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Trust and risk revisited

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ABSTRACT

A trustor faces a risky choice in the trust game when he acts upon his belief regarding the chances of betrayal by the trustee. Despite intensive research there is no clear evidence for a link between lottery risk preferences and risk involved in trusting others. We argue that this is due to crucial differences between the risk measurements in the two settings. Trusting is giving up control to a human while lottery risk arises from a mechanistic randomization device. We propose a risky trust game that experimentally measures risk in the same context as the standard trust game, but nevertheless reduces the trust decision to objective risk. Our results show that transfers in the trust game can indeed be explained by individual risk attitudes elicited with the risky trust game, while lottery risk preferences have no explanatory power.

1. Introduction

A crucial element of trust is "the willingness to increase one's vulnerability to another person whose behavior is not under one's control" (Zand, 1972). Namely, a trustor is always confronted with the possibility that his trust might not be honored. A trust decision, therefore, involves strategic uncertainty: a trustor forms a belief about the risk of betrayal by the trustee and, given this subjective probability, decides to trust or not. Moreover, if a trustor is confident about the probability of betrayal, say 50%, she actually faces a lottery with corresponding outcomes and 50% chance of losing. One could therefore argue that a trustor faces a risky choice in the trust game when he acts upon his belief regarding the chances of betrayal by the trustee (Coleman, 1990).

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But do individual risk attitudes indeed explain trust? Many experimental studies have attempted to answer the question above, but could not identify a clear link between trust and trustors' risk preferences (Etang, Fielding, & Knowles, 2011; Ashraf, Bohnet, & Piankov, 2006; Ben-Ner & Halldorsson, 2010; Eckel & Wilson, 2004; Houser, Schunk, & Winter, 2010).[1]

We argue that this is due to a mismatch between the measurement of risk and the type of risk a trustor faces in the trust game. The lottery setup, which has been typically used to elicit individual risk attitudes, does not fully capture the risk a trustor faces in the context of the trust game and thereby distorts the measurement of risk attitudes that are relevant in trusting behavior.

The essential difference between lottery risk and the risk taken in a trust game is that the former stems from a mechanistic randomization device while the latter stems from a conscious choice made by another human being. These different sources of risk can affect behavior even if both have the same objective probabilities and outcomes (Abdellaoui, Baillon, Placido, & Wakker, 2011). Such different responses towards human and mechanistic sources of risk can have many reasons. Losing money to a randomization device (nature) can be perceived as bad luck, but incurring a loss to another decision-maker might be interpreted as wrong judgment; a signal of failure to assess the social situation properly (Trautmann, Vieider, & Wakker, 2008); or as an exposure to conscious betrayal (referred to as 'betrayal aversion' by Bohnet and Zeckhauser (2004), and corroborated by Aimone and Houser (2012)). Intentionality may be another reason (Falk & Fischbacher, 2006). Imagine that John wants to drive home and has to choose between two roads. On both there is an equal objective risk of crashing because of a branch that may lie on the road. On one road the branch may have fallen off a tree by accident. On the other road a human may have intentionally broken off the branch. As the sources of risk differ, John may have a clear preference for the first road, although the probabilities and the direct outcomes are identical for both. Thus, a misalignment in the sources of risk might explain why previous studies could not find a link between risk that originates from a lottery and from a situation of trust.

The objective of this study is to identify the role of risk in trust and to suggest a novel measure of risk that is measured in the same context as the standard trust game by Berg, Dickhaut, and McCabe (1995). To elicit risk attitudes in the context of trusting, we developed a '*risky trust game*' where risk, as in the standard trust game, stems from a conscious decision of another person. We also measure lottery risk preferences by a standard lottery setup (Holt & Laury, 2002), which has been used by most studies that try to find a relationship between risk and trust (Corcos et al., 2012; Eckel & Wilson, 2004; Houser et al., 2010). We then relate both lottery risk preferences and risk preferences measured in the risky trust game to trustors' invested amount in the trust game.

We hypothesize that individuals' risk preferences stemming from the risky trust game influence trustors' decisions in the trust game, but lottery risk preferences do not. In both cases, the decision-maker faces pure risk, captured by objectively known probabilities of possible states of the world. However, in the lottery setup, the outcomes materialize due to the properties of the lottery mechanism, while the outcomes in the risky trust game were generated by a conscious choice of a human being.

In our risky trust game, the trustor objectively knows the probability that a trustee will honor her trust, and has to make a decision whether to trust or not. The fact that the probability of trustworthiness is objective and correct is guaranteed by implementing a conditional lottery design (Bardsley, 2000). We randomly match the trustor to one out of four trustees who decided individually and independently to honor trust or not. When deciding whether to trust and, if so, with which amount, the trustor knows that either none, one, two, three or all four trustee(s) are trustworthy. We ask the trustor to decide for each of these five possible scenarios which amount she would transfer to a randomly matched trustee. Hence, depending on the scenario, the trustor knows that the probability to be matched with a trustworthy trustee is either 0, 0.25, 0.5, 0.75 or 1.0. At the end of the experiment only one of the five scenarios, determined by the real return decisions made by trustees, is payoff-relevant for the trustor. Like a lottery, this risky trust game replicates a risky bet on a set of outcomes with objective probabilities. The essential difference is that the risk in the risky trust game stems from the decisions of other people and not solely from a mechanistic device. Hence, the decision in the risky trust game captures the effects of a trustor's vulnerability to another person (trustee), who is better off when keeping a trustor's transferred investment for himself.

To analyze a possible link between risk and trust we investigate the relationship between subjects' risk preferences elicited in the risky trust game and trustors' decisions in a '*standard trust game*', which builds on Berg et al. (1995). In the standard trust game, we also randomly select one trustee from four possible trustees for reasons of implementation comparability. The only difference between the risky and the standard trust game is that, in the latter, the trustor cannot condition an investment level on an objectively known probability distribution of trustworthiness among trustees.

