On the Formation and Manipulation of Reference States

Astrid Matthey*

October 14, 2008

Abstract

Experimental and empirical evidence shows that the utility an individual derives from a certain state depends on the reference state she compares it to. According to economic theory, this reference state is determined by the past, present and future outcomes of either the individual herself or her reference group. The experiment described in this paper suggests that, in addition, reference states depend to a significant degree on non outcome-relevant environmental factors. It shows that reference states - and hence utility - can relatively easily be manipulated without changing people's outcomes.

JEL classification: D01, D10, C91

Keywords: reference state, utility, manipulation, priming, experiment

*Max-Planck-Institute of Economics, Kahlaische Str. 10, D-07745 Jena, Germany. phone: +49 3641 686644, fax: +49 3641 686990, email: matthey@econ.mpg.de

I thank Vincent Crawford, Oliver Kirchkamp, Tobias Regner, Ondřej Rydval, seminar participants at University of Jena and Max-Planck-Institute of Economics, and participants in the IAREP/SABE Meeting 2008, the ESI-EVA Workshop 2008, the 4th European Conference on Positive Psychology, and the Conference on Economic De-growth 2008, for helpful comments.

1 Introduction

Can individual utility change if outcomes and expectations remain constant? According to economic theory, the answer is *no*: Individuals derive utility from their current (vNeumann and Morgenstern, 1944) or future outcomes (Caplin and Leahy, 2001), which they compare to their reference state (Kahneman and Tversky, 1979; Matthey, 2008; Kőszegi and Rabin, 2008). The reference state is also determined by outcomes, e.g., the outcomes the individual received in the past (Campbell and Cochrane, 1999), the outcomes relevant others receive (Abel, 1990), the outcomes the individual expects (Kőszegi and Rabin, 2006), etc. As long as none of these outcomes changes, reference states and individual utility do not change.

The experiment described in this paper adds a new component to this theory: It shows that reference states depend to a significant degree on the cues that individuals encounter in their environment, even if these cues are neither outcome-relevant nor are individuals consciously aware of them. In addition, it suggests that reference states are not fully determined "within" the individual, but can relatively easily be manipulated from outside.
Participants in the experiment first completed a priming task (see e.g., Dijksterhuis et al, 2005; Vohs et al, 2006). Each subject was primed with one of three concepts: a concept focusing on material achievements, a neutral concept, or a concept focusing on social achievements. The priming did neither affect participants' outcomes, nor did it reveal any outcome-relevant information, nor were participants aware of being primed. Second, all subjects participated in a lottery where they could invest all or part of their endowment. Applying prospect theory (Kahneman and Tversky, 1979), systematic differences in subjects' investments were then used to identify differences in their reference states (Matthey and Dwenger, 2007). The results show that the investments of subjects who were primed with the concept focusing on material achievements differ significantly from those of the subjects who were primed with the social and neutral concepts. This suggests that the individuals' reference states have changed as the result of encountering different environmental cues at the priming stage.

The findings have implications for economic theory and experimental methods. First, they show that reference states do not only depend on outcomes, but also on non outcome-relevant environmental factors. Through these factors they are potential subject to manipulation. Second, the results provide further evidence that individual utility is not as stable as economic theory tends to assume. Earlier research has already identified non outcome-relevant influences on behavior, like framing (Tversky and Kahneman, 1986) and anchoring (e.g., Ariely et al, 2006). The results presented here suggest that even if preferences are stable and framing effects are absent, utility can vary widely depending on - supposedly - subtle environmental factors. Finally, the findings show that nuances of the design of economic experiments may lead to unintended priming effects and influence subjects' reference states. This may render seemingly equal treatments or experiments non-comparable, and experimental results hard to interpret.

The remainder of the paper is organized as follows. The experiment is described in section 2. Section 3 discusses the theoretical background and methodology. Section 4 shows the results. A discussion and brief conclusion are provided in section 5.

2 Experiment

The experiment consisted of two stages. At the first stage, participants were primed with three different concepts. Priming is a method frequently used in psychological experiments to activate certain concepts in people's minds, without drawing participants' attention to this activation (for details see, e.g., Vohs et al., 2006). Participants in the experiment received 20 groups of five words each that they had to sort into meaningful phrases of four words. The instructions included one sample phrase. There were three treatments. Half of the phrases were of neutral content, e.g., "Trees have green leaves.". These were the same in all treatments. The remaining phrases differed between treatments. In the first treatment (MAT), these phrases referred to material achievements, e.g., "Consultants earn high wages." The second treatment (CONT) was a control treatment, which included only neutral phrases. In the third treatment (SOC), the non-neutral phrases referred to social achievements, e.g., "Volunteers help in sports clubs.". All phrases referred to common knowledge items. It seems highly unlikely that they induced participants to update their expectations regarding their future income or wealth. In addition, pre-experimental tests with student assistants who completed the tasks but where otherwise ignorant of the design indicated that participants were not aware of being primed with specific concepts. This is in line with earlier experiments using priming (see, e.g., Dijksterhuis et al, 2005).

