests reject the null hypothesis that both (adjusted) mean investments are equal for all parametrizations (Basic and High Tax[9]: $p = 0.000$, High Inequality: $p = 0.019$, High Effi-

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[8]Note that the observed investments cannot be directly compared using this equation because they are bounded from above at 100 points. We therefore use the predicted values derived from the Tobit estimation that accounts for censoring.

[9]Since NO TAX has no High Tax parametrization, we aggregate Basic and High Tax for TAX in order to perform the t-test. The two observations originating from the same

ciency: $p = 0.000$). Hence, at the between-subjects level, we can certainly conclude that the insurance effect of equally taxing gains and losses was too weak to be significant. However, our experimental design enables us to test the insurance effect and equation (6) also at the within-subjects level using a comparison of the Basic and the High Tax parametrizations, which are identical except for the tax rate (40% vs. 50%). This t-test does not reject the null hypothesis that both adjusted means are identical ($p = 0.903$). Together with the result that the coefficient of High Tax was significant in regression models II and III, this means that at the within-subjects level individuals reacted to changes in the tax rate in the way predicted by the insurance effect.

Table 5: Mean Investment by Treatment and Parametrization

| Treatment | Parametrization | | | | Total |
	Basic	High Inequality	High Efficiency	High Tax	
No Tax	52.0	29.2	70.3	—	50.9
	(1.7)	(2.5)	(2.5)		(1.8)
Tax	60.0	37.2	78.3	72.5	62.0
	(2.4)	(2.4)	(2.4)	(2.4)	(1.8)
Lump Sum	72.2	49.4	90.5	84.7	74.2
	(2.1)	(2.1)	(2.1)	(2.1)	(1.7)
Total	59.1	38.6	79.7	78.6	62.4
	(1.4)	(1.6)	(1.6)	(1.7)	(1.1)

Table notes. First row: means (linear predictions based on regression model III); second row: standard errors (in parentheses).

Finally, we turn to Hypothesis 3. We separately compute for each parametrization of No Tax and Lump Sum, respectively, the efficiency and the inequality of the expected payoff distribution according to equations (9) and (10). The result of this computation is displayed in Table 6. As can be taken from the table, the tax and lump-sum treatment produced higher investments – a result already confirmed by the regression analysis – and therefore greater group efficiency amounting to 6.7-10.8 points or percent of the initial endowment. The right panel shows, however, that inequality *decreased* significantly in all parametrizations except for *High Inequality*, where we did not detect a significant difference between No Tax and Lump Sum. Hence, we have to reject Hypothesis 3; the existence of a redistribution paradox is not supported by our data.

Figure 2 illustrates the rejection of Hypothesis 3 for the *High Inequality* parametrization of the experiment. The two lines display the relationship between efficiency on the horizontal axis and inequality on the vertical axis

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subject are not independent of course.

Table 6: Efficiency and Inequality by Treatment and Parametrization (Linear Prediction)

Parametri-zation	Efficiency (μ)			Inequality (ν)		
	NO TAX	LUMP SUM	t-Test	NO TAX	LUMP SUM	t-Test
Basic	117.2	123.9	6.7***	0.509	0.403	-0.106***
	(0.6)	(0.7)		(0.015)	(0.009)	
High Inequality	109.7	116.3	6.7***	0.558	0.540	-0.018
	(0.8)	(0.7)		(0.044)	(0.020)	
High Efficiency	136.6	147.1	10.5***	0.718	0.517	-0.201***
	(1.3)	(1.1)		(0.019)	(0.008)	
High Tax	117.2	128.0	10.8***	0.509	0.382	-0.128***
	(0.6)	(0.7)		(0.015)	(0.007)	

Table notes. First row: mean efficiency and mean inequality (linear predictions based on regression model III); second row: standard errors (in parentheses). t-Test on the equality of two means with unequal variances (Welch test). *$p \leq 0.1$, **$p \leq 0.05$, ***$p \leq 0.01$.

without (solid line) and with welfare state (dashed line). Due to the lack of insurance through the welfare state, the solid line dominates the dashed line and investments therefore exhibit higher risk in terms of inequality for any given level of efficiency. On average, subjects chose point A in NO TAX and point B in LUMP SUM. Point B involves higher investments but about the same level of inequality as point A. A redistribution paradox – greater efficiency and higher inequality at the same time – would have occurred on the segment of the dashed line that lies in the right upper quadrant of a coordinate system with point A as the reference point, for example at a hypothetical point B', which would have required much more investment by the subjects.