Our experimental results show that risk preferences, measured in the risky trust game, strongly predict transfers in the standard trust game, while lottery risk preferences (Holt & Laury, 2002) do not. These results are robust in bivariate and multivariate settings and also in regressions where both risk measurements are included together. Moreover, we find that risk preferences measured in the risky trust game setting and lottery risk preferences are not correlated with each other, supporting the notion that sources of risk matter (Abdellaoui et al., 2011; L'Haridon, Martinsson, & Vieider, 2013). Altogether, these

[1] Subjects' risk preferences are measured by a variety of tools, e.g. by questionnaires like Zuckerman's sensation scale (Eckel & Wilson, 2004), a lottery setup with a menu of pair wise comparisons of two lotteries (Corcos, Pannequin, & Bourgeois-Gironde, 2012; Eckel & Wilson, 2004; Holt & Laury, 2002; Houser et al., 2010), or by a task involving a choice between a lottery and a sure option, which mirror the distribution of outcomes in the trust games (Eckel & Wilson, 2004; Schechter, 2007; Ben-Ner & Halldorsson, 2010), or not (Etang et al., 2011).

results indicate that individual risk attitudes can predict trusting decisions, but only when elicited in the same social context as the decision to trust. The remainder of this paper is organized as follows. In the next section, we introduce a brief literature review. Subsequently we explain the experimental design and procedures in Section 3. In Section 4 we present our results. Section 5 concludes.

2. Literature review

This paper contributes to the continuing discourse on the role of risk in trust decisions, in particular to the following studies that attempted to analyze and elicit risk attitudes in trust-related settings.

Bohnet and Zeckhauser (2004) provide the first attempt of a direct assessment of risk in a trust setting. In their experiments with a binary trust game, they elicit the minimum acceptable probability (MAP) of being matched to a trustworthy trustee for which the trustor would choose to trust. This design ultimately converts the trusting decision into a decision under risk, because the trustor can condition trusting on the (subjective belief of the) trustworthiness of the trustees. The authors show that such a trusting decision is more than betting. Trustors reveal a higher willingness to bet on "trust" when a lottery generates the outcomes than when trustees decide. The authors refer to the costs of losing control to the benefit of trustee as *betrayal aversion*.

Although Bohnet and Zeckhauser (2004) find that decisions differ between trust and risk environments, this is not supported by Kosfeld, Heinrichs, Zak, Fischbacher, and Fehr (2005) and contradicted by Fetchenhauer and Dunning (2012). Houser et al. (2010) argue that the conflicting results can be due to the fact that the analyses are based on aggregate data analyses of distributions between games. By collecting individual-level data on risk attitudes, Houser et al. (2010) control for individual heterogeneity. Their experimental design consists of four variations of the trust game. In two of them, the decision-maker places a bet, and the return is decided by a computer according to a known probability distribution. The return decision either affects only the decision-maker, or it also affects a dummy player. Comparison of these two variants allows addressing the role of social preferences in placing the bet. Their role, however, is found to be negligible. In two other treatments, a trustee makes the return decision. The trustor has either no information about the trustworthiness of the trustee, or he receives social history information about the typical observed behavioral pattern in a trustees' population. Houser et al. (2010) find that subjects' lottery risk preferences, as measured by Holt and Laury (2002), explain behavior in their computerized risk treatments, but not in the interpersonal trust treatments. They state, "this finding does not necessarily imply that risk attitudes are unimportant to trusting decisions, but it does suggest that, to the extent that risk attitudes do modulate trusting decisions, the mechanism remains to be discovered".

Both Bohnet and Zeckhauser (2004) and Houser et al. (2010) attempt to align the measurement of risk preferences with uncertainty in the trust game. Risk is simulated via information about the distribution of trustees' decisions from previous rounds (Bohnet & Zeckhauser, 2004), or other experiments (Houser et al., 2010). Therefore, the information provided to trustors on which basis they can assess trustees' risk profile does not directly relate to the situation at hand and it might fail to induce purely objective risk.

In Bohnet and Zeckhauser (2004) participants' MAP was compared to a predetermined probability, P^*, in both their decision problem (lottery) and the trust game. The value of P^* in the decision problem was established by the fraction of trustees who chose to reward trust in the trust game in the first two sessions. Participants are not told how this P^* is determined, nor what its value is. As P^* is unknown it is up to the participants to form a prior. The P^* for the trust game, on the other hand, is determined in each session separately by trustees' statements, before they actually decide, whether they would reciprocate if their matched partner would choose trust. This opens the possibility that participants interpreted the P^* differently in the lottery and in the trust game. Also, participants remain uncertain whether the P^* in the trust game is the correct description of the trustees they interact with. In summary, the design does not fully induce objectively known risk in the trust decision.

In Houser et al. (2010), the probability distribution of reciprocity in both trust treatments is similar to the social history information from Berg et al. (1995). Participants knew that this information describes trustee's choices in the past, and that it does not guarantee that it precisely reflects the decisions of trustees in the current session. The social history provided to participants might not correspond to the actual probability distribution of trustworthiness in a given session, and subjects might be aware of this. This leaves room for trustors to formulate alternative beliefs about trustworthiness of trustees. Most importantly, this information does not fully remove the uncertainty about the trustworthiness of trustees in the current session.

Thus, although both studies attempt to capture risk directly in a trust setting, they do not guarantee that the trustors know the probability distribution of trustworthiness with certainty. The simple design presented in this paper generates such an environment, with trustors acting upon an objective probability distribution of trustworthiness, which is both correct and payoff-dependent. We also use a within subject design to control, like Houser et al. (2010), for individual effect confounds due to individual heterogeneity.

