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Measuring Individual Risk Attitudes in the Lab: Task or Ask? An Empirical Comparison*

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Abstract This paper compares two prominent empirical measures of individual risk attitudes — the Holt and Laury (2002) lottery-choice task and the multi-item questionnaire advocated by Dohmen, Falk, Huffman, Schupp, Sunde and Wagner (forthcoming) — with respect to (a) their correlation with actual risk-taking behaviour in the lab — here the amount sent in a trust game, and (b) their within-subject stability over time (one year). As it turns out, only the questionnaire measure is correlated with actual risk-taking behaviour (both times) and with the Big Five personality measure (gathered prior to the first experiment); and the measures themselves are uncorrelated (both times). Most importantly, however, both individual risk-taking behaviour and the questionnaire measure exhibit a significant high test-retest stability ($r = 0.70$ and $r = 0.79$, resp.), while virtually no such stability is present in the lottery-choice task. Thus, the results suggest that the questionnaire measure is more reliable in eliciting individual risk attitudes than the lottery-choice task. Moreover, with respect to trust, the data further support the conjecture that trusting behaviour indeed has a component which itself is a stable individual characteristic (Glaeser, Laibson, Scheinkman and Soutter, 2000).

Keywords: Risk Attitudes, Trust, Personality, Lab Experiments

JEL codes: D81, C91, Z10

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1 Introduction

Risk-aversion has long since been a standard ingredient of economic theory (seminal works being Arrow, 1965, and Pratt, 1964). Moreover, with the growing body of experimental studies in the social sciences in general and in economics in particular (see Falk and Heckman, 2009, for a discussion), individual risk attitudes have also been linked empirically to a good many behavioural patterns. For example, Goeree, Holt and Palfrey show how the distribution of bids in a private-values auction experiment, including the prevalence of overbidding, can be captured in a quantal response equilibrium model with risk averse bidders (Goeree et al., 2002), and how deviations from Nash-equilibrium in a generalised matching pennies game can be explained if the subjects' risk aversion is taken into account (Goeree et al., 2003). Dohmen and Falk (forthcoming) in turn find that individuals self-select into different types of payment schemes according to their risk attitudes with more risk averse individuals choosing less performance dependent payment schemes (see also Guiso and Paiella, 2005). And these are but some of the many examples that have been discussed in the literature (see Harrison and Rutström, 2008, for further examples).

Despite the empirical relevance of individual risk attitudes, however, there is still an ongoing debate as to their adequate elicitation (cf. Harrison and Rutström, 2008). Among other aspects — including specific procedural issues as well the general question whether risk aversion is at all a plausible phenomenon for the small stakes which are commonly offered in the lab (cf. Rabin, 2000) — the relevance of proper incentives has given rise to discussions: Should risk preferences be inferred from incentivised behavioural measures such as lottery choice tasks (e.g. Holt and Laury, 2002) as commonly done in economics? Or should they rather be assessed using non-incentivised questionnaires based on so called Likert statements in which subjects specify their level of agreement to a certain statement as predominantly used in psychology (see Lauriola and Levin, 2001, for a historical review; see also Dohmen, Falk, Huffman, Schupp, Sunde and Wagner, forthcoming)? Of course, lottery choices in general will be easier to translate into formal indices and, hence, will be preferable when questions about the shape of utility functions are at issue. Yet, also questionnaire measures, which have witnessed a growing popularity in recent years (e.g. Dohmen and Falk, forthcoming; Dohmen, Falk, Huffman and Sunde, 2008 and forthcoming), have their virtues as predictors of behaviour — not least because they are both cheaper to gather and arguably easier to respond to without further instructions.