6 Conclusion

In this paper, we have experimentally tested two constituents of Sinn's Theory of the Welfare state, namely, the Domar-Musgrave effect and the redistribution paradox. Subjects were assigned to groups of eight and individually chose the share of their initial endowments they wanted to invest into a 'super lottery' (Wagner, 1958) with eight outcomes and positive expectation. We used the 'individual-choice treatment' of Traub et al. (2009) in order to create the social-welfare context: Each group member was randomly assigned to one outcome of the lottery and each outcome was assigned only once. The experiment involved three treatments: a control treatment without welfare state, a 'tax' treatment with full loss deductability, and a 'lump-sum' treatment with an additional transfer. In order to avoid the framing effect
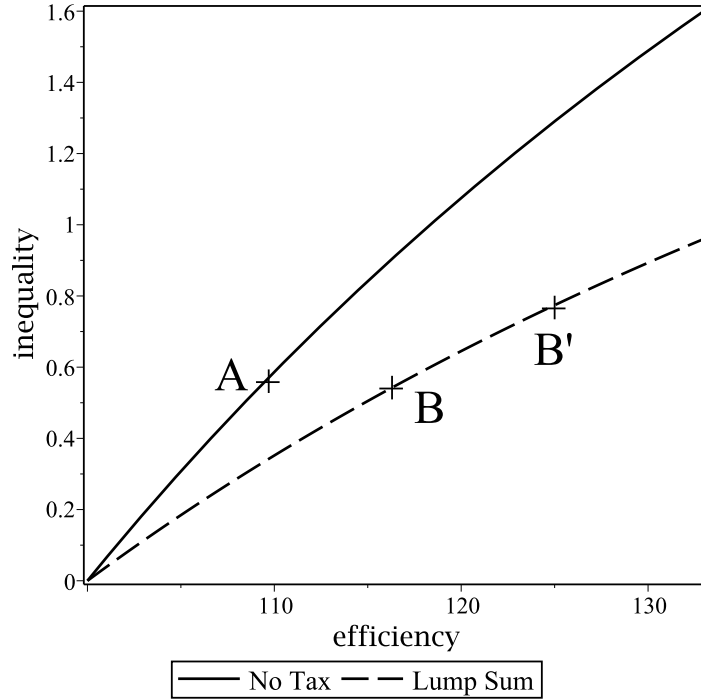
Figure 2: Efficiency and Inequality

discovered by Fochmann and Hemmerich (2014), we used a neutral framing.

Our main findings can be summarized as follows. Subjects' investments significantly increased in the way predicted by theory when introducing redistributive taxation and lump-sum transfers. Our results regarding the Domar-Musgrave effect are ambivalent: at the between-subjects level it turns out to be positive but insignificant; at the within-subjects level, we observe that subjects significantly change their investments in the way predicted. A possible explanation for this contradiction might be that subjects' investments were bounded from above by the size of their initial endowments and investment shares were already quite high in the control treatment. The redistribution paradox is not confirmed by our data. In three out of four parametrizations of the experiment, inequality actually shrunk significantly; in one parametrization (with high initial inequality), the level of inequality remained unchanged. Hence, we conclude that subjects' preferences did not exhibit decreasing relative risk aversion.

Can these results be carried over to the welfare state outside the lab? According to Eurostat the average tax-to-GDP-ratio of the EU28 member states was 40% in 2014. Though the tax and social system clearly differs

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in many aspects from the one described by our model, the tax rates chosen for the parametrization of our experiment (40% in three parametrizations, 50% in one parametrization) comes close to the average tax burden of 'real' taxpayers. Furthermore, the 'super lottery' generated degrees of income inequality comparable to the 'real world'. For example, full investment of the initial endowment in the *Basic* parametrization would result in a top-bottom income ratio of 5.4 as compared to an average quintile share ratio of 5.2 reported by Eurostat for the EU28.

The good news for the welfare state is: income redistribution seems to actually induce people to take more risk, leading to higher efficiency in terms of average lifetime income and to less income inequality. This conclusion, however, hinges on many assumptions. Most importantly, we assumed proportionality of the tax system and full deductability of losses throughout the model and experiment. This is an assumption that certainly does not exactly match real world welfare states. Moreover, in our simplified version of the Theory of the Welfare State, we ignored that moral hazard effects could countervail the insurance effect.

