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Abstract

We elicit and compare risk preferences from student subjects and subjects drawn from the general population, using the multiple price list method devised by Holt and and Laury (2002). We find evidence suggesting that students have lower relative risk aversion than others.

Keywords: Risk aversion, CRRA, expo-power, multiple price list

JEL codes: C91, D01, D81

1. Introduction

Economic lab experiments have been mainly performed in academic environments and students have therefore posed as the natural standard subject pool. Whether student samples provide a reliable sample for extrapolating results to the general population is an issue that is heavily criticized. Concerns on the use of students as research surrogates for consumers or adults in general, is rather old (Enis et al., 1972; McNemar, 1946). Reasons are attributed to the fact that students exhibit psychological, social and demographical differences from other segments of the population but also to the fact that students are not yet complete personalities.

In addition, most decisions in life and in the lab are made under conditions of uncertainty, rendering risk behavior as a fundamental concept in the economic decision making process. Risk preferences are important to decisions varying from career choice to stock picking (Barsky et al., 1997) as well as production decisions (Koundouri et al., 2009; 2006). If risk-neutrality is not a general characterization of the sample under investigation, it is important to know the subject's pool preferences over risk. Previous results in the literature regarding risk behavior and the nature of the subject pool have not been uniform (Andersen et al., 2010a; 2010b). This study sheds more light to risk preference elicitation in a conventional lab experiment (i.e., using a student subject pool) and an artefactual lab experiment (i.e, using a general population subject pool).

2. Experimental data

We compiled data from two previous experiments that involved risk preference elicitations tasks. These two experiments were part of a larger project on choice under risk which also involved some standard experimental auction tasks. Experimental instructions for the experiments are available at https://sites.google.com/site/riskprefs/ . The first experiment used a student subject pool while the second experiment used a subject pool drawn from the general population. General population subjects were recruited by a professional company. The same proctor was used in both experiments.

In the student subject pool experiment, the purpose was to explore whether risk preferences can be manipulated by some treatment variables, so we only used data from the control treatment sessions. In the consumer subject pool experiment, risk preferences were not part of the experimental manipulation. In all, we used elicited risk preferences from 34 general population subjects and 23 student subjects. In the student subject pool experiment, in one session the auction task was placed after risk elicitation. For all other subjects, risk elicitation followed the auction. We use a dummy variable in our econometric estimation to control for this session-specific characteristic.

To elicit risk preferences we used the multiple price list (MPL) design devised by Holt and Laury (2002). In this design each subject is presented with a choice between two lotteries, A or B as illustrated in Table 1. In the first row the subject is asked to make a choice between lottery A, which offers a 10% chance of receiving €2 and a 90% chance of receiving €1.6, and lottery B, which offers a 10% chance of receiving €3.85 and a 90% chance of receiving €0.1. The expected value of lottery A is €1.64 while for lottery B it is €0.475, which results in a difference of €1.17 between the expected values of the lotteries. Proceeding down the table to the last row, the expected values of the lotteries increase but increases much faster for lottery B.

For each row, a subject chooses A or B and one row is then randomly selected as binding for the payout. The last row is a simple test of whether subjects understood the instructions correctly. In our experiments subjects undertook three risk aversion tasks: they made choices from Table 1 (the 1x table), a table where payoffs were scaled up by 10 (the 10x table) and a table similar to Table 1 but without the last three rows (the 1x-framed table). The order of appearance of the tables for each subject was completely randomized to avoid order effects (Harrison et al., 2005). One of these tables was chosen at the end as binding for the payout. Thus, to infer risk preferences, subjects were asked to provide 27 binary choices from the risk preference task.

3. Estimation and Results

To estimate risk attitudes and assess the importance of the sample type as well as the demographics on risk preferences, we follow similar procedures to Holt and Laury (2002) and Harrison, et al. (2007).

Let the utility function be the constant relative risk aversion (CRRA) specification:

$$U(M) = \frac{M^{1-r}}{1-r} \qquad (1)$$

for $r \neq 1$, where r is the CRRA coefficient. In (1), $r=0$ denotes risk neutral behavior, $r>0$ denotes risk aversion behavior and $r<0$ denotes risk loving behavior.

The binary choices of the subjects in the risk preference tasks can be explained by different CRRA coefficients (as reported in Table 1).

