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### Is trust an ambiguous rather than a risky decision?

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#### Abstract

According to an early approach, the decision to trust in the one-shot anonymous trust game is intuitively tantamount to a risky decision: the willingness to bet on the reciprocation of my investment. In a seminal study, Eckel and Wilson (2004) explored the correlation between risk attitudes (as elicited through a Holt and Laury mechanism) and the behavior of investors in the trust game. They found no correlation: trust decision cannot be viewed as a risky decision. However, since the probabilities of possible returns are unknown, we argue that trust behavior may correlate more specifically with ambiguity aversion rather than with risk aversion. We therefore modified Eckel and Wilson's experimental procedure in order to investigate the question as to whether trust is an ambiguous decision. We extended Holt and Laury switching-point elicitation mechanism between risky lotteries to ambiguous lotteries as Chakravarty and Roy (2009) did. We then ran an experimental session including a standard one shot anonymous trust game (OSG). We found significant negative correlations between aversion to ambiguity and behavior in OSG. This result is a plea in favor of a decision-theoretical analogy between choices in ambiguous lotteries and trust-games.

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## 1. Introduction

In the trust game (Berg *et al.* 1995), the first player (the investor) has to decide which amount to send to the second player (the trustee) and expects a profitable return. A purely strategic and calculative approach to trust would be liable to make individuals think of their offers in the trust-game as risky bets. But previous investigators have observed no correlation between trust-game behavior and measures of risk-aversion. For example, Eckel and Wilson (2004) have tested the hypothesis of a correlation between measures of risk attitudes and the behavior of investors in a trust game. They found no statistical relationship between the behavioral risk measures they used and the decision to trust. This result has been confirmed by Houser *et al.* (2010) who observed no correlations between a classical measure of risk aversion (Holt and Laury's price list) and behavior in the trust game. However, they emphasized such a correlation when the trust-game was known by subjects to be played against a computer.

But is risk, in the Knightian (1921) sense<sup>1</sup>, the most adequate informational characterization of the situation faced by investors in a trust game? In a one-shot trust game the investor interacts with an anonymous trustee, and his decision to trust is rather an ambiguous one (Ellsberg (1961)) than a risky one due to the fact that, indeed, human partners are essentially unpredictable. What they lack precisely is the information about the probability of what variable counter-offers by trustees could be made, if they decide to trust them. The probabilities of possible returns are unknown and trust behavior may correlate more specifically with aversion to ambiguity than with aversion to risk. Loosely speaking, trust in that situation is certainly a risky bet, but speaking in more proper informational terms, it is rather tantamount to decision-making under ambiguity.

Following this idea, our specific aim is to investigate potential correlations between measures of ambiguity aversion and investments in a one-shot trust-game. We resort to Chakravarty and Roy's (2009) elicitation mechanism of ambiguity aversion, in order to apprehend potential correlations between attitudes toward ambiguity and levels of offers in the trust-game.

Following Chakravarty and Roy's methodology with respect to the measure of ambiguity aversion and that of Holt and Laury (2002) to elicit risk aversion, our experimental procedure explores possible correlations between these measures and the behavior of the investor in the oneshot trust game. Participants were therefore invited to participate in two main experimental stages. We first proceeded to the measure of risk and ambiguity attitudes by eliciting trade-offs between series of pairs of lotteries presenting contrasts between these alternative probabilistic backgrounds. Then, all pairs of subjects were faced to a one-shot trust game environment.

In line with Eckel and Wilson's results, we could not find any correlation between attitudes towards risk and the behavior of investors in our one-shot trust game. However, one-shot

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<sup>1</sup> Risk, taken properly relates to an informational context in which information about payoffs and their probabilities is available.

<sup>2</sup> As in Holt and Laury (2002), there is a link between the number of risky choices and the degree of risk

decisions to trust were correlated with attitudes towards ambiguity. Together, both results give support to the idea that individuals subjectively perceive trust as a strategic decision involving ambiguity.

In section 1, we will detail our experimental design and procedures implemented to elicit risk attitudes. In section 2, we model our hypotheses about the possible correlations between probabilistic attitudes and trust game behavior. In section 3, our main results are presented and discussed.

