Satisficing or Optimizing? An Experimental Study

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Abstract

This experimental study investigates whether individuals prefer bounded rationality over rational choice theory when facing simple investment tasks. First, participants state some personal parameters that serve as an input to render a theoretical approach, namely satisficing or optimality, applicable. Then, they are guided through the decision making process where either 'satisficing' or 'optimality' is suggested and has to be implemented. The behavioral appeal of the two approaches is measured by the adjustments of personal parameters until accepting the investment decision suggested by theory. Additionally, a questionnaire is administered to elicit subjective contentment with the two approaches.

Keywords: bounded rationality; aspirations; rational choice; investment decisions; decision under risk

JEL-codes: C91; D81; G11

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1 Introduction

Optimal choice in the spirit of expected utility theory is appealing from a normative perspective, especially because of its axiomatic justification (see, for instance, Machina, 1989). What renders such axioms very convincing when trying to define perfect rationality, however, at the same time casts doubt on their descriptive qualities. Unlike the ideally rational economic man (homo oeconomicus) the more worldly homo sapiens has neither solved all possible evaluations consistently nor does he have the capacity to process and store all relevant information. When conceding that due to our cognitive limitations we can be at best boundedly rational, the satisficing approach (see Simon (1955)) becomes particularly attractive. Its constituent elements of

- aspiration formation,
- (search for) satisficing (decision alternatives) and
- aspiration adaption[1]

are intuitive and rely on categories that are adopted in daily life.

We do not intend to review the debate between hardcore rational choice-theorists and more empirically minded behavioralists, whether (economic) behavior is best described, or ,[2] as rational or boundedly rational. In our view, both approaches have their merits, namely serving the scientific curiosity when asking what rationality should mean or helping to predict and explain how decisions emerge.

As such, the two approaches mainly offer a terminology but hardly provide any guidance on what behavior will be selected. To overcome this non-specificity of the two approaches one needs bold assumptions. In the present study we therefore impose a functional specification of cardinal utilities when

[1] See Selten (1998).

[2] The so called as if-justifications of optimality, e.g. suggesting the survival of the fittest, do not claim rationality of the decision makers but argue that only those, whose behavior is optimally adjusted to the environment, can survive (see Güth and Peleg, 2001).

analyzing optimal portfolio selection. Similarly, we assign mathematically precise interpretations to aspirations.

How will we avoid the non-specifity of the optimizing and satisficing approach? In addition to imposing a functional form for cardinal utilities or a (mathematically) precise interpretation of aspirations, we rely on a special class of portfolio selection problems in stochastic environments. Not only can states be ranked from worst to best but also investment options can be clearly ordered according to their monetary expectations where (except for one dominated option) a higher monetary expectation implies a larger variance of monetary returns. In such situations interior portfolios require considerable risk aversion to render them optimal. On the other hand, state specific return aspirations may imply an either empty or a rather large set of satisficing portfolios.

We do not explore such situations in full generality, but like Fellner, Güth, and Maciejovsky (2005), concentrate on the simplest case of two equally-probable states of the world. Fellner, Güth, and Maciejovsky (2005) simply compare the predictive success of the satisficing approach with the implications of the actual investment choices for (the stability of) participants' risk attitudes.

Given these structural specifications, we first familiarize participants with both approaches and let them afterwards freely decide on which of the two approaches to rely. Will satisficing be an absorbing decision mode because it relies on natural categories? Or will participants want to discipline themselves by committing to a (constant) risk parameter? Based on earlier experiences with similar situations (Fellner, Güth, and Maciejovsky, 2005; Fellner, Güth, and Martin, 2006) we did neither expect optimizing nor satisficing behavior to be dominating. After the experiment, we administer a questionnaire to learn more about participants' motivations than is possible through decision data only.

The remainder of the paper is organized as follows: In section 2 the experimental design and protocol are described in more detail. Section 3 presents the results and finally, section 4 concludes.

2 The experimental setup

Our experiment builds upon the study by Fellner, Güth, and Maciejovsky (2005). The financial decision environment as well as formalization of the bounded rationality approach and the normative rational-choice approach presented there are groundwork for this study.