If we assume that Expected Utility Theory holds for the choices over risky alternatives, the likelihood function for the choices that subjects make can be written for each lottery i as:

$$EU_i = \sum_{j=1,2} \left(p\left(M_j\right) \cdot U\left(M_j\right) \right) \qquad (2)$$

where $p\left(M_j\right)$ are the probabilities for each outcome M_j that are induced by the experimenter. To specify the likelihoods conditional on the model, the Luce stochastic specification is used. The expected utility (EU) for each lottery pair is calculated for candidate estimate of r, and the ratio:

$$\nabla EU = \frac{EU_B^{1/\mu}}{EU_A^{1/\mu} + EU_B^{1/\mu}} \qquad (3)$$

is then calculated where EU_A and EU_B refer to options A and B respectively, and μ is a structural noise parameter. The index in (3) is linked to observed choices by specifying that the option B is chosen when $\nabla EU > 1/2$.

The conditional log-likelihood can then be written as:

$$\ln L^{RA}\left(r, \mu; y, \mathbf{X}\right) = \sum_i \left(\left(\ln\left(\nabla EU\right) \mid y_i = 1 \right) + \left(\ln\left(1 - \nabla EU\right) \mid y_i = -1 \right) \right) \qquad (4)$$

where $y_i = 1(-1)$ denotes the choice of the option B (A) lottery in the risk preference task i. Each parameter in equation (4) is allowed to be a linear function of demographic and treatment variables as exhibited in Table 2. A portion of subject's fees was stochastic since this have been demonstrated to be very important for recruitment (Harrison et al., 2009). In addition, recruitment practices necessitated a higher show-up fee for consumer subjects. Thus, a total fee endowment variable is included in the econometric model. Equation (4) is maximized using standard numerical methods.

Table 3 (Panel A) shows estimates when assuming a CRRA function with a Luce stochastic error. It is obvious that even after controlling for all possible demographic effects general population subjects appear more risk averse than the student sample and the difference is highly significant.

The CRRA characterization of risk preferences, while popular, restricts relative risk aversion to be constant over the prize domain. To allow for the possibility that the relative risk aversion is not constant we adopt a more flexible functional form; the hybrid expo-power function of Saha (1993). The expo-power function can be defined as $u(M) = \left(1-\exp\left(-aM^{1-r}\right)\right)/a$, where *M* is income and a and r are parameters to be estimated. Relative risk aversion (RRA) is then $r + a(1-r)M^{1-r}$. Results assuming the expo-power form are presented in Table 4 (panel A). It is obvious that by allowing a more flexible functional form the coefficient of the relevant sample type dummy is no longer statistically significant for neither a or r. The magnitude of the r coefficient is reduced as well.

The Luce error popularized by Holt and Laury (2002), however, implicitly imposes a stochastic identifying restriction that the true stochastic model is CRRA-neutral (Wilcox, 2008). Different stochastic models should then be evaluated. Therefore, we also test the Fechner specification (as in Harrison and Rutstrom, 2008), which posits $\nabla EU = \frac{EU_B - EU_A}{\mu}$ instead of (3). Results for the CRRA and expo-power functions are exhibited in panels B in Table 3 and 4 respectively. The estimates for the *Consumer* dummy for r are statistically significant, positive and remarkably close to the expo-power with Luce error specification estimate. The estimate for a turns negative and is statistically significant.

So which specification should we trust? A non-nested hypothesis test like the Vuong (1989) test is appropriate in this context. The expo-power with Fechner error specification is favored in all cases [Vuong statistic: 2.07 (vs. expo-power Luce), 3.69 (vs. CRRA-Luce), 5.00 (vs. CRRA-Fechner)]. In the expo-power with Fechner error specification the negative coefficient of the relevant dummy for a (-6.142) implies lower RRA for general population subjects as compared to the student sample, ceteris paribus. In addition, the average prediction for a is positive for both subsamples, indicating increasing RRA. Given a positive a, the coefficient of the *Consumers* dummy for r (0.331) implies a lower RRA for subjects of the general population as compared to students, ceteris paribus.

Table 5 exhibits RRA predictions for the two subject pools for *M*=1 and *M*=5. The predictions indicate higher RRA for general population subjects and lower RRA for students. At a first glance this may seem like contrasting with the previous paragraph but should be of no surprise given the sign of the *Age* coefficients and the age difference between subject pools.