In the present study, we take up the question about the adequate elicitation of risk attitudes and investigate the ability of two different types of measures to predict actual risk-taking behaviour in the lab. In doing so, we operationalise risk-taking behaviour via a standard trust / investment game (Berg, Dickhaut and McCabe, 1995) taking the amount sent by first movers as a measure for their willingness to take risks. Although the question whether the investment decision in trust games eventually measures risk or trust (or both) is contentious — with some studies emphasising the role of risk (e.g. Snijders and Keren, 1998, Ben-Ner and Putterman, 2001) and others rather questioning it (e.g. Eckel and Wilson, 2004, or Bohnet and Zeckhauser, 2004) or arguing directly in favour of trust (e.g. Houser, Schunk and Winter, 2010), it appeared to us as an intuitive item to analyse. In fact, the popular view that giving money to strangers is risky (also expressed, for example, in Kosfeld, Heinrichs, Zak, Fischbacher and Fehr, 2005) intuitively suggests that doing so should somehow be correlated with risk attitudes. In conjunction with the mixed evidence on this correlation, it thus seemed appealing to try and scrutinise whether the type of risk measure applied may be crucial in this context.

In the experiment we conducted, subjects first played a standard one shot trust game – the main experimental task. Once that was completed, subjects were given the Holt and Laury (2002) lottery choice task and, eventually, the questions about individual risk-attitudes advanced by Dohmen et al. (forthcoming) as part of the post experimental questionnaire.¹ Moreover, in order to further analyse the connection between risk attitudes and other fundamental personal characteristics, we also gathered data on the subjects’ Big Five personality traits (Neuroticism, Extraversion, Openness to Experience, Agreeableness, Conscientiousness), which subsume a huge variety of personality attributes and provide a concise summary of stable individual differences in personality (Digman, 1990).² These traits had previously been shown to be correlated with risk-taking behaviour (Nicholson, Soane, Fenton-O’Creevy and Willman, 2005; or Lauriola and Levin, 2001), so that it seemed plausible to expect them to be correlated with the measures of individual risk attitudes under scrutiny, i.e. with behaviour in the lottery-choice task and the answers to the questionnaire.

¹Risk-measures were gathered after the trust game (the main behavioural task) and without being explicitly announced before in order to avoid any external indications that trusting behaviour is supposed to be risky. It is noteworthy in this respect that Houser et al. (2010), who ran a similar experiment combining a trust game with the Holt and Laury lottery-choice task in changing order, do not find any order effects. Inasmuch as possible, we also do not find any evidence in this direction in our data (see Section 3).

²The Big Five personality measure is also used, for example, by Bartling, Fehr, Marechal and Schunk (2005) who provide evidence that Agreeableness is related to a person’s competitiveness.

The data on personality were gathered prior to and independent of the actual (first) experiment, though, in order to obtain an additional external reference point against which to compare our later results. Finally, in order to further check on the stability of our results, we reran the actual experiment with (some of) the same subjects after about a year’s time and compared test and retest results.

The results show the following general patterns: (1) The investment decision in the trust game is *correlated* with a factor that was statistically extracted from the questionnaire measure about risk attitudes as well as with some of the single items, but is *uncorrelated* with the subjects’ behaviour in the Holt and Laury lottery-choice task (this holds for both test and retest); and we do not find any evidence for hedging or reference point effects that could explain the lack of correlation with the subjects’ lottery choices (see Section 3 for details). (2) The two measures of risk-attitudes themselves are uncorrelated (both studies). (3) The factor derived from the questionnaire as well as all single items are correlated with the Big Five personality measure, while behaviour in the lottery-choice task is not.³ (4) Both individual risk-taking behaviour and the questionnaire measure (factor and all single items) exhibit a high and significant test-retest stability (trust $r = 0.70$, factor $r = 0.79$), while virtually no such stability is present in the lottery-choice task ($r = 0.21$, $p > 0.1$).

From these observations, we conclude that the type of multi-item questionnaire advocated by Dohmen et al. (forthcoming) is a useful and reliable measure of individual risk attitudes in connection with lab experiments, whereas the behavioural measure, i.e. the Holt and Laury (2002) lottery-choice task, is rather problematic in this respect. Moreover, regarding the discussion about the determinants of trust (as measured in the Berg-Dickhaut-McCabe trust game), we interpret the data as suggesting that individual risk attitudes, once elicited in the appropriate way, indeed play a significant role in such behaviour (in particular attitudes towards “risk in financial matters,” see Section 3 for details). Last but not least, we see the high over-time stability of investment behaviour in the trust game as a strong indication that trusting behaviour indeed has a component which is a stable individual characteristic as conjectured by Glaeser, Laibson, Scheinkman and Soutter (2000, p. 827).⁴

The rest of this paper is structured as follows: In Section 2, we present the exper-

³Data on personality were gathered only prior to the test-study.