The second stage was identical across treatments. People received an endowment of 5 Euro and could invest any amount between 0 and 5 Euro in a lottery. In this lottery, investments were tripled or lost, each with 50% chance. Not invested amounts were kept by the participants, i.e., the expected payoff was

$$E(\text{payoff}) = 5 - \text{investment} + 0.5 * 3 * \text{investment} = 5 + 0.5 * \text{investment} \quad .$$

In addition to stating their investments, participants were also asked for the minimum fixed amount of money they would have preferred over their participating in the lottery.

The experiment was run as a paper-and-pen classroom experiment in two undergraduate lectures at the University of Jena in fall 2007. There were 193 participants overall. After participants had made their decisions, 25 of them were drawn randomly to be paid. Their lottery results were determined by throwing a coin, and payments were made after the lecture. All participants were aware of this procedure when making their decisions (See a translated version of the instructions in appendix B.).

3 Background and Methodology

There is by now broad agreement in the literature that individual utility from realized outcomes depends on the individual's outcome x and on the reference state r that she compares this outcome to (see Kahneman and Tversky, 1979):[1]

$$U(x) = u(x) + v(x|r)$$

There is, however, less agreement on how the reference state is formed. The most frequently suggested factors to influence r are: one's own previous outcomes (status quo or habit formation, see, e.g., Campbell and Cochrane, 1999; Gomes and Michealides, 2003), the outcomes of relevant others (social comparison, e.g., Abel, 1990), one's expected outcomes (e.g., Shalev, 2000; Kőszegi and Rabin, 2006), or the outcomes one aspires for (e.g. Simon, 1959; Lopes and Oden, 1999, McBride, 2007, Matthey and Dwenger, 2007). As these examples show, models of reference formation assume the reference state to depend on the individual's or relevant others' *outcomes*, be them past, present, or future. Individual differences in the evaluation of these outcomes are captured by the functional forms of u and v, which are individual specific. However, u and v are assumed to be stable at least in the medium term. This means that although the form of u and v may change over a life-time, in the short-run individual utility depends only on the arguments of u and v, that is, on outcomes.

The hypothesis that this paper is based on is that reference states - and hence utility - also depend on non-outcome relevant factors that individuals encounter in their environment. To test this hypothesis, the experiment systematically varies the cues that the subjects encounter at the priming stage, and attempts to identify differences in reference states that result from this variation. The way to identify these differences is through measuring differences in people's risk attitudes. This approach has been used by Matthey and Dwenger (2007), and is described in detail there. It is based on prospect theory, which suggests that loss averse individuals who face prospective losses take more risk than individuals who face prospective gains. This is due to the value function being concave for gains, but convex for losses (see Kahneman and Tversky, 1979).

Given the same prospects, for individuals with higher reference states it is more likely that (some of) the possible outcomes are worse than their reference states. Accordingly, individuals with higher reference states are more likely to face losses from these prospects, and hence are less risk averse on average. Using this relation, and keeping the prospects that subjects can choose from the same across treatments, one can infer the influence of the different treatments on subjects' reference states from the influence on their risk attitudes. In contrast to survey studies of reference state formation, one therefore does not have to rely on self-reports when determining whether the treatments lead to systematic differences in subjects' reference states.

[1] In addition, utility has been shown to depend on the individual's expected outcomes, which she compares to her reference expected outcomes (see Caplin and Leahy, 2001; Matthey, 2008; Koszegi and Rabin, 2008). However, this component of utility is not of relevance here.

The argument is as follows: participants are randomly distributed across treatments. Since it is possible that students who sit in the first rows differ systematically from those who sit in the last rows, the treatments were distributed equally across rows. This means that subjects' pre-experimental outcomes and reference states can be assumed to be randomly distributed. Participants in all treatments face the same lottery at stage two of the experiment, that is, a priori they face the same expected outcomes. Accordingly, past, present and expected future outcomes (given investments) do not differ systematically between treatments. The priming at stage one of the experiment intends to affect subjects' reference states. If environmental cues systematically influence reference states, then the reference states of participants in different treatments will differ systematically. But if reference states differ systematically, then expected outcomes are also evaluated differently. According to the relation between prospective gains and losses on one hand, and risk attitudes on the other, this should be reflected in systematic differences in subjects' risk attitudes between treatments. Hence, if one can find significant differences in average risk aversion between treatments, this implies that the treatments have influenced subjects' reference states, and hence their utility.