4. Conclusions

In this article we tested whether risk preferences of subjects drawn from the general population differ with respect to a standard student subject pool. We found evidence suggesting that students have lower relative risk aversion than others. Our finding is important given that previous studies have either found no difference in risk aversion between students and the general adult population (Andersen et al., 2010a) or that students are more risk averse (Andersen et al., 2010b). This finding has significant implications for conventional laboratory experiments practice given the importance of risk preferences in everyday economic decision making. More studies that will examine differences in risk preferences between students and the general population are indeed warranted.

5. References

Andersen, S., G.W. Harrison, M.I. Lau, E.E. Rutström, 2010a. Discounting behavior: A reconsideration. working paper.

Andersen, S., G.W. Harrison, M.I. Lau, E.E. Rutström, 2010b. Preference heterogeneity in experiments: Comparing the field and laboratory. Journal of Economic Behavior and Organization 73, 209-224.

Barsky, R.B., F.T. Juster, M.S. Kimball, M.D. Shapiro, 1997. Preference parameters and behavioral heterogeneity: An experimental approach in the health and retirement study. Quarterly Journal of Economics 112, 537-579.

Enis, B.M., K.K. Cox, J.E. Stafford, 1972. Students as subjects in consumer behavior experiments. Journal of Marketing Research 9, 72-74.

Harrison, G.W., E. Johnson, M.M. McInnes, E.E. Rutström, 2005. Risk aversion and incentive effects: Comment. The American Economic Review 95, 897-901.

Harrison, G.W., M.I. Lau, E.E. Rutstrom, 2007. Estimating risk attitudes in Denmark: A field experiment. Scandinavian Journal of Economics 109, 341–368.

Harrison, G.W., M.I. Lau, E.E. Rutström, 2009. Risk attitudes, randomization to treatment, and self-selection into experiments. Journal of Economic Behavior & Organization 70, 498-507.

Harrison, G.W., E.E. Rutstrom, 2008. Risk aversion in the laboratory, in: Cox, J.C., Harrison, G.W. (Eds.), Research in Experimental Economics Vol 12: Risk Aversion in Experiments. (Emerald Group Publishing Limited, Bingley, UK), pp. 41-196.

Holt, C.A., S.K. Laury, 2002. Risk aversion and incentive effects. The American Economic Review 92, 1644-1655.

Koundouri, P., M. Laukkanen, S. Myyrä, C. Nauges, 2009. The effects of EU agricultural policy changes on farmers' risk attitudes European Review of Agricultural Economics 36, 53-77.

Koundouri, P., C. Nauges, V. Tzouvelekas, 2006. Technology Adoption under Production Uncertainty: Theory and Application to Irrigation Technology. American Journal of Agricultural Economics 88, 657-670.

McNemar, Q., 1946. Opinion-attitude methodology. Psychological Bulletin 43, 289-374.

Saha, A., 1993. Expo-power utility: A flexible form for absolute and relative risk aversion. American Journal of Agricultural Economics 75, 905-913.

Vuong, Q.H., 1989. Likelihood ratio tests for model selection and non-nested hypotheses. Econometrica 57, 307-333.

Wilcox, N., 2008. Stochastic models for binary discrete choice under risk: A critical primer and econometric comparison, in: Cox, J.C., Harrison, G.W. (Eds.), Research in Experimental

Economics Vol 12: Risk Aversion in Experiments. (Emerald Group Publishing Limited, Bingley, UK), pp. 197-292.

Table 1. Sample payoff matrix for the risk preferences tasks

Lottery A				Lottery B				Open CRRA interval if subject switches to Lottery B and background consumption=0	
p	€	*p*	€	*p*	€	*p*	€		
0.1	2	0.9	1.6	0.1	3.85	0.9	0.1	-∞	-1.71
0.2	2	0.8	1.6	0.2	3.85	0.8	0.1	-1.71	-0.95
0.3	2	0.7	1.6	0.3	3.85	0.7	0.1	-0.95	-0.49
0.4	2	0.6	1.6	0.4	3.85	0.6	0.1	-0.49	-0.15
0.5	2	0.5	1.6	0.5	3.85	0.5	0.1	-0.15	0.14
0.6	2	0.4	1.6	0.6	3.85	0.4	0.1	0.14	0.41
0.7	2	0.3	1.6	0.7	3.85	0.3	0.1	0.41	0.68
0.8	2	0.2	1.6	0.8	3.85	0.2	0.1	0.68	0.97
0.9	2	0.1	1.6	0.9	3.85	0.1	0.1	0.97	1.37
1	2	0	1.6	1	3.85	0	0.1	1.37	+∞

Note: Last two columns showing implied CRRA intervals were not shown to subjects.