⁴In fact, this observation also squares well with the results by Cesarini et al. (2008) which indicate a correlation between trusting behaviour and the subjects genetic code; see also Fehr (2009) for a recent summary on the literature on the determinants of trust.

imental design and procedures. The empirical results of our study are gathered and briefly discussed in Section 3. Section 4 concludes.

2 Experimental Design and Procedures

In the sequel, we describe the design of the lab-experiment (2.1) and the procedures of the overall study (2.2).

2.1 Design of the Experiment

The lab-experiment consisted of three different parts which were implemented using z-tree (Fischbacher, 2007): the trust game, the Holt and Laury lottery-choice task and a post experimental questionnaire including the questionnaire measure of risk attitudes. These are described below.

The Trust Game – Risk-taking behaviour

The main experimental task for the subjects was the type of trust game first proposed by Berg, Dickhaut and McCabe (1995). In this game, there are two players, an investor and a responder. Initially, all players were given 10 Talers (1 Taler = 0.60 Euro). Responders just pocketed the money. By contrast, investors were given the opportunity to transfer any non-negative integer part of the endowment to a randomly matched and anonymous responder. All transfers were tripled by the experimenter. Upon receiving the transfer, responders then had to decide how much to return to the investor; responders' back-transfers, which were elicited with the strategy method (i.e. without any information about actual transfers), are not analysed in the present paper. The amount transferred by investors was taken as our measure of risk-taking behaviour. The trust game concluded with some questions about the subjects' expectations about behaviour which are only partly reported in the sequel.

The Lottery-Choice Task

As an incentivised behavioural measure of individual risk attitudes, we used the well established lottery choice task proposed by Holt and Laury (2002).⁵ This measure presents participants with ten choices between paired lotteries with payoffs ranging from 0.10 to 3.85 Euros (see Table 1 in Holt and Laury, 2002, P. 1645, who pay in US-Dollars instead of Euros). The first four pairs of lotteries give a higher expected payoff for the safer choice, whereas the latter six pairs give a higher expected payoff

⁵See also Harrison, Johnson, McInnes and Rutström (2005), and Holt and Laury (2005).

for the more risky choice. Thus, the risk neutral option is to make four safe choices and then six risky choices. At the end of the experiment, one of the ten pairs of lotteries is randomly selected, the preferred lottery of that pair is conducted and the subject is payed accordingly. Following Holt and Laury (2002), we took the number of risky decisions the participant made as our measure of individual risk attitudes.⁶

Asking About Risk Attitudes

As a non-incentivised questionnaire measure of individual risk-attitudes, we adhered to the questionnaire items presented by Dohmen et al. (forthcoming) and asked subjects to express their willingness to take risks in (1) general (2) driving (3) financial matters (4) sport and leisure activities (5) career decisions (6) health behaviours and (7) trusting strangers, using an eleven-point scale with zero indicating complete unwillingness to take risks and ten indicating complete willingness to take risks.⁷ As our measure of individual risk attitudes, we used a factor which was statistically extracted from the answers to all seven questions (using a standard factor analysis), henceforth referred to as the *general risk factor* - GRF for short.⁸ However, in the sequel, we occasionally report also correlations of single items.

2.2 Procedures

The study was conducted in three phases. In the first phase, participants' personality profiles were gathered using a questionnaire posted on a University of Helsinki website;⁹ the questionnaire also asked about some further items which are unrelated to the present study as well as some statistical data which allowed us to track subjects over time. The questionnaire was open from November 15th to December 6th 2007. Participants were contacted through a mailing list of the Laboratory for Experimental Economics (University of Bonn) to which they had signed up in order to take part

⁶We also conducted the subsequent analyses using the point at which subjects crossed over from the safe choice to the risky choice as our measure of risk-taking (215 subjects, i.e. 93%, had such a crossover point and did not switch back from the risky choices to the safe choices). However, as the results were virtually identical, we report only the results for the former type of coding.