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A Instructions

A.1 Preliminaries

Welcome to the experiment. In this experiment, you will earn money provided that you read these instructions carefully and follow the rules. The money will be paid out to you in cash immediately after the experiment. During the experiment, we will use the term 'points' instead of Euros. Points will be converted into Euros as follows: 100 points = 2 Euros. During the experiment, you must not talk to other participants. If you have a question, please ask us. We will answer your questions individually. Compliance with these rules is important; otherwise, the results of the experiment will be of no scientific use. The experiment consists of three parts. Each part will be explained separately. In each part, you can earn money. All together, the experiment will last for approximately 60 min.[10]

A.2 Part 1

In the 1st part, we will ask you to make 10 decisions. In each decision, you are assigned to a group with another participant, who is called 'passive agent'. Your decision as an 'active decision maker' and the decision of the passive agent are made anonymously. In each of the 10 decisions, the passive agent is a different randomly chosen participant. In all decisions, you always have to choose between a left and a right option. The options are payoff distributions, meaning that both options are associated with a payoff for you and for the passive agent.

   We ask you to decide for each of the 10 decisions between the left and right options. The 10 decisions will be presented in two blocks of 5 decisions each. Please compare row by row the left and right options and decide on your preferred distribution for each row. You can make your decision by clicking on the left or right button.

   Calculation of your payoff from Part 1: Your payoff from Part 1 results from two partial payoffs. The 1st partial payoff results from the situation in which you were the active decision maker. At the end of the 1st Part, the program will randomly select 1 of the 10 decisions. For this decision situation, your decision between left and right will determine the payoff for yourself and the passive agent.

   The 2nd partial payoff results from the situation in which you were the passive agent. Following the same procedure as mentioned above, another

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[10]The original instructions were in German.

participant is randomly selected and determines with her chosen left-right-decision your payoff in the role of being the passive agent. We make sure that no two participants are in a reciprocal relation of being an active decision maker and a passive agent for the same person.

Your total payoff from the 1st part of the experiment is calculated by adding the payoffs from the situations in which you were the active decision maker and the passive agent.

If you have any questions, please raise your hand. One of the supervisors will come to you and answer your questions.

If you do not have further questions, please start and make your decisions between the left and right options.

Table 7: Choices in the Distributional-preferences Elicitation Task: Disadvantageous Inequality Block

LEFT		Your choice	RIGHT	
You get	Passive person gets		You get	Passive person gets
48 points	78 points	○ LEFT RIGHT ○	60 points	60 points
54 points	78 points	○ LEFT RIGHT ○	60 points	60 points
60 points	78 points	○ LEFT RIGHT ○	60 points	60 points
66 points	78 points	○ LEFT RIGHT ○	60 points	60 points
72 points	78 points	○ LEFT RIGHT ○	60 points	60 points

Table 8: Choices in the Distributional-preferences Elicitation task: Advantageous Inequality Block

LEFT		Your choice	RIGHT	
You get	Passive person gets		You get	Passive person gets
48 points	42 points	○ LEFT RIGHT ○	60 points	60 points
54 points	42 points	○ LEFT RIGHT ○	60 points	60 points
60 points	42 points	○ LEFT RIGHT ○	60 points	60 points
66 points	42 points	○ LEFT RIGHT ○	60 points	60 points
72 points	42 points	○ LEFT RIGHT ○	60 points	60 points

A.3   Part 2

Now we start with the 2nd part of the experiment. The choices in the 2nd part have no consequences on the payoffs of part 1 and 3 of the experiment. This part is played for four rounds, i.e., the task is repeated 4 times in a row.[11]

At the beginning of each round, you are randomly assigned to a group which consists of 8 people (group 1 or group 2). Each group member receives an initial amount of 100 points and has to decide on an investment. The invested amount can lie between 0 and 100 points. The rest of the initial amount is not invested. The investment decisions of other group members do not have an influence on your payoff.

Calculation of Payoff in Part 2: Your payoff is calculated as follows: You receive the amount that was not invested for sure. For the invested amount, there are 8 outcomes that have the same probability. The outcomes are referred to as position A, B, C, D, E, F, G, and H. Each group member is assigned to one of the positions after all participants have submitted their investment. Each position is only assigned once within a group. Every group member receives the outcome belonging to the position based on her own investment. The outcome may involve a gain, i.e., an increase of your invested amount, or a loss, i.e., a decrease of your invested amount. However, the loss is limited to the size of your investment. Hence, the payoff in each round consists of the sure amount plus the outcome of your investment.

On the decision screen in the experiment (see Figure 3), you can test the payoff for different investments for each position by moving a slider from left to right. Please use the provided possibility to inform yourself about the payoffs of different investments. Note that the size of gains and losses varies within each round. Therefore, please inform yourself anew at the beginning of each round as the possible payoffs have changed compared to the previous round.