## 2. Experimental design

### Procedures

93 pairs of subjects took part in our experimental sessions which were run in the experimental economics laboratories at the University of Picardie and at Ecole Normale Supérieure of Cachan. Participants sat in front of an individual computer isolated from other players in the lab and could read the instructions on the screen. They were then submitted the two steps of our experiment: i) an elicitation of attitudes towards risk and ambiguity; ii) choices in a one-shot trust game.

#### *Step #1 Measures of aversion to risk and ambiguity*

We first replicated the original experiment by Holt and Laury (2002). In that experiment, used also by Eckel and Wilson (2004) in order to investigate the possible correlation between risk and trust, subjects faced choices between pairs of risky lotteries. Holt and Laury sequentially present a menu of 10 pairs of lottery choices ordered such as to present gradual trade-offs between riskier and safer options in order to infer risk aversion from the point at which individuals switch from a riskier to a safer bet. Table 1 presents these choices between risky prospects: payoffs and probabilities are scaled in such a way that a risk neutral decision maker (DM) would choose option A until step 4 and would definitely switch to option B after. A risk-averse DM would switch later from option A to option B while a risk lover would switch before step 4<sup>2</sup>. Thus, the number of risky choices positively correlates with risk aversion and provides an indicator of risk attitudes.

We also developed trade-offs between risky lotteries and ambiguous ones, following Chakravarty and Roy's methodology, in order to capture an ambiguity aversion indicator revealed by the switch from risky lotteries to ambiguous ones. Their methodology is consistent with the theory of smooth ambiguity, proposed by Klibanoff *et al.* (2005), which enables to distinguish between attitudes towards risk and towards ambiguity. According to their approach, decision making under ambiguity can be characterized by a double

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<sup>2</sup> As in Holt and Laury (2002), there is a link between the number of risky choices and the degree of risk aversion (if the DM switches only one time). According to the timing of the switch from option A (safe option) to option B (risky option), and assuming a Constant Relative Risk Aversion (CRRA) utility function we can infer an interval for the risk aversion parameter.

expectational form  $E_{\mu}\varphi(E_{\pi}U(\cdot))$ , where  $U(\cdot)$  is a von Neumann-Morgenstern utility function while  $\varphi$  characterizes ambiguity aversion given the subjective prior  $\mu$ .

**Table 1: indicator (RR): choices between risky lotteries (Option A and Option B)**

Decision	Option A				Option B				Bounds for Relative Risk Aversion
	Probability A1 (%)	Gains A1 (€)	Probability A2 (%)	Gains A2 (€)	Probability B1 (%)	Gains B1 (€)	Probability B2 (%)	Gains B2 (€)	
1	10	10	90	8	10	19.20	90	0.50	$]-\infty ; -0.953]$
2	20	10	80	8	20	19.20	80	0.50	$[-0.953 ; -0.492]$
3	30	10	70	8	30	19.20	70	0.50	$[-0.492 ; -0.147]$
4	40	10	60	8	40	19.20	60	0.50	$[-0.147 ; 0.143]$
5	50	10	50	8	50	19.20	50	0.50	$[0.143 ; 0.408]$
6	60	10	40	8	60	19.20	40	0.50	$[0.408 ; 0.674]$
7	70	10	30	8	70	19.20	30	0.50	$[0.674 ; 0.968]$
8	80	10	20	8	80	19.20	20	0.50	$[0.968 ; 1.367]$
9	90	10	10	8	90	19.20	10	0.50	$[1.367 ; +\infty[$
10	100	10	0	8	100	19.20	0	0.50	

By implementing the Multiple Price List (MPL) procedure of Holt and Laury (2002) successively in a context of risk and in a context of ambiguity, Chakravarty and Roy (2009) have shown how to obtain estimates of both risk aversion and ambiguity aversion. If we resort to a Constant Relative Risk Aversion (CRRA) utility function like  $U(x) = x^r$ , with  $x > 0$  and  $U(0) = 0$ , the Arrow-Pratt index of Relative Risk Aversion,  $(1-r)$  can be inferred from the switching point in the MPL list (See Table 1). To achieve the KMM representation, we need to specify the function  $\varphi$  which characterizes attitude towards pure ambiguity:  $\varphi(z) = z^a$ , with  $z > 0$  and  $\varphi(0) = 0$ . As shown in Chakravarty and Roy (2009), it is then possible to infer the level of Ambiguity Aversion,  $(1-a)$ , according to the same principle. In Table 2, the participant has to choose between a risky option A and an ambiguous option B. This procedure discloses the preference for ambiguity: when the participant switches from option A towards option B, she reveals her ambiguity aversion. Decisions have been built in such a way that an ambiguity neutral individual would be indifferent, in decision 5, between option A and option B. At the same time, an ambiguity averse individual would switch after decision 5 while an ambiguity lover would switch before. As in the previous case, it is possible to infer an interval for the ambiguity aversion parameter by observing the switching point in the MPL list (see Table 2).