⁷The last item is not part of the questions asked by Dohmen et al. (forthcoming) but was added for purposes of the present study. In view of the later discussion, it is noteworthy that its inclusion into the factor model is not crucial for the results.

⁸Parallel analysis revealed that the questionnaire data can be modelled by just one principal component that accounted for 39% of the variance. In the present setting, results for the factor, which is a kind of (normalised) sophisticated average, are almost identical to those for the standard average, though.

⁹Personality was measured with a 60-item questionnaire (Konstabel, Lönnqvist, Walkowitz, Konstabel and Verkasalo, 2009) that captures the five personality factors conceptualised in the Five-Factor Model (Costa and McCrae, 1992).

in research conducted at the lab. The mailing list consisted of around 3000 names. As an incentive to participate, participants were offered feedback on their personality profiles and a potential payoff from a short non-related decision task placed after the questionnaires; 945 subjects participated in this phase.

Out of the 945 subjects for which personality profiles had been gathered, a total of 232 responded to our subsequent invitation (which made no reference to phase 1) and participated in the experimental sessions conducted in phase 2 of our study at the Laboratory for Experimental Economics in Bonn between December 2007 and February 2008 (109 male, mean age 23.5 years, *SD* of age = 3.2).¹⁰ Upon arriving at the lab, subjects were seated in computer cubicles and, thereby, randomly assigned to either of two roles for the trust game so that we ended up with $N = 116$ investors and equally many responders. The experiment started once the subjects had read the instructions and (correctly) answered a set of control-questions. After decisions for the one shot trust game had been made, all subjects had to complete the Holt and Laury lottery-choice task and, eventually, the questionnaire measure about risk attitudes as part of the post experimental questionnaire (i.e. both measures had not been announced before as they were not part of the primary experiment). Feedback about the actual outcome of the trust game and the lottery was given individually at the end of the experiment.

In phase 3, we reinvited subjects from the 232 participants of phase 2 for a new experiment which took place on March 16 2009; 44 out of the 232 subjects from phase 2 participated in phase 3 (22 male, mean age 24.0 years, *SD* of age = 4.1).¹⁰ The actual experiment was identical to the one described in phase 2 except for the fact that the assignment of subjects to their roles in the trust game was not random but determined by phase-2-assignments; also two items were added at the end of the post-experimental questionnaire:¹¹ First, trust attitudes were elicited with the General Trust Scale developed by Yamagishi and Yamagishi (1994).¹² And, at the very last, subjects were asked whether they had taken part in a similar experiment before (without suggesting that they had).

¹⁰To be precise, 252 subjects participated in the experiments. However, due to technical problems, the first session happened to end up without the questionnaire measure of individual risk attitudes. The session was excluded for the later analysis (this also affects the retest to which 2 additional subjects from the respective session turned up but were excluded from the analysis).

¹¹The additional items were added at the very end of the post-experimental questionnaire in order to avoid any interference with the earlier aspects of the experiment.

¹²This scale measures trustfulness in the benevolence of human nature in general. Respondents indicate on a five-point scale the extent to which they agree with six statements (e.g. “Most people are basically honest”).

3 Results

In the sequel, we report the results of the our experiments from phase 2 (the test) and phase 3 (the retest) of our study focusing in particular on investment decisions in the trust game and correlation with and between the different measures of individual risk attitudes. The results are collapsed across genders as we do not find gender to be correlated with either the lottery-choice behaviour, the general risk factor¹³ or trusting behaviour; if not mentioned otherwise, all reported correlation coefficients are Pearson correlation coefficients of two-sided tests.¹⁴

3.1 The Test Study

In the first experiment, the average transfer in the trust game was 4.664 Taler (SD 3.095) with single transfers ranging from the full endowment of the truster (10 Taler) to none of it (0 Taler).