Instead of calculating risk parameters from investment decisions or relating investment decisions to aspirations, we ask which of the two approaches is more suitable to guide simple investments. In order to do so, we ask for the relevant personal parameters, such as risk aversion and aspirations, that enable behavioral predictions according to each theory. On the basis of these parameters, we suggest to participants investments that are 'predicted' by the respective theory. Individuals are then free to accept the suggestion and invest accordingly or revise their earlier stated personal parameters to arrive at a different suggestion.

More specifically, in case of bounded rationality theory, aspirations have to be stated such that there is at least one investment possibility warranting them. Otherwise, participants are requested to adapt their aspirations. In case of rational-choice theory as investment guidance, subjects state their risk parameter determining their cardinal utility function, for which the optimal investment is then derived. If they do not like the resulting investment advice, they can only change it by varying their risk parameter.

Note that neither approach may be applied naturally. Although bounded rationality theory, if well understood, pays attention to individuals' computational limitations, it may require teaching or consulting and learning. It may not be easy to form adequate aspirations and then find choice alterna-

Table 1: Parameters of the investment task

Task	r	l	h	p
1	1.20	0.9	1.8	.5
2	1.25	0.8	1.9	.5

tives satisfying them. For the rational-choice approach the computational demands may even exceed computational capacities.

In any case, we interpret the number of adjustments in personal parameters before arriving at the final investment decision as one possible indicator of how applicable the particular theory is.

2.1 The investment decision

The financial decision tasks provide investors with a credit line e that they can

- keep idle yielding a return rate of 1, or
- invest in a riskless bond with a return rate $r\,(> 1)$, or
- invest in a risky asset yielding a low return rate l with $0 < l < 1$ in state 1 (with probability p) and a high return rate $h\,(> r)$ in state 2 (with probability $1 - p$).

Specifically, the investment tasks are characterized by the parameters of Table 1.

The maximum credit line was 1000 ECU.[3] The actual credit e could be chosen from 0 up to this maximum amount. To facilitate computations, the credit could only amount to multiples of 100 or 0.

[3]Experimental Currency Units. The exchange rate was 50 ECU = 1 Euros.

2.1.1 The satisficing approach

Satisficing in this specific decision environment is assumed to rely on

- an aspiration $\underline{A}$ that subjects want to achieve in the bad state 1, and
- an aspiration $\overline{A}$, that subjects want to achieve in the good state 2

Subjects may have infeasible aspirations that no investment can fulfill. Thus, aspirations have to be such that the return $R = (r-1)b+(l-1)i$ from investing b in the bond and i in the risky asset (with $b, i \geq 0$ and $b + i \leq e$) guarantees $\underline{A}$ in state 1, and similarly, that the return $R = (r-1)b+(h-1)i$ in state 2 does not fall below $\overline{A}$.

When imposing the bounded rationality requirement $b+i = e$ or $b = e-i$,[4] this can be formally expressed as follows:[5]

$$\underline{i} \leq i \leq \bar{i} \text{ where } \underline{i} = \frac{\overline{A} - er}{h - r} \text{ and } \bar{i} = \frac{er - \underline{A}}{r - l} \tag{1}$$

Since participants are requested to adapt their aspirations if $\bar{i} < \underline{i}$, we will conclude from the frequency and extent of adjustments how subjects cope with the satisficing approach. Note that changes of aspirations occur

1. necessarily if there exists no investment that could fulfill both aspirations.
2. voluntarily if the subject does not like the suggested investment.

We view the number of both modifications as an indicator for the acceptability of the satisficing approach, as formalized above.

[4]Even a boundedly rational investor would not keep any money idle.

[5]Note that the probabilites p, respectively $1 - p$, of the two states play not role at all. They could, of course, matter for aspiration adaptation. But even then, the satisficing approach as presented here is strictly non-Bayesian.