In line with our procedure, we resorted to two types of lotteries: risky (R) and ambiguous (A). Participants faced 2 types of pairs of lotteries combining informational contexts: (*RR*) and (*RA*) (see tables 1 and 2). By counting the number of times that option A is selected before the switching point, we obtain two indicators: RR for risk aversion (Table 1) and RA for ambiguity aversion (Table 2)

**Table 2: indicator (RA): choices between risky lottery (Option A) and ambiguous lottery (Option B)**

Decision	Option A				Option B (Unknown probability distribution)		Bounds for ambiguity Aversion
	Probability A1 (%)	Gains A1 (€)	Probability A2 (%)	Gains A2 (€)	Gains B1 (€)	Gains B2 (€)	
1	50	32	50	0	0	20	$]-\infty ; -0.81]$
2	50	29	50	0	0	20	$[-0.81 ; -0.72]$
3	50	26	50	0	0	20	$[-0.72 ; -0.43]$
4	50	23	50	0	0	20	$[-0.43 ; -0.22]$
5	50	20	50	0	0	20	$[-0.22 ; 0]$
6	50	17	50	0	0	20	$[0 ; 0.26]$
7	50	14	50	0	0	20	$[0.26 ; 0.57]$
8	50	11	50	0	0	20	$[0.57 ; 1]$
9	50	8	50	0	0	20	$[1 ; 1.71]$
10	50	5	50	0	0	20	$[1.71 ; +\infty[$

Due to the proximity between values at stake in the trust game and those in our lotteries, our indicators should characterize both risk and ambiguity attitudes whenever participants view trust as an asset investment. Indeed, our implementation of the multiple price list method has been highly structured by the decision structure of the Trust Game. Each decision consists of a risky or an ambiguous lottery. In accordance with the trust-game monetary possibilities, each lottery belongs to the gain domain and two values play a leading role, 0€ and 20€. These values have been selected in order to generate a comprehensive measure of risk attitudes. Indeed, 0€ corresponds to the minimum amount, achievable in the TG when the investor sends all of her 10€ while the trustee keeps all the money. On the other side, facing a strictly fair trustee, the investor could finally win a theoretical maximum of 20€ by sending all of her 10€ (in this case, the trustee receives 30€ and reciprocates 20€ corresponding to half of his whole wealth (including her 10€ endowment)).

*Step # 2: One-shot anonymous trust game (OSG).*

In this step of the experimental session, participants played the trust game as originally described by Berg *et al.* (1995). They were randomly located in two different premises. Participants were informed that they would play the trust game, which was described to them on their screen, in the position of either investor or trustee, depending on the room they had been assigned to initially. They were informed that they were individually paired with other actual human players located in the other room of the laboratory. Our computer network allowed us to randomly associate each participant, either investor or trustee, with one partner in the other room. The identity of partners was not disclosed.

Each participant was endowed with €10. Investor could entrust their partner a part, the whole or nothing of this sum. The engaged amount  $s$  was multiplied by 3 when reaching the trustee. The trustee had then to decide in her turn whether she decided to share the received amount of money with the investor by sending her back an amount  $r$  ( $r \in [0;3s]$ ). The choice made by the trustee appeared on the investor's screen as soon as it was implemented. And this step ends. This device was common knowledge for all participants.

### **Incentives**

Our participants were remunerated according to their payoffs in the two lotteries choice menus and to their gain in the trust-game. Total average earnings were about €18.6. Participants were informed in advance of this incentive procedure which was realized at the end of the whole experiment.