Regarding the predictive power of our risk-attitude measures, it turns out that the general risk factor is significantly correlated with the amount invested in the trust game, cf. Table 1; a more detailed analysis shows that this result is mainly driven by the subjects willingness to take risks in financial matters and when trusting strangers, cf. Table 2.¹⁵ The correlation between investment decisions and the lottery-choice task, by contrast, is weaker and not significant (or only marginally so, despite the large number of observations); see Table 1. Furthermore, the lottery-choice measure and the GRF themselves are uncorrelated ($r = -.002$, not sign.) suggesting that they measure different things.

In order to find out more about the reliability of the respective risk-attitude measures, we analysed correlations with the Big Five personality factors; see Tables 1 and 3. Based on a self-report measure of risk-attitudes in six decision domains Nicholson, Soane, Fenton-O’Creevy and Willman (2005) find that risk-taking is associated positively with Extraversion and Openness, and negatively with Neuroticism, Agree-

¹³Gender was correlated with one single item of the underlying questionnaire, though, namely the willingness to take risks in financial matters. For this the average for females was 2.642 as opposed to 3.553 for males (an F-test for the difference in means gives $F = 8.936, p < .001$).

¹⁴Spearman correlation coefficients of non-parametric testing give essentially the same results. They are available from the authors on request.

¹⁵Despite the strong influence of the “risk in financial matters” item, we stick to the general risk factor for the main part of the analysis as this appears to be the more robust measure which is more likely to generalise to scenarios other than the trust game investigated in the present setting.

	Risk Attitude Measure	
	LM	GRF
Personality ($N = 232$)		
Neuroticism	-.126(*)	-.202**
Extraversion	.152*	.224***
Openness	.024	.243***
Agreeableness	.092	-.081
Conscientiousness	.099	-.126(*)
Risk taking behaviour ($N = 116$)		
Trust game transfer	.166(*)	.242**

Table 1: Pearson correlation coefficients of risk-attitude measures (Lottery Measure [LM] and Questionnaire Measure [GRF]) with personality traits (all subjects) and risk-taking behaviour (investors only). *** $p < .001$, ** $p < .01$, * $p < .05$, (*) $p < .10$.

Risk attitudes	Pearson's r
general	.179(*)
driving	.154(*)
financial matters	.358***
sport and leisure	.067
career	.089
health behaviour	.039
trusting strangers	.219*
GRF	.242**
‡ risky dec. in lottery	.166(*)

Table 2: Pearson correlation coefficients of transfers as truster with risk measures per item, factor and lottery choice ($N = 116$). *** $p < .001$, ** $p < .01$, * $p < .05$, (*) $p < .10$.

ableness and Conscientiousness (see also Lauriola and Levin, 2001).¹⁶ Accordingly, we expected similar relations to hold for the risk-attitude measures tested in the present study. Yet, as shown in Table 1, only the questionnaire measure (GRF) shows four of the five expected correlations, while the lottery-choice measure shows only two. Moreover, all five personality factors significantly predict the GRF but do not predict behaviour in the lottery-choice task in multiple regression analyses which model

¹⁶The six decision domains considered by Nicholson et al. are: recreation, health, career, finance, safety and social.

Measure	OLS-Regression		Tobit Regression	
	LM	GRF	LM	GRF
Neuroticism	-.049 (.046)	-.067** (.022)	-.049 (.045)	-.067** (.022)
Extraversion	.058 (.038)	.050** (.019)	.058 (.038)	.050** (.018)
Openness	-.013 (.042)	.080*** (.021)	-.013 (.041)	.080*** (.020)
Agreeableness	.057 (.046)	-.051* (.022)	.057 (.045)	-.051* (.022)
Conscientiousness	.027 (.036)	-.064*** (.017)	.027 (.035)	-.063*** (.017)
Constant	4.086** (.232)	-.143 (.113)	4.086*** (.229)	-.143 (.112)
Prob > $F(\text{chi}^2)$ (Pseudo) R^2	.111 .039	.000 .180	.098 .039	.000 .180