Example (compare Figure 3): You can invest 100 points. Suppose, you decided to invest an amount of 50 points and the hypothetical payoff of Figure apply. If you are assigned to position A, your payoff in this round would equal 200 points (Figure 3, column 2). Hence, you would have made a gain of 100 points. In position B, C or D you would get a payoff of 123 points, in position E, F and G the payoff would equal 94 points and in position H 83 points. Your invested amount would have therefore increased in position B, C and D, but decreased in position E, F, G or H. Please be aware that each position is assigned with the same probability of 1/8 and that each position

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[11]This is an example for the Lump Sum treatment with the *Basic* variation. The instructions for the other treatments are available on request.

is only given out once.

Figure 3: Decision Screen in the Investment Task (Example: 50 Invested Points)

Position	A	B	C	D	E	F	G	H
Payoff	200	123	123	123	94	94	94	83

Please move the slider in order to test different investments.   0 | | 100

Your tested investment: 50

When you have made your decision, please enter the final investment in the box below.

OK

A.3.1 Part 3

Now we start with the 3rd part of the experiment. In this part, you can again earn some money. This part has no consequences for the payoff you obtained from the other parts of the experiment. In this part of the experiment, you choose between two options A and B for 10 different situations, which means you choose 10 times between options A and B. Option A always involves a safe payoff of a certain amount of points. Option B always determines your payoff by exactly the same lottery.

The table below shows the 10 situations and the 2 options among which you will have to choose. Either you see the table shown in Figure 4 or you see it in just the reverse order. The presentation of the table to you is randomized.

Example: Option A in the 9th line is 112.5 for sure. Option B in the 9th line is 5/10: 125 and 5/10: 0. If you select option A in the 9th line, you get a payoff of 112.5. If you select option B in the 9th line, you will get, in 5 out of 10 cases (50%), a payoff of 125, and in 5 out of 10 cases (50%), a payoff of 0 points.

We ask you to decide for each of these following 10 situations between options A and B. Please compare line by line options A and B and decide for each line by clicking A or B.

Calculation of payoff from Part 3: Your payoff from this part of the experiment is determined as follows: The computer randomly selects 1 of the 10 situations. Your decision in this situation is relevant for your payoff. For example you have decided for option B in the 2nd line and the computer randomly selects the situation in line 2 as relevant for the payoff. With a probability of 5 out of 10 cases (50%), you will get 125 points as payment, and in 5 of 10 cases (50%), you will get 0 points. You can imagine an urn filled with 5 white and 5 black balls for playing out the lottery. When a blindfolded person grabs into the box and draws a white ball, you will receive a payout of 125. If the drawn ball is black, you will get 0 points. The drawing of the balls is automated in the experiment and is performed by the computer.

If you have any questions, please raise your hand and wait quietly until someone comes to you. If you have no further questions, then you can make the selection of options A and B on the screen. After all participants have completed the 3rd part of the experiment, all participants see their individual payoffs of all three parts of the experiment, the total number of points, and thus, the total payment resulting from the addition of the three payments from the different parts of the experiment. This screen is followed by a short questionnaire. Finally, you will receive your payoff in cash and the experiment is finished.

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Thank you for your participation.

Figure 4: Decision Screen of Risk-preference Elicitation Task

	Verbleibende Zeit [sec]: 82

The table below shows the 10 situations and the two options among which you will have to choose. You have to make ten decisions about choosing option A or B.

After you have made the 10 decisions and confirmed your decisions, one decision will be randomly selected. If you have selected the lottery in the payoff-relevant situation, the lottery is played out. Your payoff is calculated given your decisions and the lottery outcome.

Option A	Option B	Selection
12,5 safe.	with 5/10: 125; with 5/10: 0	A ○ ○ B
25 safe.	with 5/10: 125; with 5/10: 0	A ○ ○ B
37,5 safe.	with 5/10: 125; with 5/10: 0	A ○ ○ B
50 safe.	with 5/10: 125; with 5/10: 0	A ○ ○ B
62,5 safe.	with 5/10: 125; with 5/10: 0	A ○ ○ B
75 safe.	with 5/10: 125; with 5/10: 0	A ○ ○ B
87,5 safe.	with 5/10: 125; with 5/10: 0	A ○ ○ B
100 safe.	with 5/10: 125; with 5/10: 0	A ○ ○ B
112,5 safe.	with 5/10: 125; with 5/10: 0	A ○ ○ B
125 safe.	with 5/10: 125; with 5/10: 0	A ○ ○ B

OK

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