The remuneration associated with the lotteries was implemented by randomly drawing one of the ten possible choices on each menu. Despite lotteries were *drawn* at the end of the first step, they were *played* only at the end of experiment in order that payoff remains unknown until the end of experiment. By doing so we avoid that intermediate payoffs influence responses in the subsequent experimental steps by generating a wealth effect.

Incentives in the one-shot trust game treatment simply corresponded to returns from the trustee plus the amount of initial endowment not invested.

We also had to consider the possibility that, since the final lotteries payoffs are postponed to the end of the experiment, subjects objectively face a background risk when playing the trust-game in the second stage. In accordance with the portfolio theory (see Eeckhoudt *et al.* (1996), Gollier and Pratt (1996) or Kimball (1993)), the effect of an independent background risk reduces the demand for other independent coming risks. When applied to our experiment<sup>3</sup>, this effect means that the two lotteries would act as a background risk, inducing risk averse investors to reduce their investment in the trust-game. Therefore, if this portfolio effect plays a role in our participants' behavior it is expected to reduce the amount sent in the

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<sup>3</sup> Despite our lotteries are not exactly actuarially fair.

trust-game and weaken the degree of correlation between risk taking in the lotteries and risk taking in the trust-game.

We resort to two statistical tests in order to settle the issue. For a given class of ambiguity aversion<sup>4</sup>, we performed mean comparison tests (see table 3 below) according to whether the pair of drawn lotteries were good or bad<sup>5</sup>. A portfolio effect should induce differences in mean of investment in the TG depending on the lotteries drawn. On the contrary, our tests show clearly that, controlling for ambiguity aversion, there is no significant difference in average of investment according to the drawn lotteries classes.

**Table 3: Tests of drawn lotteries' effect on investment in the TG**

	Low returns lotteries	High returns lotteries	Comparison tests
	Mean (Standard deviation)	Mean (Standard deviation)	t-statistic (p-value)
Low Ambiguity Aversion	4.90 (3.04)	4.52 (2.41)	0.50 (0.62)
High Ambiguity Aversion	3.86 (1.83)	3.53 (1.66)	0.59 (0.56)

Besides, we compared our data with in principle portfolio-effect-free data from one-shot trust-game experiments. In particular we gave special scrutiny to Willinger *et al.* (2003), given that, as ours, they conducted their study among French students. We performed equality tests of variances and equality tests of means which did not yield any significant differences between data. As shown in Table 4, in our data –93 investors based, investment average is about €4.3 with a standard deviation of €2.44 while in Willinger *et al.* study, investment –30 investors based – is in average €4.2 with a standard deviation of €2.59. The test of equality variance provides us with a p-value of 0.634; that of equality mean test is 0.88. None of these tests allows the null hypothesis to be rejected. They support the hypothesis of the neutrality of our incentive procedure vis-à-vis investments in the trust-game.

<sup>4</sup> Participants have been segmented depending on whether they were ambiguity averse (i.e.  $RA \geq 6$ ) or ambiguity lover ( $RA \leq 5$ ).

<sup>5</sup> A good lottery provides high expected payoffs (i.e. decision  $\geq 6$  in tables 1 and 2) while bad lotteries are characterized by low returns (decision  $\leq 5$  in tables 1 and 2). We have partitioned pairs of drawn lotteries along with their returns. The first class includes participants whose pair of drawn lotteries has high returns; symmetrically, the second class encompasses participants whose pair of drawn lotteries yields low returns. We have left apart participants whose pair of lotteries includes both low and high returns since we expect portfolio effect, if exists, to be stronger in the first two cases.

Therefore our empirical findings seem robust enough to resist this possible impact of a portfolio effect. It then seems that our incentive scheme does not induce our participants to any portfolio diversification strategy.

**Table 4: Comparison tests with Willinger *et al.* 's data**

	Our data	Willinger <i>et al.</i> study	Comparison tests Statistics (p-value)
mean	4.3€	4.2€	0.15 (0.88)
Standard deviation	2.44 €	2.59€	0.88 (0.634)
Number of obs.	93	30	

### Debriefing and control

After the computerized experimental session, a questionnaire was filled in order to check whether players were having the feeling that they had been playing with human partners, which, due to the random pairings and the web interface, could have been doubted.