Table 3: Multiple ordinary least square (OLS) and Tobit regression analyses predicting risk-attitude measures (Lottery Measure [LM] and Questionnaire Measure [GRF]) as a function of the Big Five personality factors (all subjects; $N = 232$). Table entries are the predictors' un-standardised B-coefficients from multiple regression analyses; numbers in brackets indicate standard errors. *** $p < .001$, ** $p < .01$, * $p < .05$.

the respective risk-attitude as a composite of the Big Five; see Table 3. Thus, these findings cast some doubt on the reliability of the lottery-choice task as a measure of individual risk attitudes.

A possible explanation for the fact that the data from the lottery lottery-choice task do not correlate with the general risk factor, personality or actual risk-taking behaviour, of course, may be found in the fact that the lottery was also incentivised and was *always* run after the trust-game. Thus, subjects may have used the lottery to hedge their behaviour in the trust game in a way that confounds the results of the lottery choice task (instead of treating the lottery-choice as an isolated item). Yet, we find no evidence for such behaviour in the data: As reported above, lottery choices are uncorrelated with investment behaviour. Moreover, there is also no significant correlation between the subjects' beliefs about their expected outcome from the trust game and their lottery-choice behaviour. And, as we will report in more detail further below, there is also no significant correlation between the change of behaviour in the trust game and that in the lottery choice task over time. As also Houser et al. (2010)

find no order effects in a study on the determinants of trust, which combined the Berg et al. investment game with the Holt and Laury lottery-choice task in varying order, we are confident that order effects did not affect the outcomes in the present study.

3.2 The Retest

One year after the first study, the retest study was conducted under almost identical conditions (cf. Section 2.2); the results are reported below. In order to ensure that participants could not remember their prior responses, we asked them at the very end of the retest study whether they had taken part in a similar study before. One participant could remember taking part in the first study and was therefore excluded from the below analyses leaving us with 22 investors and 21 responders.

Experimental Results - Retest only.

All in all, the experimental results of the retest study are very similar to those of the first study. The mean transfer was 4.409 Taler (SD 3.647) with transfers again ranging from the full endowment (10 Taler) to nothing (0 Taler). Moreover, as before, only the general risk factor is correlated with investment behaviour in the trust game ($r=.518$, $p=.014$) while behaviour in the lottery-choice task is not ($r=.230$, $p=.303$).

Having gathered data about trust attitudes with the General Trust Scale (Yamagishi and Yamagishi, 1994) in the retest study, we also extended the previous analysis by examining whether and how either risk-attitude measure combined with trust attitudes in predicting the amount transferred in the trust game. In order to do so, we conducted four different OLS and Tobit regression analyses in which trust attitudes were always entered in the first step and where the two risk-attitude measures were entered in steps two and three (only one at the time). In a fourth step we estimated the complete model; see Table 4.

The results show that the attitudinal trust measure itself has no significant predictive power regarding the subjects' investment behaviour (neither on its own nor in combination with the different risk measures).¹⁷ Moreover, also adding the lottery measure of risk attitudes does not significantly affect the predictive power of

¹⁷It is beyond the scope of this paper to analyse in detail why trust attitudes fail to predict investment behaviour in the trust game. We speculate, though, that one reason for this observation is the strong focus of the trust game on financial matters while "real-life" trust is often less about money; recall that also among the risk attitude questions the one about the subjects' willingness to take risks in financial matters exhibits the strongest correlation with trusting behaviour.