It should be noted that an alternative interpretation of systematic differences in subjects' risk attitude is possible, which is not based on reference states. Participants may distinguish between expected utility from income (EUI) and expected utility from terminal wealth (EUTW) (e.g., Cox and Sadiraj, 2006). The broader the range of outcomes that they take into account when making their investment decision, the less risk averse subjects will be under a concave utility function. Hence, if the treatments lead to systematic differences in investments, this could suggest that environmental cues influence the range of outcomes that individual utility is based on. Although this interpretation bears on a different theoretical effect than the one discussed above, the underlying argument is similar. In both cases, systematic differences in risk attitudes between treatments indicate that environmental cues influence the way individuals evaluate a given outcome, and the utility they derive from it. By focusing on the interpretation based on prospect theory, I therefore do not rule out alternative interpretations that are derived from this basic argument. Rather, prospect theory is chosen for the abundance of experimental and empirical evidence that exists in its support (see section 1).[2]

Finally, note that differences in risk attitudes between treatments cannot be explained by framing effects. The part of the experiment that is related to the lottery and subjects' investment decisions was formulated in exactly the same way in all three treatments. Hence, the investment decision was made given the same frame for all subjects. The two parts were also clearly separated in the instructions, with the lottery (the "game") appearing as a reward for the subjects rather than as part of the actual task (see instructions). The term 'experiment' was not mentioned at either stage.

[2]In addition, it cannot be ruled out that the treatment influences risk attitudes directly. However, to my best knowledge, such an effect has never been described in the literature.

4 Results

The results are summarized in table 1. Average and median investments are higher in the MAT treatment than in the CONT and SOC treatments. The difference between the MAT and the SOC treatments is statistically significant (Wilcoxon rank-sum test, p=0.0287). With 16% and 25%, respectively, the average and median differences in investments between the MAT and the SOC treatment are also non-negligible in size. The distribution of individual investments is displayed in figure 1 in the appendix. It indicates that the main differences between treatments arise at the tails of the distribution. Figure 4 shows that the cumulative distribution of the investment in the MAT treatment first-order stochastically dominates those of the CONT and SOC treatments. Further, it indicates that the cumulative distribution of the investment in the CONT treatment second-order stochastically dominates the one of the SOC treatment.

A similar picture arises for the minimum fixed amount people would have preferred over their participating in the lottery ('minimum'), with the caveat that these amounts were not incentivized. The differences in minimum amounts are significant between the MAT and SOC treatments (p=0.0087) and the MAT and CONT treatments (p=0.0041), but not between the SOC and CONT treatments (see also figures 2 and 5).

The risk premium, defined as the difference between the expected payoff given an individual's investment and her minimum, is lower in the MAT treatment than in the CONT and SOC treatments. The Wilcoxon test shows again that the differences between the MAT and SOC treatments (p=0.0552) and the MAT and CONT treatments (p=0.0055) are statistically significant, but the difference between the CONT and SOC treatments is not (see figure 3 for the distribution). Figure 6 shows that the cumulative distribution of the risk premium in the SOC treatment first-order stochastically dominates the one of the MAT treatment, which again is second-order stochastically dominated by the CONT treatment.

Table 1: Summary statistics for MAT, CONT and SOC treatments

		MAT	CONT	SOC
investment	mean	3.84	3.48	3.23
	median	4	3.5	3
minimum	mean	7.9	5.48	5.86
	median	7.5	5	5
risk premium	mean	-1.57	0.55	0.14
	median	-0.5	0.58	0
observations		48	75	69

Regressions confirm the results of the non-parametric tests, also showing significant differences in investments and minimum amounts for the MAT, CONT and SOC treatments (1% level, see the appendix for details.).

When making their investment decisions, the participants in all three treatments faced the same situation, i.e., the same expected outcomes given their investments. Hence, the lower average risk aversion in the MAT treatment (higher investment, lower risk premium) implies that subjects in this treatment have a higher average reference state regarding monetary outcomes than subjects in the CONT and SOC treatments (Kahneman and Tversky, 1979). Since participants were randomly assigned to treatments, the difference in reference states can be attributed to subjects being exposed to different concepts at the priming stage.

Another result is noteworthy: the standard deviation of the risk premium is significantly higher in the MAT and SOC treatments than in the CONT treatment (Variance ratio test, $p < 0.001$, see also figure 7). This suggests that there may be different types of subjects that show different reactions to a particular environmental cue. For example, subjects with a generally social attitude may experience a weak or even resisting reaction when primed with the material concept, while subjects that generally focus more on material achievements may experience a strong enforcing reaction. In contrast, if the same subjects encounter materialistic environmental cues, they may experience opposite reactions.

5 Discussion

The experiment shows that individuals' reference states are influenced by the concepts they encounter in their environment. This leads to a change in utility and behavior, even if individuals are neither consciously aware of the different concepts, nor are their outcomes affected by them.