2.2 The rational choice approach

We assume a specific type of cardinal utility functions, namely $U(x) = x^\alpha$ with $\alpha > 0$ where x denotes the final monetary payoff[6]. If $\alpha > 1$, one would be risk loving, if $\alpha = 1$ risk neutral and in case of $\alpha < 1$ risk averse. However, as $ph + (1-p)l > r$, we can only capture different degrees of risk aversion, so that $0 < \alpha < 1$. From maximizing the expected utility function,

$$U(i) = p[r(e-i) + hi - e]^\alpha + (1-p)[r(e-i) + li - e]^\alpha$$

we can – in case of an interior optimum i – infer either the risk parameter α from the choice i or solve equation (2) for a given risk parameter α. Formally, the first-order condition for i with $0 < i < e$ is:

$$\alpha(i) = \frac{\ln(\frac{h-r}{r-l} \cdot \frac{p}{1-p})}{\ln(\frac{(r-1)e+(l-r)i}{(r-1)e+(h-r)i})} + 1 \tag{2}$$

Note that $\alpha(i)$ goes to $-\infty$ if i approaches 0, it converges asymptotically to 1 as i increases, and is not defined for

$$e \geq i \geq \frac{r-1}{r-l} \cdot e$$

Since $\alpha < 0$ does not make sense from an economic perspective, we set α to 0 whenever $\alpha < 0$, i.e., if $i \leq \frac{e(r-1)(2r-h-l)}{2(r-h)(r-l)}$. In order to facilitate the estimation of the individual risk parameter we set $\alpha(i)$ to its asymptotic values in case of border solutions, such that

$$\tilde{\alpha}(i) = \left\{ \begin{array}{lll} +1 & \text{for} & i \geq \frac{r-1}{r-l}e \\ \alpha & \text{for} & \frac{e(r-1)(2r-h-l)}{2(r-h)(r-l)} < i < \frac{r-1}{r-l}e \\ 0 & \text{for} & i \leq \frac{e(r-1)(2r-h-l)}{2(r-h)(r-l)} \end{array} \right\}$$

[6]Please note that the credit has to be deducted for calculating final monetary payoff.

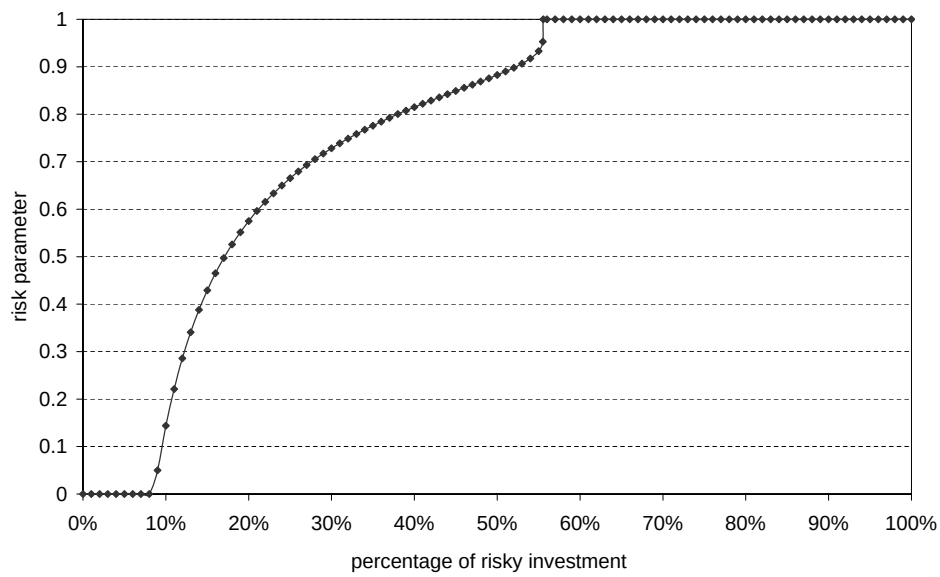

Figure 1: Relation of α and investment i for task 1

In the experiment, the interrelation of $\tilde{\alpha}$ and i was presented graphically. Figure 1 presents the graph of function $\alpha\tilde{(}i)$ for task 1. In the experiment, a subject chooses the risk-parameter α and is then confronted with its implication i resulting from inverting $\tilde{\alpha}(i)$ where for $\alpha = 1$ we offered them the whole interval $[\frac{r-1}{r-l}e, e]$ and for all $\alpha \leq 0$, the interval $[0, \frac{e(r-1)(2r-h-l)}{2(r-h)(r-l)}]$. Only when a participant did not like any of the possible investment levels she had to revise her choice of α. Thus, adjustments of $\tilde{\alpha}$ indicate difficulties with the rational choice approach.