Table 2. Variable description

Variable	**Description**	**General population subject pool**		**Student subject pool**	
		Mean	*Std.dev.*	*Mean*	*Std.dev.*
Age	Subject's age	41.176	10.376	20.739	1.322
Gender	Dummy, 1=males, 0=females	0.324	0.475	0.391	0.499
Income	Dummy, household's economic position is above average=1, else=0	0.471	0.507	0.435	0.507
Education	Dummy, university graduate or higher=1, else=0	0.676	0.475	0	0
TotFee	Total fee endowment	23.794	6.594	16.717	1.146
ExpCharact	Dummy, risk preference task was conducted after an auction, else=0	1	0	0.522	0.511

Table 3. Estimates of risk preferences (CRRA function)

	r coefficient							
	Estimate	Std.Error	Lower 95% CI	Upper 95% CI	Estimate	Std.Error	Lower 95% CI	Upper 95% CI
	A. CRRA with Luce error				**B. CRRA with Fechner error**			
Consumers	0.878	0.268	0.352	1.404	0.345	0.084	0.180	0.511
Age	-0.038	0.015	-0.067	-0.008	-0.017	0.004	-0.025	-0.009
Gender	-0.011	0.262	-0.525	0.503	-0.081	0.057	-0.193	0.032
Income	0.070	0.188	-0.299	0.439	0.062	0.043	-0.022	0.146
Education	-0.311	0.217	-0.735	0.114	-0.099	0.063	-0.222	0.024
TotFee	-0.138	0.262	-0.651	0.375	-0.149	0.052	-0.251	-0.047
ExpCharact	-0.041	0.011	-0.063	-0.019	-0.009	0.005	-0.018	0.000
Constant	1.831	0.278	1.286	2.376	1.259	0.119	1.026	1.491
μ	0.328	0.053	0.224	0.431	0.140	0.051	0.040	0.240

Table 4. Estimates of risk preferences (expo-power function)

	r coefficient				α coefficient			
	Estimate	Std.Error	Lower 95% CI	Upper 95% CI	Estimate	Std.Error	Lower 95% CI	Upper 95% CI
	A. Expo-power with Luce error							
Consumers	0.351	0.507	-0.643	1.345	27.962	231.477	-425.724	481.647
Age	-0.044	0.014	-0.072	-0.017	3.320	5.899	-8.243	14.882
Gender	0.198	0.245	-0.282	0.677	-18.323	20.585	-58.668	22.022
Income	-0.117	0.139	-0.390	0.157	13.488	18.856	-23.469	50.446
Education	-0.027	0.429	-0.868	0.815	-89.374	220.908	-522.345	343.597
TotFee	0.101	0.535	-0.948	1.149	-4.330	11.894	-27.641	18.982
ExpCharact	-0.029	0.017	-0.063	0.005	4.898	6.765	-8.361	18.158
Constant	1.725	0.305	1.127	2.322	-140.857	208.494	-549.497	267.783

μ	0.317	0.056	0.207	0.427				
				B. Expo-power with Fechner error				
Consumers	0.331	0.115	0.106	0.556	-6.142	2.219	-10.491	-1.792
Age	-0.023	0.007	-0.036	-0.010	0.042	0.111	-0.176	0.260
Gender	0.233	0.081	0.075	0.392	-1.297	1.153	-3.558	0.964
Income	-0.064	0.052	-0.166	0.038	1.378	1.031	-0.643	3.399
Education	-0.187	0.084	-0.352	-0.022	-6.534	1.890	-10.238	-2.830
TotFee	-0.013	0.009	-0.031	0.004	1.637	1.023	-0.368	3.642
ExpCharact	-0.026	0.010	-0.045	-0.006	1.276	0.303	0.682	1.871
Constant	1.647	0.178	1.298	1.997	-22.392	5.823	-33.804	-10.980
μ	0.031	0.018	-0.005	0.066				

Table 5. Relative risk aversion predictions based on expo-power function with Fechner error

	Consumers	***Students***
M=1	2.71	1.06
M=5	47.10	1.27