When interpreting the results, it should be taken into account that the priming took place in the noisy environment of a classroom experiment, where participants' concentration on the task is naturally limited. Further, communication between participants of different treatments could not be avoided completely, which must be expected to lead to a reduction in the treatment effects. In addition, the priming phase took only about five minutes, since constructing the phrases was fairly straightforward. The significant differences between treatments that arise in spite of these constraints point to the large potential effect that exposure to different concepts in one's environment may have on reference states, and hence on individual utility and behavior.

The findings have three major implications. First, they offer new insights into the formation of reference states. In particular, they suggest that apart from an individual's own past, present and expected future outcomes and the outcomes of relevant others, reference states also depend on environmental factors that do not influence outcomes. This makes them potential subject to manipulation by intentional or unintentional provision of environmental cues. Second, the results provide further evidence that a purely outcome-based model of individual utility may be incomplete, and may lead to unexplained differences in welfare and behavior. Finally, they show that when conducting experiments in economics, even small nuances of the instructions or design can influence subjects' reference states and hence their behavior. This can render

the results non-comparable to other experiments, and hard to interpret in absolute terms.

If the results of this experiment can be confirmed by future studies, they also have implications for policy. In particular, they suggest that individuals who encounter less emphasis on material achievements in their environment have on average lower reference states regarding these achievements. They derive higher utility from any given level of material consumption. Put differently, with lower reference states a given level of utility requires less material achievements. This makes it easier for individuals to accept lower levels of consumption, or slower rises in material living standards. In times of shrinking natural resources, this may eventually contribute to a sustainable use of these resources without compromising individual utility.

Finally, two limitations of the study should be mentioned. First, as most experimental studies, it was conducted with students rather than with a representative sample of the population. Second, the effect on reference states was measured less than ten minutes after the priming, and it is hard to predict to what extent it would persist in the medium-term. Both points should be addressed in future studies before the results can be generalized.

Appendix A - Data

Table 2: Tobit regressions with investment and minimum as dependent variables

	investment		minimum	
	coeff.	st.error	coeff.	st.error
CONT	-1.539185	.5632448***	-3.230444	.9108868***
SOC	-1.685845	.5708359***	-2.472167	.925395***
AGE	.1037581	.0625196*	.0550808	.1062533
MAT*FEMALE	-1.520697	.6686019**	-1.022349	1.116593
constant	3.039196	1.458732**	7.377128	2.492411***
Pseudo R^2	0.0202		0.0151	

MAT, CONT and SOC denote the treatments, with MAT as the default. The differences between the treatments are significant at the 1%-level (***). Age is weakly significant at 10% (*), with older participants investing more. Female participants do not invest differently in general, but they react less in the MAT treatment.

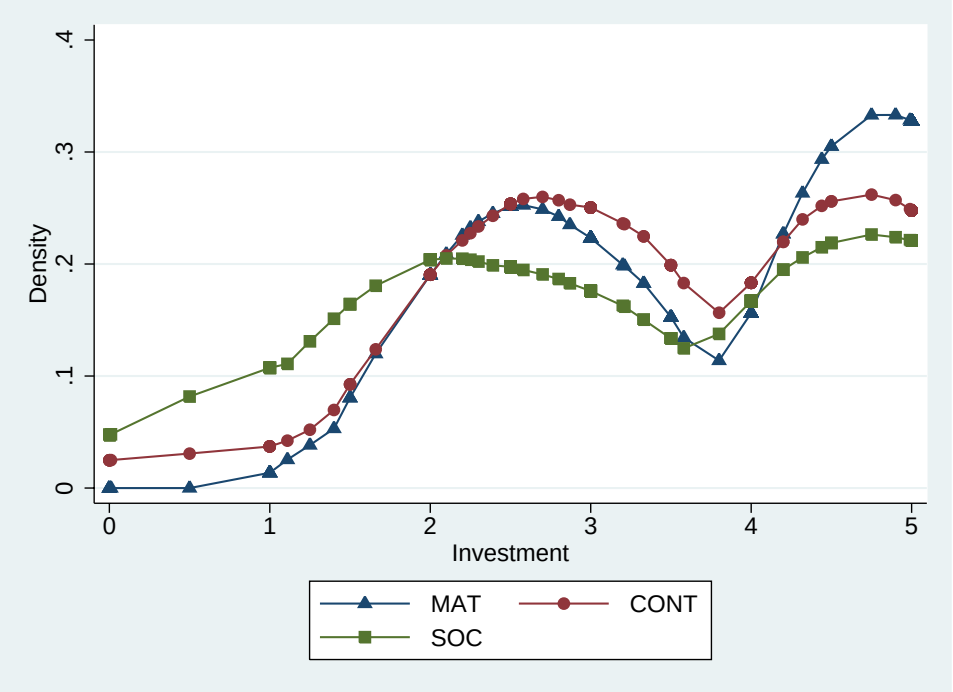

Figure 1: Distribution of *investment* over treatments.