### 3. Hypotheses modelling

In the one-shot trust game, investors were informed that they will play the trust game only once and that experiment will end. In that situation, their decision directly reflects their willingness to bet on the fact that another person will tend to reciprocate their risky move. The amount engaged by the investor is a direct measure of the risk taken vis-à-vis an anonymous player, which is certainly a way of conceiving of trust. But a more precise apprehension of that decision context likens the one-shot trust game to a choice under ambiguity, participants having no precise information about the probabilities of how their offer will be reciprocated. Since the potential states of nature are known, but not their associated probabilities, we suggest that the decision to trust, and to what extent, takes place within a context of ambiguity. This remark leads us to hypothesize that trust decision can be similar to a choice under ambiguity where investor's behavior appears to be characterized by RA (ambiguity aversion). Under this assumption (H2), a negative impact of aversion on trust is expected.

We have also checked the non-significance of risk aversion indicator RR with offers in the OSG (H1), in line with previous results in the literature.



Double censored tobit models<sup>6</sup> (1) and (2) explain the investor's offer by reference to an indicator of aversion to risk RR – equation (1)—or to ambiguity RA – equation (2). We expect  $\alpha_1$  to be non-significant –showing that a trust decision cannot be reduced to a risky choice—while  $\beta_1$  to be negative and significant meaning that investments in OSG decrease with aversion to ambiguity) and brings support to hypothesis H2.

In the following,  $s$  is the amount of money transferred by an investor to a trustee ;  $j$ -indices refer to pairs of players (investors/trustee:  $j=\{1, \dots, 93\}$ ).

$$s_j = \begin{cases} 0 & \text{if } s_j^* \leq 0 \\ s_j^* & \text{if } 0 < s_j^* < 10 \\ 10 & \text{if } s_j^* \geq 10 \end{cases}$$

$$s_j^* = \alpha_0 + \alpha_1 RR_j + \varepsilon_j \quad j=\{1, \dots, 93\} \quad (1)$$

$$s_j^* = \beta_0 + \beta_1 RA_j + \varepsilon_j \quad j=\{1, \dots, 93\} \quad (2)$$

$\varepsilon$  is the error-term.

#### 4. Results

We found a positive correlation between risk and ambiguity attitudes over the domain of gains as in Lauriola and Levin (2000), Chakravarty and Roy (2009). But, along with the observations made by Cohen *et al.* (1987) and Di Mauro and Maffioletti (2004), this correlation coefficient was not significant (see table 5 the non parametric statistics).

**R.1: Correlation between attitudes towards risk and ambiguity is positive but not significant.**

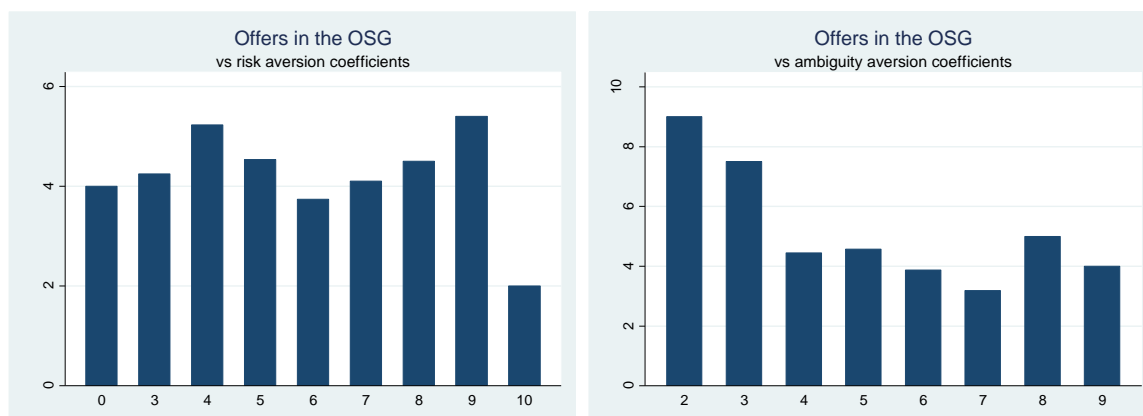
**Table 5: Spearman and Kendall's rank correlations between RR and RA**

	Spearman	Kendall
Stat	0.0763	0.0519
(p-value)	(0.4671)	(0.4260)
Obs	93	93

<sup>6</sup> Resort to a double censored tobit is justified by the fact that investment decisions are bounded by the initial endowment amount. Investors' offers have a 0€ lower bound and a 10€ upper bound.