3. Experimental design and procedures

3.1. The standard trust game

The standard trust game (STG) that we study as a baseline builds on the trust game by Berg et al. (1995). We implement the game as follows. The first mover, trustor, decides how much of his endowment E = 10 tokens (1 token = €0,50) to transfer to the second mover, the trustee. Transfer $x \in \{0, 1, \ldots, 9, 10\}$ is multiplied by three before reaching the trustee. Trustees on their behalf make a binary choice between either keeping the full amount or sending back half of the transferred tokens. We implement the game behind the veil of ignorance. All subjects make their decisions as a trustor first and then as trustee. They receive no feedback on decisions of others before providing complete information in the experiment. At the end of the experiment, one of these roles is assigned to each subject, and only the decisions in the assigned role are payoff-relevant for the subject.[2]

When making their decision to honor trust, trustees do not know whether a trustor has sent money or not. Trustees make a binary choice between returning either half or nothing of the money in case of a transfer. Such a restricted trustee strategy set is also used in, for example, Bohnet and Zeckhauser (2004). This design ensures that trustors choose a level of investment that exclusively stems from their inherent beliefs about trustees' trustworthy behavior and prevents that the decision to trust is confounded by other motives, for example signaling or elicitation of positive reciprocity.[3]

3.2. The risky trust game

For the risky trust game (RTG) we use the same setup as in the STG (see above) but implement the Conditional Information Lottery design developed by Bardsley (2000).[4] Trustors receive information that four trustees have been randomly assigned to them, and that one of these four trustees will be matched to them at random after the trustees' decisions have been made. The trustor is confronted with five possible scenarios: either none, one, two, three, or all four trustee(s) may choose to return one half of the received amount. In the moment of decision-making, the trustor does not know which of these five possible scenarios will materialize.

For each of the five possible scenarios, we ask the trustor to choose an amount that she wants to transfer to the trustee that will be randomly matched to her. Thus, trustors in the RTG make five decisions, x_0, x_1, x_2, x_3 and x_4, where x_i, $i = 0,1,\ldots,4$, denotes the payoff-relevant transfer in case the group of four trustees assigned to the trustor contains i trustworthy trustees. Allowing trustors to condition their transfer in the RTG on all possible scenarios of trustworthiness that may occur transforms the trust decision into a decision under risk with objectively known probabilities of trustees' trustworthiness (in our case probabilities are 0, 0.25, 0.5, 0.75, and 1).

At the end of the experiment, the actual distribution of trustworthiness in the group of four trustees will determine the payoff-relevant scenario for the trustor. The trustor's specific transfer in the materialized scenario of trustworthiness is randomly matched to one of the four trustees assigned to him. The return decision made by this trustee subsequently determines the monetary outcome of the randomly paired trustor and trustee.

For comparability reasons, we use the same matching procedure in the STG. Each trustor is assigned to four trustees, and one of the four trustees is randomly selected as the payoff-relevant trustee for the trustor. In the STG, as explained in the previous section, the trustor cannot condition the transfer on the trustworthiness of these four trustees. Hence, the only difference between both trust games is that trustors have objective probabilities about the trustworthiness of the trustees in the RTG but not in the STG.

3.3. Risk preference measures

We elicit subjects' **lottery risk preferences** with a standard lottery setup (Holt & Laury, 2002). In this lottery risk task subjects make a sequence of 10 choices between two lotteries with changing probabilities of given outcomes. Subjects' lottery risk preferences are measured as the (last) point where a subject switches from option A, the less risky lottery, to option B, the more risky lottery (Holt & Laury, 2002).[5] At the end of the experiment one of the 10 choices between option A and B is randomly drawn and the chosen lottery (A or B) is then played out with another random draw by a mechanistic random device (the computer).

[2] If subjects engage in both roles (as trustor and trustee) this can have a negative impact on trustworthiness (Casari & Cason, 2009). To the best of our knowledge, no studies have shown any significant effects on trust (Johnson & Mislin, 2011), which is the main focus of our study.

[3] Servátka, Tucker, and Vadovic (2007), for example, argue that trustors may choose to invest a significant amount of their endowment in the hope that trustees are more inclined to reciprocate, possibly due to guilt aversion.

[4] The Conditional Information Lottery offers all the benefits associated with deception in experiments, without actually deceiving anyone. The deceptive scenarios of designs, which use deceit, are replaced with scenarios, each of which, from a subject's viewpoint, has a chance of being true (Bardsley, 2000).

[5] Only four subjects switch more than once from the safer to the more risky lottery. The results we report later do not change if we drop subjects who switch more than once.

For all subjects, we also estimate their **RTG risk preferences** by using their decisions in the five conditional scenarios in the RTG. The expected utility of a trustor transferring x_i from an initial endowment (E) in a scenario with a fraction of p trustworthy trustees ($p = \frac{i}{4}$), who return half of the tripled transfer, is given by:

$$EU(xi) = p \cdot U\left(E - xi + \frac{3}{2}xi\right) + (1 - p) \cdot U(E - xi) \quad (1)$$

We assume the functional form of the trustor's utility function to come from the family of constant relative risk aversion functions: $U(w) = W^{\alpha}$ (see, e.g., Holt & Laury, 2002; Wakker, 2008). The first order conditions of the trustor's expected utility maximization imply:

$$ln\frac{p}{2(1-p)} = (\alpha - 1)\left[\ln(E - xi) - \ln\left(E + \frac{1}{2}xi\right)\right] \quad (2)$$

The parameter α is estimated by means of an ordinary least square estimation for each subject separately, and we use it as our measure of interest for RTG risk preferences.

3.4. Extra auxiliary measures

We also tested participants' lottery ambiguity preferences, their social preferences and their beliefs regarding the behavior of trustees in the trust game.