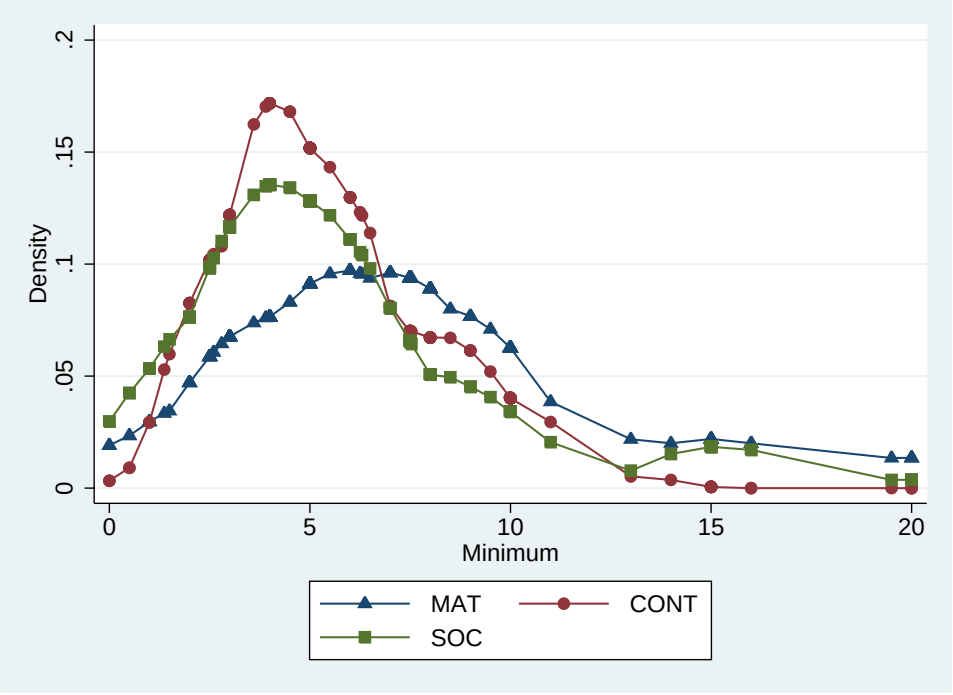

Figure 2: Distribution of *minimum* over treatments.

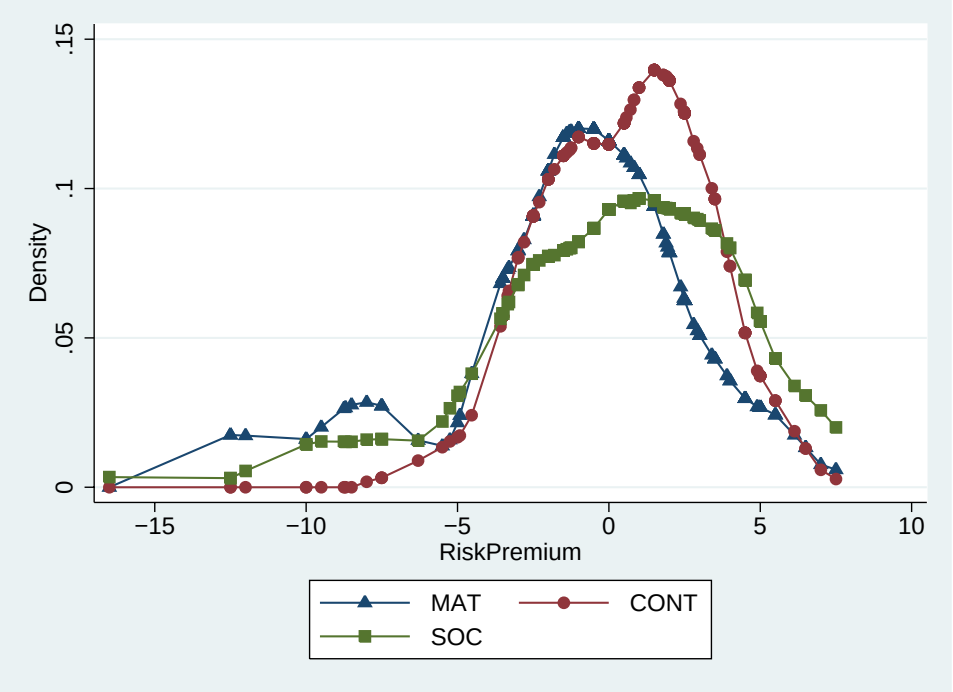

Figure 3: Distribution of *risk premium* over treatments.