Besides, investors have sent, in average, 4.31€ in the OSG; their risk aversion indicator was in average about 5.99 that of ambiguity was about 5.48. Their correlation with offers in the trust game was respectively -0.084 (p-value=0.421, non significant) for the risk aversion indicator and -0.245 (p-value=0.018, significant) for the RA ambiguity aversion indicator. Figure 2 below also displays the decreasing relation between offers in the trust game and ambiguity aversion indicator while figure 1 exhibits absence of relation between offers and risk aversion indicator.

**Figure 1: Interplay between offers and risk aversion**      **Figure 2: Interplay between offers and ambiguity aversion**



Estimations of models (1) and (2) are given in Table 6 below. These results indicate a good fit to our predictions. They explain investor decision in our trust game by lotteries and allow us to find an existing link with risk-taking measures of investors (RR or RA) in the different lotteries menus and trust attitudes.

**Table 6: Models Estimations.**

Variable	Models: OSG Coefficient (p-value)	
	(1)	(2)
RR	-0.126 (0.449)	
RA		-0.553 (0.021)*
Constant	5.079 (0.000)**	7.359 (0.000)*
Log Likelihood	-212.897 (0.448)	-210.484 (0.0202)*
Pseudo R2	0.0013	0.0126

\*:5% significant

\*\*:1% significant

(): p-value

Number of observations=93

For the experimental condition OSG, our estimation confirms anterior results such as by Eckel and Wilson (2004) who found no significant correlation between trust behavior, in that particular experimental condition, and measures given by indicators of risk aversion. However, the estimation yields that the RA explanatory variable correlates with investor behavior. These results seem to validate our hypothesis H2.

**R2: In the OSG the offer made by the investor decreases correlatively with his aversion to ambiguity (as apprehended by variable RA).**

## 5. Conclusion

Are strategic decisions in the trust-game tantamount to choice over lotteries? Our extensions over Eckel and Wilson's seminal investigation were essentially meant to address the question whether there are any correlations between risk and/or ambiguity attitudes and the decision to trust a partner in the trust game. A recent article by Houser *et al.* (2010) reports that risk attitudes and trusting decisions are not tightly connected. These authors more precisely argue, and demonstrate, that risk attitudes, elicited through a Holt and Laury's pairs of lotteries menu device, are not good predictors of social decisions in the trust game, while they were positively correlated with behavior on a risk game. The trust and risk games used by these authors were actually similar except for the fact that in one case participants were aware that they were playing with a human counterpart and in some other cases against a computer. Risk attitudes then correlate with the fact that the game we play, even though it has the structure of a trust game and replicates human behavioral patterns, is rightly perceived as a random device. The fact that the trust game involves a human dimension seems enough to make it essentially distinct from a pure probabilistic context.

There are several remarks that we can formulate in response to the facts reported by Houser and his colleagues. First, like Eckel and Wilson, although with a different methodology, the authors address the issue of a correlation between risk attitudes – as elicited on the basis of Holt and Laury's price list – and behavior in the trust game. Their data clearly indicate no correlation. We confirm this result as we likewise observed no significant correlation between risk aversion – measured in the same way – and behavior in a one-shot trust-game. But when human behavior in the trust game is known to be replicated by a computer, an investor is entitled to think that there are definite probabilities with which return occurs and that it is like playing a lottery. A human partner adds a margin of imprecision and triggers deliberation with respect to the return which makes it inherently more ambiguous. The correlations we observe between our menu (RA) and offers in the one-shot trust game might precisely capture this very fact that investors think, when playing with a human partner, that there are no definite probabilities of return to be known in advance.

In the one-shot trust game context, two more precise explanations could be considered. First, investors have no clue of the probability with which trustees will reciprocate their offers. Intuitively, then, one would be tempted to label the informational context in which investors find themselves in that situation as uncertain rather than risky. Second, one could further

argue that past social interactions shape the investor's expectations on reciprocation when he enters the trust game. It is most likely that these expectations take the form of imprecise and general beliefs and that an investment decision in the trust game is then analogous to a choice between a sure gain and an ambiguous lottery.

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