To elicit **lottery ambiguity preferences**, each subject made a sequence of 20 pair wise choices between a lottery with a known composition of a typical Ellsberg urn and a sure option (risk choice list); as well as a sequence of 20 pair wise choices between a lottery with an unknown composition of the urn and a sure option (ambiguous choice list). The sure option increases with each row to a maximum amount of 5 tokens. From both choice lists we define a subject's certainty equivalent as the midpoint of two sure payoffs related to the choice before and at the (last) switching point.[6] For instance when a subject chooses ten consecutive times to draw a ball from the urn before switching to the sure payoff of 2.75 tokens, this subject's certainty equivalent is 2.625 tokens (midpoint between 2.5 and 2.75 tokens). We estimate each subject's lottery ambiguity preferences based on certainty equivalents (Wakker, 2010).

$$\textit{Lottery ambiguity preferences} = (CE_R - CE_A)/(CE_R + CE_A)$$

CE_r and CE_a denote the certainty equivalents of the risk choice list respectively the ambiguous choice list. This measure ranges from −1 (extreme ambiguity seeking) to 1 (extreme ambiguity aversion). A score of 0 indicates ambiguity neutrality. The difference between CE_r and CE_a is divided by the absolute level of risk and ambiguity attitude in order to control for the fact that similar differences in certainty equivalents will weigh more heavily for a risk averse subject than a risk neutral or risk seeking subject (Sutter et al., 2013).

We measure **social preferences** by applying the value orientation task (ring task) (Liebrand, 1984). By collecting 24 decisions on pairs of payoffs this task measures the willingness to increase/decrease the payoff of an anonymous co-player at a cost. All pair of choices can be represented in a circle on adjacent equally spaced coordinates. The horizontal axis of the imaginary circle indicates the amount of money allocated to oneself and the vertical axis indicates the amount of money allocated to the other anonymous person. Summing all decisions, a measure of the unconditional willingness to give or take is obtained. Five roles can be distinguished, namely altruistic subjects (vectors lying between 67.5 and 112.5), cooperators (vectors lying between 22.5 and 67.5), individuals (vectors lying between −22.5 and 22.5), competitors (vectors lying between −67.5 and −22.5) and finally aggressors (vectors lying between −112.5 and −67.5).

We also collected subjects' **beliefs** by administering a non-incentivized questionnaire in which they indicated (on a 5-point Likert scale) how likely they considered each of the scenarios of trustworthiness from the RTG to materialize. The variable beliefs records the most likely scenario of $x_0, x_1, \ldots, x_4$ that subjects expect. A higher value indicates subjects' optimism about the general trustworthiness in trustees.

3.5. Experimental procedure

The experiments were conducted at ELSE (Experimental Laboratory for Sociology and Economics) at the University of Utrecht with 92 students (49 females and 43 males). The experiments were computerized using the software z-Tree (Fischbacher, 2007). At the end of each session, subjects were paid, in cash and in private, €11.50 on average for a session lasting about one hour.

In the experiment, we control for individual heterogeneity by implementing a within-subject design. Subjects submit their decisions in two blocks. One block contained both versions of the trust game, the STG and RTG. Another block contained the measurement of lottery risk and the other incentivized auxiliary measures of social preferences and lottery ambiguity

[6] Seven participants switched back and forth between the lottery and the sure option in the risk choice list respectively 11 participants in the ambiguous choice list. These figures are consistent with Hogarth and Villeval (2014) who report that 10.5% of their participants (N = 210) switch more than once.

measures. We balance the order of the trust games (RTG before or after the STG) in the trust game block, as well as the order of the two blocks themselves.

In the trust games, subjects always submit their decision in the role of a trustor first, and only then in the role of a trustee. All subjects received the same set of instructions and were aware of the fact that they had to submit choices for both roles in the trust game, and that payment in the trust game would depend on one role only. We also administered a non-incentivized post-experimental questionnaire.

All decisions were one-shot and we delayed any feedback about the decision of others and the outcomes of the randomization devices until the end of the experiment. The instructions for all tasks can be found in online supplementary file.

4. Experimental results

We first show descriptive statistics on trustors' and trustees' decisions in the trust games we implemented in this study. Fig. 1 reports the distribution of transfer decisions in the STG. The transfer distribution reveals the common peaks at the extreme transfers, as well as a considerable mass of transfers between zero and half of the endowment. The average transfer is 3.6 out of maximum 10 tokens, which is lower than the average in Berg et al. (1995), but well within the bounds of previously reported trusting decisions (Johnson & Mislin, 2011).

Fig. 2 shows the average transfers of trustors for all scenarios in the RTG (see Fig. A1 in the online supplementary file for a more detailed overview of the distribution of trustors' transfer choices in each RTG scenarios). As expected, the transfers increase in the number of trustworthy trustees in a group. Average transfers in scenarios with 0, 1,...,4 trustworthy trustees per group are 1.02, 1.83, 3.45, 6.28 and 8.59 tokens, respectively.[7]

About two thirds of participants decided to return half of the received tokens in their role as trustee (n = 61), and thus the remaining one third decided to keep the tripled investment for themselves. This implies that the most common RTG scenarios contained either 2 or 3 trustworthy trustees in the group of four trustworthy trustees. The probability of trustworthiness differs substantially between sessions (see Table A4 in the online supplementary file).

We now focus on the risk parameters in our study: risk elicited from the RTG and from the Holt and Laury task (2002). The transfer of a risk-neutral trustor in RTG would form a step-function with a transfer of 0 in scenarios with 0, 1, or 2 trustworthy trustees and transfer of all tokens in scenarios with 3 or 4 trustworthy trustees. The corresponding value of the parameter α for the constant relative risk aversion utility function is 0.656.

Table 1 reports the estimates for parameter α in equation 2 above, which measures subjects' risk preferences in the RTG. There are 8 participants with value $\alpha = 0.656$, corresponding to risk-neutral behavior. However, the majority of participants (n = 64) are risk averse in the RTG.[8] As Table 1 shows, the RTG risk preferences range from a minimum of −18.529 (one extreme outlier) to a maximum of 2, with a mean of −0.278 and a median of 0.378. Both of the latter are well below risk neutrality.