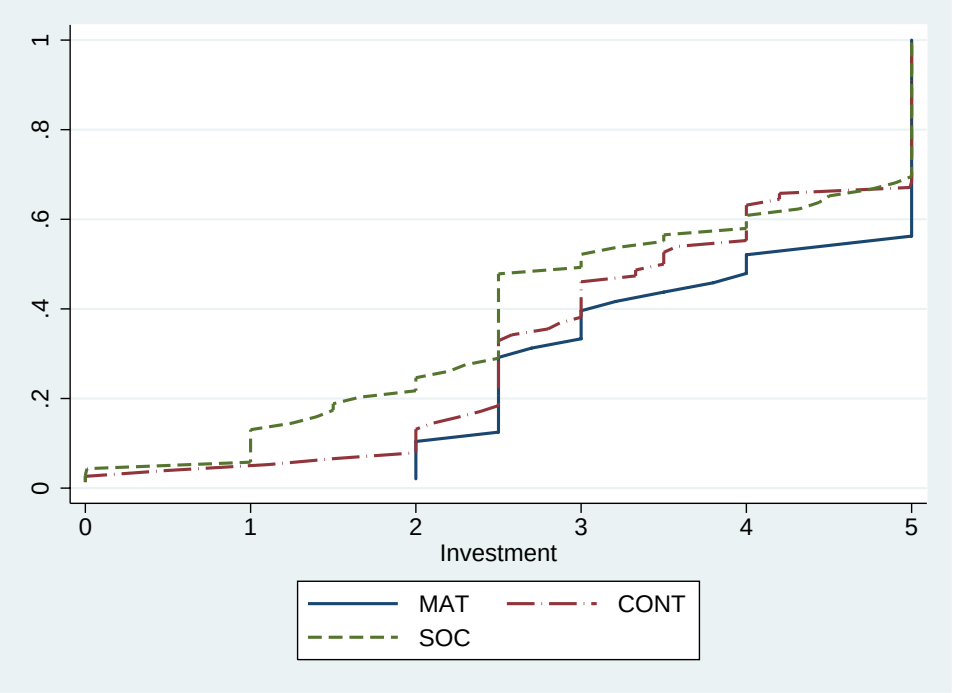

Figure 4: Cumulative distribution of *investment* over treatments.

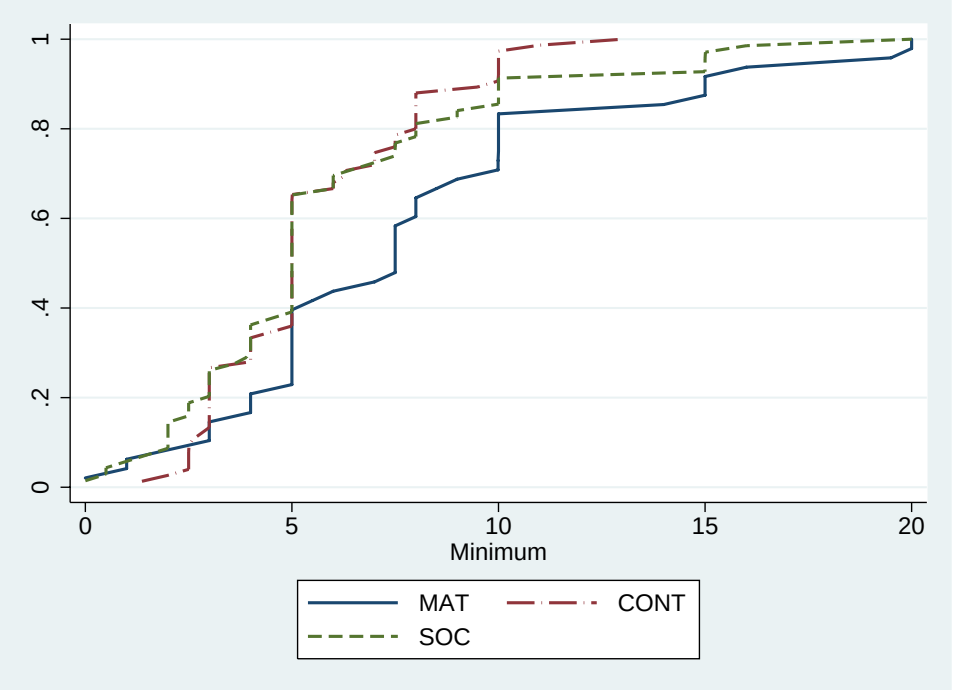

Figure 5: Cumulative distribution of *minimum* over treatments.