Model	OLS-Regression				Tobit-Regression			
	(1)	(2)	(3)	(4)	(1)	(2)	(3)	(4)
Trust Att.	-.020 (.258)	.037 (.263)	.205 (.236)	.205 (.240)	-.020 (.246)	.037 (.245)	.204 (.219)	.204 (.217)
Risk LM		.380 (.366)		-.232 (.399)		.380 (.340)		-.232 (.361)
Risk GRF			1.931* (.683)	2.229* (.865)			1.930** (.636)	2.229** (.784)
Const.	4.627 (2.925)	2.368 (3.640)	2.228 (2.657)	3.235 (3.214)	4.627 (2.789)	2.368 (3.383)	2.236 (2.470)	3.245 (2.909)
R^2	.000	.054	.296	.309	.000	.054	.295	.308

Table 4: Hierarchical ordinary least square (OLS) and Tobit regression analyses predicting invested amount as a function of trust attitudes and risk-attitude measures (Lottery Measure [LM] and Questionnaire Measure [GRF]); retest study. Table entries are the predictors' un-standardised B-coefficients from hierarchical regression analyses (numbers in brackets indicate the standard error). ** $p < .01$, * $p < .05$, (*) $p < .10$.

either model (R^2 changed from .000 to .054; OLS and Tobit). The general risk factor, by contrast, significantly contributes to the prediction of investment behaviour (R^2 of the model changed from .000 to .296, OLS, and from .000 to .295, Tobit); higher scores on the GRF predicting higher transfers in the trust game ($B = 1.931$, $p = .011$, OLS; $B = 1.930$, $p = .002$, Tobit). The complete models, columns “(4)” in the table, confirm this finding: only the general risk factor has significant predictive power regarding the subjects' investment behaviour; the results are robust across OLS and Tobit regression analyses. Thus, again the data suggest that trusting behaviour (i.e. investments in the trust game) can be predicted with individual risk attitudes but only if these are measured by the type of questionnaire advocated by Dohmen et al. (forthcoming).

Test-Retest Comparison.

The main aspect of running the retest study, however, was to scrutinise the over-time stability of the different measures elicited in the course of our experiment, i.e. the amount invested in the trust game, and the the risk-attitude measures.

Regarding the stability of individual risk attitudes over time, we first analysed the correlations between the test and the retest study responses. The general risk factor as well as all single items of the underlying questionnaire show a very high over-time stability (GRF: $r = .793$, $p < .001$), while the lottery-choice measure shows no such stability ($r = .205$, not sign.); see Table 5 for details. Being surprised by the instability of behaviour in the lottery-choice task, we also examined the test-retest stability of the lottery-choice measure by categorising participants into risk-averse (cross-over point after more than four safe decisions), risk-neutral (cross-over point after exactly four safe decisions), and risk-taking (cross-over point before more than four safe decisions). This could be done for 33 participants (those who had cross-over points in both studies). Yet, also the category shows no stability over time ($\chi^2(4) = 5.38$, not sign.). Thus, the test-retest comparison casts further doubt on the reliability of the lottery-choice task as a measure of individual risk-attitudes.

Risk attitudes	Pearson's r
general	.779***
driving	.556***
financial matters	.627***
sport and leisure	.656***
career	.579***
health behaviour	.591***
trusting strangers	.680***
GRF	.793***
‡ risky dec. in lottery	.205

Table 5: Test-retest stability of risk measures (all subjects; N=43). *** $p < .001$, ** $p < .01$, * $p < .05$, (*) $p < .10$.

For comparison purposes and to examine what type of test-retest correlation we could reasonably expect for a behavioural decision-making measure, we also computed the test-retest correlation of the amount transferred in the trust game. This correlation was almost as high as that of the general risk factor ($r = .697$, $p < .001$) suggesting that trusting behaviour indeed has a component which is a stable individual characteristic as hypothesised by Glaeser et al. (2000, p. 827).

Finally, we used the results of the retest study for a further test of the possibility that the results of the lottery-choice task are confounded due to order effects, i.e. a conditioning of lottery choices on investment behaviour in the trust game that

might have blurred the underlying correlation between risk and trust. In particular, we tested whether the direction of over-time changes in investment behaviour (trust game) are correlated with direction of changes in lottery-choice behaviour. If subjects had conditioned their behaviour in the lottery choice task on their earlier investment behaviour, it seemed reasonable to expect the direction of the deviations to be correlated. However, we do not find any evidence for such a correlation: 11 trusters change their investments over time (3 invest more, 8 less). Of those who invest more in the retest-study, one makes a safer choice in the lottery task and two make a more risky one, while the 8 subjects who invest less in the retest-study split equally into safer and more risky choices (4 each). Accordingly, we find that the direction of change in the trust game is not correlated with the direction of change in the lottery-choice task (Fisher's exact test $p = .576$).¹⁸ Thus, also the combination of test and retest data gives no indication of order effects which might have confounded the results of the lottery-choice task.