Table 2 provides descriptive statistics for risk preferences elicited with the Holt and Laury (2002) lottery task. A risk neutral subject would switch to Option B, the more risky lottery, after having chosen Option A four times. We find a mean switching point of 5.82, which indicates that our subjects are risk averse, on average, in the lottery task. Compared to Holt and Laury (2002) our subjects are slightly more risk averse as they report a mean switching point of 5.2. Our mean switching point, however, is well in line with previously reported figures. Houser et al. (2010), for instance, report a mean switching point of 5.86.

In the online supplementary file we provide descriptive data of the remaining auxiliary measures of lottery ambiguity preferences (Table A1), social preferences (Table A2) and beliefs (Table A3). In Table A4 we also describe participants' accuracy of beliefs regarding trustees' trustworthiness. For participants in their role as trustor, the level of trustworthiness in their own session determines the RTG scenario that is most likely to materialize. In Table A4 we list the mean level of trustworthiness per session together with participants' beliefs regarding the most likely RTG scenario. Although there are differences between sessions, in general trustors' beliefs regarding the trustworthiness of trustees are more pessimistic than the actual trustworthiness of trustees in the experiment.

Having described the most important data, we now move to bivariate analyses on risk and trust. Fig. 3 reports the relationship between RTG risk preferences and trusting behavior in the STG. For visualization purposes we split the scores for risk preferences elicited from the RTG in three equally sized categories, ranging from most risk averse to least risk averse. Subjects who are least risk averse send, on average, nearly 4 tokens more in the STG compared to subjects who are most risk averse.

A Jonckheere-Terpstra test rejects the Null that there are no systematic relationships among the medians of the three different categories, in support of the alternative that the medians are ordered from most risk-averse (lowest) to least risk-

[7] We also observe that about 30% of subjects transfer more than zero in the scenario with zero trustworthy trustees. These positive transfers may reflect mistakes, warm glow from investing, or even belief that one can beat the odds even when this contradicts the available information (Andreoni & Miller, 2002). Most of these subjects transfer one or two units only, suggesting that some motivation rather than misunderstanding or noise guide such seemingly irrational transfers. At the other extreme, most of the subjects transfer the whole endowment when the probability to meet a trustworthy trustee is equal to one. Here, the omission to transfer the whole endowment, next to mistakes, may be explained by competitive social preferences because any transfer below 10 creates a payoff disparity to the advantage of the trustor.

[8] As a control measure, we analyze transfer decisions in scenario x_3 separately. In this scenario participants should transfer the whole endowment or at least much more compared to previous scenarios. The transfer in x_3 is highly correlated with the parameter α, elicited from all scenarios in the RTG.

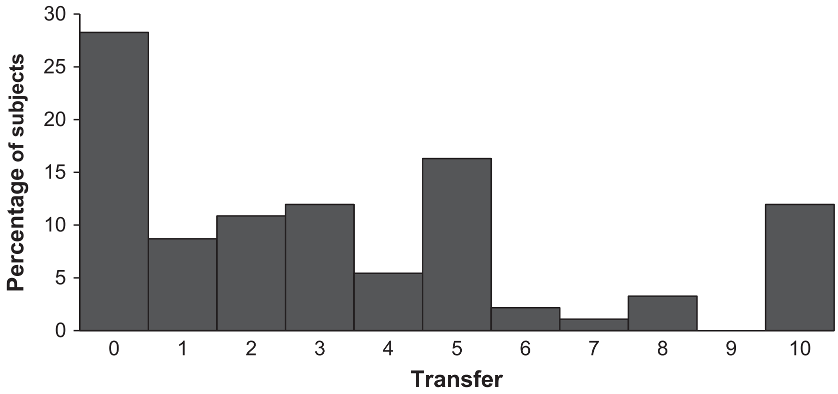

Fig. 1. Distribution of transfers in the standard trust game (STG).

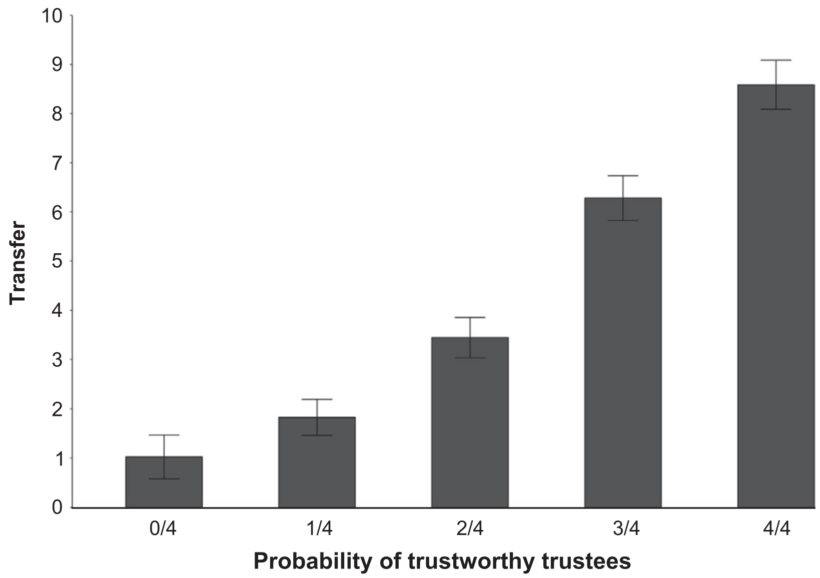

Fig. 2. Average transfer in the risky trust game (RTG), for each scenario (with confidence intervals).

Table 1
RTG risk preferences.