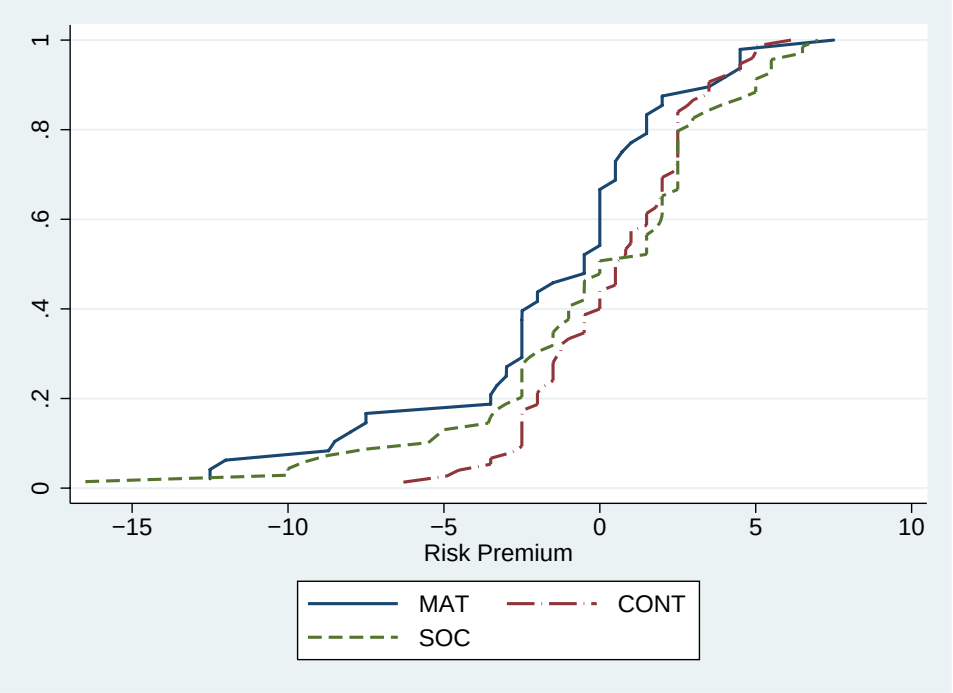

Figure 6: Cumulative distribution of *risk premium* over treatments.

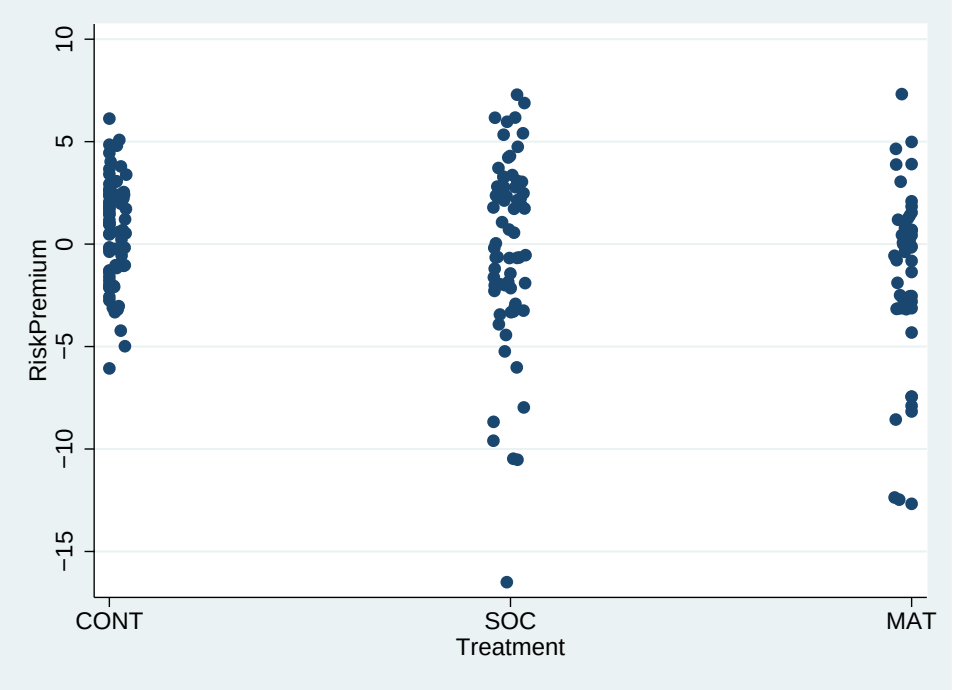

Figure 7: Distribution of *risk premium* over treatments, scatter view. Horizontal differences between data points of one treatment are included for reasons of visibility.

Appendix B - Instructions

1. Sorting of groups of words

Please sort the following words into meaningful phrases. In each line you should omit one word. [..] Please use no more than about 20-30 seconds per line. Afterwards, just move on to the next line. If you think there are two ways to form a phrase, choose one.

[Here followed the 20 groups of words.]

For grammatical reasons,
a literary translation is not possible.

Statistics:

Major:
Semester:
Age:
Sex: o female o male

Thank you for sorting the words! Now you still have the opportunity to earn a certain amount of money. In order for that not to be boring, we do this in the form of a small game. The rules of the game can be found on page 2.

2. Game

You just have "virtually" received 5 EUR. You can invest part of it or the whole amount in a lottery. Afterwards we throw a coin. If the coin shows "heads", you receive three times your invested amount. In addition you receive the remaining amount of the 5 EUR that you did not invest. If the coin shows "tails", you receive only the remaining amount of the 5 EUR that you did not invest.