4 Concluding Remarks

The data presented in this paper show that the general risk factor derived from a questionnaire about individual risk attitudes similar to the one used by Dohmen et al. (forthcoming) has good construct validity (being correlated with an external predictor of risk-taking behaviour, namely personality, almost exactly as expected), reasonable predictive power (regarding behaviour in the trust game), and a very good test-retest stability over time (one year). By contrast, the Holt and Laury (2002) lottery-choice measure shows no construct validity (again when related to personality), almost no predictive power, and most importantly no test-retest stability. Furthermore, we also find no evidence supporting the convergent validity between general risk factor and the Holt and Laury (2002) lottery-choice task, i.e. both are uncorrelated in our study. Taken together, the results thus suggest that behaviour in the lottery-choice task is not a reliable measure of stable individual differences in risk-attitudes.

Moreover, the lack of reliability of the lottery-choice measure can neither be clearly attributed to the method of measurement (i.e. relying on a single behavioural item), as our other one-shot behavioural measure – transferred amount as truster – shows a

¹⁸The same remains to hold if also trustees are drawn into the picture: 10 of them change their back-transfer behaviour over time. Combining those who invest more (less) with those who back-transfer more (less), we again find that the direction of change in one task is not correlated with that in the other (Fisher's exact test $p = .410$).

very high test-retest stability. Nor can it be attributed to the construct being measured (i.e. risk attitudes), as the multi-item questionnaire measure shows a very high test-retest stability. Thus, the problem appears specific to the behavioural measurement of individual risk attitudes by means of lottery choice tasks such as the one proposed by Holt and Laury (2002).¹⁹ From an applied point of view, our results therefore recommend using the type of questionnaire measure advocated by Dohmen et al. (forthcoming) rather than — or at least complementary to — common lottery-choice measures when studying the connection between individual risk-attitudes and behaviour in laboratory experiments.

Apart from the aspects about the adequate measurement of individual risk attitudes mentioned above, our results also contribute to the current discussion on the relation between risk and trust. Challenging the claim that there is an intrinsic relation between these constructs (suggested e.g. by Snijders and Keren, 1998, or Ben-Ner and Putterman, 2001), Eckel and Wilson (2004) reported that their risk instruments (including the Holt and Laury measure) could not predict the decision to trust in a binary trust game (for similar results, see Bohnet and Zeckhauser, 2004; Houser et al., 2010). By contrast, our results support the intuitive contention that trusting behaviour, as revealed in the Berg et al. trust / investment game, does indeed entail an element of risk. In how far these results translate to more general instances of trust, of course, remains an open question.²⁰ The results of the present study, however, strongly suggest that future research into the nature of trust and its connection to risk should include a questionnaire measure of individual risk-attitudes of the type advocated by Dohmen et al. (forthcoming) instead of relying on lottery-choice tasks alone.

Finally, we want to reemphasise that the high test-retest stability of the observed investment behaviour in the trust game strongly suggests that trusting behaviour indeed has a component which is a stable individual characteristic as hypothesised by Glaeser et al. (2000, p. 827).²¹ Thus, although the exact determinants of trust remain an open question, it seems that trust is at least a comparably stable phenomenon — a fact that, despite all remaining difficulties, should facility future enquiries into the nature of trust.

¹⁹The more general claim going beyond the Holt and Laury task, of course, calls for further research to be substantiated.

²⁰See Fehr (2009) for an interesting recent discussion about the determinants of trust.

²¹As mentioned earlier, the respective hypothesis is also supported through a study by Cesarini et al. (2008) who identify a correlation between trusting behaviour and the subjects' genetic code.

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