Descriptives	Parameter α
Minimum	−18.529
q 0.25	0.354
Median	0.378
q 0.75	0.656
Maximum	2
Mean	−0.278
Standard deviation	2.416

averse (highest) ($p < 0.001$). Moreover, a Pearson product-moment correlation test confirms that subjects' individual RTG risk preference measures are positively significantly correlated with corresponding transfers in the STG ($r = 0.242$; $p < 0.05$). This is also confirmed by Kendall's tau rank correlation coefficient between RTG risk preferences and STG transfers, which is $\tau = 0.341$ with $p < 0.01$. *Hence, as a first result, we find a strong positive bivariate relationship between risk preferences measured in a trust setting (RTG) and trusting behavior in the standard trust game (STG).*

Table 2
Lottery risk preferences.

Number of safe choices	Total (N = 92)	Holt and Laury
0–1	0.00 (0)	0.01
2	0.01 (1)	0.01
3	0.01 (1)	0.06
4	0.16 (15)	0.26
5	0.16 (15)	0.26
6	0.25 (32)	0.23
7	0.27 (25)	0.13
8	0.00 (0)	0.03
9–10	0.03 (3)	0.01
Mean	5.82	5.2

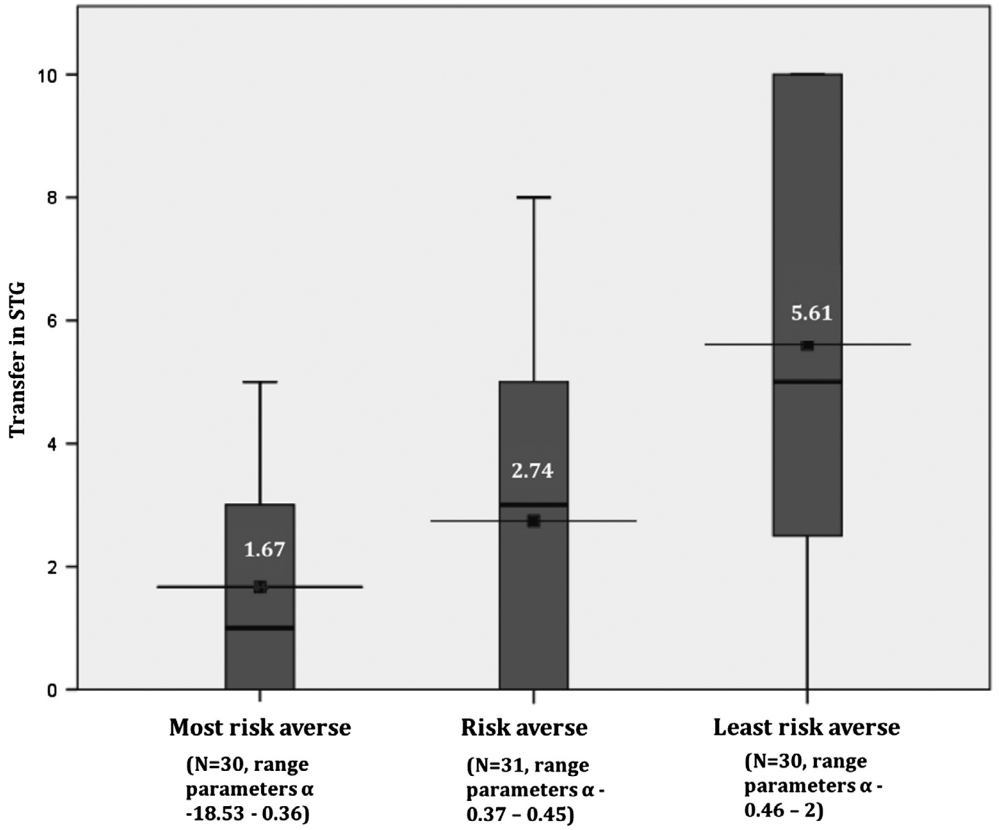

Fig. 3. Relating risk preferences measured in RTG and transfer in the standard trust game (STG).

Fig. 4 shows the relationship between lottery risk preferences and trusting behavior in the STG. To enable a comparison with Fig. 3 we split the lottery risk preferences into three equally sized categories ranging from most risk averse to least risk averse.[9]

Although the mean transfer in the STG slightly increases from 2.85 to 3.15 and to 3.97 as we move into less risk averse categories, the bivariate relationship between lottery risk and trust is not statistically significant. A Jonckheere-Terpstra test cannot reject the Null that there are no systematic relationships among the medians of the three different categories ($p = 0.220$). Also, the Pearson's correlation coefficient ($r = 0.151$; $p = 0.15$) and Kendall's tau rank correlation coefficient ($\tau = 0.114$; $p = 0.17$) cannot reject that subjects' individual lottery risk preferences are uncorrelated with transfers in the STG. *Hence, as a second result, we find no bivariate relationship between lottery risk preferences and trusting behavior in the standard trust game*.

[9] If we apply the categorization based on Holt and Laury (2002), we find that, on average, risk averse participants transfer 2 tokens, risk neutral participants 4.73 tokens and risk seeking participants 3.12 tokens.