Ex. 1: You received 5 EUR. You invest 1.13 EUR. a) The coin shows heads. You receive 3*1.13 EUR = 3.39 EUR, and 5.00 EUR - 1.13 EUR = 3.87 EUR as the remaining amount. This means that overall you receive 3.39 EUR + 3.87 EUR = 7.26 EUR. b) The coin shows tails. You receive only the remaining amount, i.e., 3.87 EUR.

Ex. 2: You received 5 EUR. You invest 4.32 EUR. a) The coin shows heads. You receive 3*4.32 EUR = 12.96 EUR, and 5.00 EUR - 4.32 EUR = 0.68 EUR as the remaining amount. This means that overall you receive 12.96 EUR + 0.68 EUR = 13.64 EUR. b) The coin shows tails. You receive only the remaining amount, i.e., 0.68 EUR.

After you state the amount you want to invest below, we collect the sheets. Then we randomly draw 25 numbers. For the sheets with these numbers we pay you according to your investment and the throw of the coin. We throw a coin separately for each of the 25 numbers. You can pick up your payoff immediately after the lecture, or at the secretaries office.

[Here followed some technical remarks regarding the identification of sheets with subjects.]

Now please state the amount you would like to invest in the lottery. The amount should be between 0.00 EUR and 5.00 EUR:

I invest _ . _ _ EUR in the lottery.

Instead of playing the game, we could simply have given you a fixed amount of money. What minimum amount of money would you have preferred over your participation in the game?

at least _ . _ _ EUR

References

Abel, A., 1990: Asset Prices under Habit Formation and Catching up with the Joneses, The American Economic Review, Vol. 80, No. 2, Papers and Proceedings of the Hundred and Second Annual Meeting of the American Economic Association, 38-42.

Ariely, D., Loewenstein, G. and Prelec, D., 2006: Tom Sawyer and the construction of value, Journal of Economic Behavior and Organization, Vol. 60, p. 1-10.

Campbell, J. and Cochrane, J., 1999: By Force of Habit: A Consumption-Based Explanation of Aggregate Stock Market Behavior, Journal of Political Economy, Vol. 107(2), April 1999.

Caplin, A. and Leahy, J., 2001: Psychological Expected Utility and Anticipatory Feelings, Quarterly Journal of Economics, Vol. 116, No. 1, p. 55-80.

Cox, J.C. and Sadiraj, V., 2006: Small- and large-stakes risk aversion: Implications of concavity calibration for decision theory, Games and Economic Behavior, Vol. 56, p. 4560.

Dijksterhuis, A., Aarts, H., and Smith, P. K., 2005: The power of the subliminal: On subliminal persuasion and other potential applications. In R. Hassin, J. S. Uleman, and J. A. Bargh (Eds.), The new unconscious (pp. 77106). New York: Oxford University Press.

Gomes, F. and Michaelides, A., 2003: Portfolio Choice with Internal Habit Formation: A Life-Cycle Model with Uninsurable Labour Income Risk, CEPR Discussion Paper No. 3868.

Kahneman, D., Tversky, A., 1979: Prospect Theory: An Analysis of Decision under risk, Econometrica, Vol. 47, No. 2, p. 263-292.

Kőszegi, B., Rabin, M., 2006: A Model of Reference-dependent Preferences, Quarterly Journal of Economics, Vol. 121(4), p. 1133-1165.

Kőszegi, B., Rabin, M., 2008: Reference-dependent consumption plans, Working Paper, University of California, Berkeley.

Lopes, L. and Oden, G.C., 1999: The Role of Aspiration Level in Risky Choice: A Comparison of Cumulative Prospect Theory and SP/A Theory, Journal of Mathematical Psychology, Vol. 43, p. 286-313.

Matthey, A. and Dwenger, N., 2007: Don't aim too high: the potential costs of high aspirations, Jena Economic Research Paper 2007-097.

Matthey, A., 2008: Yesterdays expectation of tomorrow determines what you do today: The role of reference-dependent utility from expectations, Jena Economic Research Paper 2008-003.

McBride, M., 2007: Money, Happiness, and Aspirations: An Experimental Study, University of California-Irvine, Department of Economics Working Papers 060721.

Neumann, J.v. and Morgenstern, O., 1944: Theory of Games and Economic Behavior, Princeton University Press.

Shalev, J., 2000: Loss Aversion Equilibrium, International Journal of Game Theory, Vol. 29, No. 2.

Simon, H., 1959: Theories of decision making in economics and behavioral science, American Economic Review, Vol. 49, p. 253-283.

Tversky, A. and Kahneman, D., 1986: Rational Choice and the Framing of Decisions, The Journal of Business, Vol. 59, No. 4, Part 2, p. S251-S278.

Vohs, K. D., Mead, N. L., Goode, M. R., 2006: The psychological consequences of money, Science, Vol. 314, p. 1154-1156.