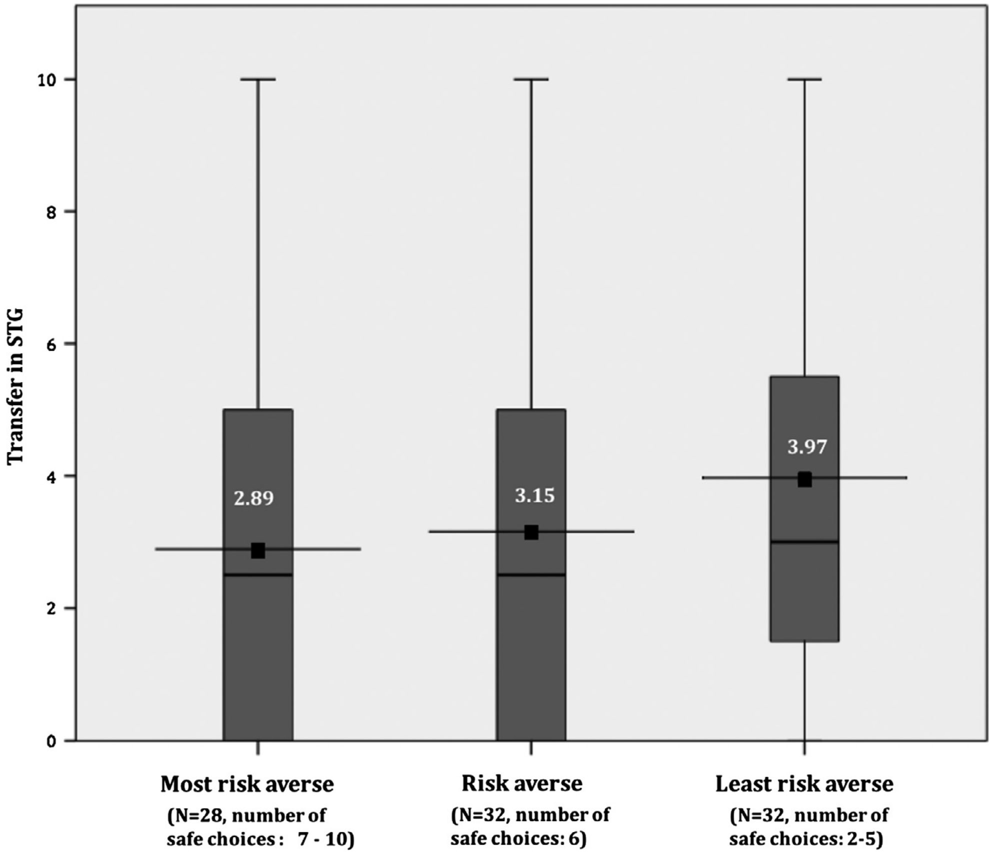

Fig. 4. Lottery risk preferences and transfer in the standard trust game.

As the RTG risk preferences of trustors predict transfers in the STG but lottery risk preferences do not, we expect to find no direct correlation between the two risk measures. Indeed the Pearson correlation coefficient for the two risk measurements is not statistically significant ($r = -0.10$; $p = 0.921$). This also applies to Kendall's tau rank correlation coefficient ($\tau = 0.081$; $p = 0.301$), which rejects any significant relationship and suggests that the two risk preference measurements are orthogonal. *Hence, as a third result, we find no bivariate relationship between lottery risk preferences and RTG risk preferences.*

Finally, we support our bivariate findings with multivariate estimations where we use the transfers in the STG as dependent variable and both risk measures as independent variables. Table 3 presents the results of OLS regression models where we control for demographic variables and session fixed effects.

The estimation results in Table 3 clearly show that risk preferences stemming from the risky trust game remain economically and statistically significant predictors of trust. RTG risk preferences are an important predictor of trusting behavior in the STG with or without lottery risk preferences as simultaneous independent variable (see Model 1 and 3). In contrast, as expected, we find no relation between lottery risk preferences and transfers in the STG, neither individually (Model 2) nor in combination with RTG risk preferences (Model 3). *Hence, as a fourth and most prominent result, we find an economically and statistically significant relationship in multivariate regressions between risk preferences and trusting behavior, provided that risk preferences are measured in a trust setting and not with a lottery setup.*

We conducted several robustness checks to analyze the validity of the above results (see Tables A5 and A6 and corresponding explanations in online supplementary file). First, we ran regression models in which we excluded all subjects from the regression analyses, who transferred more than zero (less than ten) tokens in the scenarios with zero (with four) trustworthy trustees. This resulted in a smaller sample of 51 subjects. Furthermore, we controlled for session and order effects in our regression models. In all these robustness checks the fourth result mentioned above stays intact.

As a final robustness check, we included all auxiliary measures elicited in the experiment (lottery ambiguity preferences, social preferences and trustor's beliefs) in our main regression model (see Table 4 for results). In line with previous studies (Dufwenberg & Gneezy, 2000) we find that trustors' beliefs about trustees' return decisions play a role when explaining the variation of transfers in the STG. Importantly, within our framework, these beliefs refer to the most likely RTG scenario. As one of the five RTG scenarios is the actual, yet unknown description of trustworthiness in the STG, our finding indicates that trust in the STG is influenced by participants' expectations regarding the composition of trustworthy and untrustworthy trustees within their group of four randomly assigned trustees. Similar to Houser et al. (2010), we do not find any relation-

Table 3
OLS regression models explaining transfer in STG.

	Model 1	Model 2	Model 3
Constant	3.729 (0.890)	1.855 (1.326)	2.053 (1.436)
RTG risk preferences	0.303*** (0.098)	–	0.316*** (0.091)
Lottery risk preferences	–	0.367 (0.265)	0.405 (0.273)
Gender	−0.048 (0.817)	0.084 (0.857)	0.236 (0.834)
Economics major	−0.001 (0.844)	−0.008 (0.820)	−0.123 (0.808)
Session 1	0.291 (1.209)	0.387 (1.243)	0.121 (1.192)
Session 2	−2.029** (1.016)	−1.868* (1.047)	−2.137** (0.970)
Session 3	0.595 (1.066)	1.080 (1.058)	0.627 (1.039)
Session 4	0.121 (1.133)	0.177 (1.155)	−0.288 (1.083)
Session 5	−0.197 (1.301)	0.128 (1.326)	−0.350 (1.274)
N	92	92	92
F test	(8, 83) 2.96	(8, 83) 1.67	(9, 82) 3.00
Prob. > *F*	0.0057	0.1168	0.0038
R - squared	0.1363	0.1085	0.1596

Heteroskedasticity-corrected (robust) standard errors in parentheses.
* Significant at the 0.1 level.
** Significant at the 0.05 level.
*** Significant at the 0.01 level.

Table 4
Trust and risk: controlling for additional individual measures.

Transfer in STG (dependent variable)	Model 1	Model 2	Model 3
Constant	2.842 (0.915)	1.043 (1.406)	1.072 (1.467)
RTG risk Preferences	0.344*** (0.096)		0.367*** (0.090)
Lottery risk preferences		0.364 (0.267)	0.434 (0.270)
Lottery ambiguity preferences	−0.351 (1.395)	−0.617 (1.356)	−0.121 (1.230)
Social preferences	−0.002 (0.015)	−0.002 (0.016)	−0.007 (0.016)
Beliefs	0.703** (0.309)	0.631* (0.313)	0.707** (0.308)
Gender	−0.192 (0.849)	−0.052 (0.914)	0.142 (0.877)
Economic major	−0.064 (0.860)	−0.047 (0.853)	−0.141 (0.827)
Session 1	−0.033 (1.255)	0.103 (1.328)	−0.273 (1.251)
Session 2	−2.008* (1.055)	−1.822 (1.130)	−2.200** (1.049)
Session 3	0.088 (1.163)	0.681 (1.177)	0.101 (1.144)
Session 4	0.069 (1.026)	0.167 (1.092)	−0.308 (0.958)
Session 5	−0.345 (1.181)	0.099 (1.256)	−0.574 (1.148)
N	92	92	92
F test	(11, 80) = 3.32	(11, 80) = 2.07	(12, 79) = 3.63
Prob > *F*	00009	00319	00002
R - squared	01995	01596	02249

Heteroskedasticity-corrected (robust) standard errors in parentheses.
* Significant at the 0.1 level.
** Significant at the 0.05 level.
*** Significant at the 0.01 level.

ship between social preferences and trust. Although the actual likelihood of trustworthiness is unknown in the STG, participants' ambiguity preferences fail to predict trustors' variation of transfer in this game. In all models in Table 4, RTG risk preferences remain highly significant while lottery risk preferences fail to be meaningful predictors of trust, supporting once again our fourth and main result mentioned above.

5. Conclusion

In this paper we propose a measure of risk preferences relevant for decisions of trustors in the trust game. We present a new design, the 'risky trust game', which aligns the context for the measurement of risk preferences with the context of the trust game. We show that subjects' risk preferences, measured in the risky trust game, explain transfers in the standard trust game. In contrast, and in line with previous studies, our results also show that subjects' lottery risk preferences are not able to explain variations in transfers in the trust game. This suggests that subjects perceive the same objective risk in trusting differently from the risk in a lottery. In fact, we find that risk preferences that are elicited in a trust setting (in our risky trust game) are completely uncorrelated with risk preferences elicited with the well-known Holt and Laury (2002) lottery design. Subjects' risk preferences are context dependent, and the risk measure obtained in the lottery context does not sufficiently capture the risk that subjects perceive in the trust decisions.

Our RTG was designed to capture the context of the trust game as close as possible as well as the social source a trustor faces in the standard trust game. As the RTG cannot be an exact replica of the STG in terms of context it changes (some) context with the source. This is an unavoidable limitation of our design, but based on our results and previous findings, we believe that the social source and not the context is the primary driver that links behavior from the RTG to the STG. Note that in the design by Houser et al. (2010) a Holt and Laury risk measurement was related to trust decisions in a computerized version of a standard trust game, but not to transfer choices in a trust game with social history. This indicates that risk preference measures elicited by Holt and Laury (2002) predict behavior in a trust setting where the sources of risk are both mechanistic even though the context of the (risk and trust) decisions is different. Furthermore, our results show that transfer in the STG is influenced by both RTG risk preferences and participants' beliefs regarding the most likely RTG scenario. This indicates that trustors use their expectations regarding trustees' behavior to decide how much to transfer in the STG. As trustees are the social source of uncertainty in the STG, we believe that risk in the RTG accurately captures this particular source, whereas the Holt and Laury (2002) risk measurement does not rely on any social source, but is determined by a random mechanistic device.

Our findings and explanation of the measurement of the RTG relate to recent research on sources of risk (Abdellaoui et al., 2011; L'Haridon et al., 2013; Weber, Blais, & Betz, 2002). Rather than describing a risky decision purely in terms of the set of states and objectively known probabilities of these states, the sources of risk take into account that human decision-makers process objectively known probabilities in a context-dependent way. This notion is supported by recent neurocognitive studies, which propose that the origins of source dependence in risk processing can be found in human neurobiology. They highlight the importance of a brain circuit that specifically underlies the representation of other's beliefs and intentions (Behrens, Hunt, & Rushworth, 2009; Behrens, Hunt, Woolrich, & Rushworth, 2008; Hampton, Bossaerts, & O'Doherty, 2008; Saxe, 2006). The dissociation in processing of risks from social and non-social sources was also linked to neuroanatomy. Brain signals from the regions processing social risk are strongly interconnected with other brain regions involved with the processing of emotions and facial expression (Van Hoesen, Morecraft, & Vogt, 1993). Closely related to our research, Lauharatanahirun, Christopoulos, and King-Casas (2012) observe that risky decisions in a social vs. non-social setup recruit different brain regions of interest, giving further support to the source perspective of risk decisions of human decision-makers. It would be an interesting avenue for future research to advance theoretical models that account for the cognitive processes that are linked to social sources of risk.

Coming back to the question we started this paper with – can trust in the standard trust game be explained by a person's risk preferences – our results suggest the following answer: Yes, it can, but only if we align the measurement of risk preferences to the social source of uncertainty a person faces in trust decisions.

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Appendix A. Supplementary material

Supplementary data associated with this article can be found, in the online version, at http://dx.doi.org/10.1016/j.joep.2016.10.001.

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