2.3 Experimental Protocol and Procedure

The experiment was computerized and conducted at the experimental laboratory of the Max Planck Institute in Jena using the software z-Tree (Fischbacher, 1999). The 36 male and 27 female participants were undergraduate students from different disciplines at the University of Jena, recruited via the online system ORSEE (Greiner, 2004). Their average age was about 24 years.

Participants earned on average 16.79 Euro for about one hour in the lab.

The experiment was structured in 3 phases. Phase 1 and 2 were designed to introduce both approaches to the participants. Part of the subjects (n=31) experienced the bounded rationality approach in phase 1 and the rational-choice approach in phase 2. For the other part of the subjects (n=32), the order was reversed. In both phases, the underlying financial setting was investment task 1. After getting familiar with both approaches in the first two phases, subjects were confronted with a new decision task (task 2) in phase 3, where they could freely decide which approach to rely on. Their choices are taken as an indicator for their liking of the two approaches.

Participants were instructed that each phase will last for at least 5 rounds with a continuation probability of 80% in every subsequent round. In fact, the duration of each phase was once predetermined according to the probability distribution. Subjects experienced the bounded rationality approach for 6 rounds and the rational choice approach for 8 rounds. The free choice-mode, where subjects could decide in each round which approach to use, lasted for 7 rounds. Table 2 gives on overview of the experimental design.

Table 2: Overview of experimental design

		session 1 ($n = 31$)			session 2 ($n = 32$)		
phase	task	mode	rounds	decisions	mode	rounds	decisions
1	1	S	6	186	RC	8	256
2	1	RC	8	248	S	6	192
3	2	free	7	217	free	7	224

S=satisficing approach, RC=rational choice approach and free=free choice mode

After being seated a computer terminal, participants received written instructions on the experiment in general (see the Appendix for an English translation). They were informed that the experiment consists of three phases and that they will receive separate instructions for each phase. Subsequently, subjects learned about the specific investment task (task 1).

The most important aspect of the experiment, i.e. the guidance of behav-

ior by a specific decision theory, was explained as follows: subjects were told that the computer would assist them in their decision. To do so they will have to provide some personal information on which the advice will be based on. Afterwards, the software will suggest them either an interval or an specific amount that they should invest in the risky asset. With respect to the required personal information, they knew that they would encounter several approaches. Moreover, general instruction included the following overview of all necessary steps within one period:

- **step 1:** decision about how much credit to take
- **step 2:** questions for individual parameters
- **step 3:** suggested investment by the respective software
- **step 4:** investment-decision

After reading the general instructions, subjects had to correctly answer control questions on the investment decision to ensure their understanding of the task. Participants then received specific instructions on the first approach (satisficing or rational choice). These instructions explained the aforementioned steps in more detail. Subjects were told tno other investments will be accepted than the ones suggested by the software.

The parameters that were asked for in step 2 in case of the satisficing approach, were aspirations $\underline{A}$ and $\overline{A}$. Participants were informed that the software could only give advice if there exists at least one investment level i that guarantees both aspirations. Else, they will have to adjust their aspirations until a satisfactory amount i or an interval for i is found.

In case of the rational choice approach the risk parameter $\tilde{\alpha}$ of the assumed cardinal utility function was explained. People were instructed that a high (low) α reflects a risky (risk-shy) investor. Moreover, the instructions included a graph of the relation between α and the risky investment (see Figure 1).

Instructions for phase 3 first presented the new decision task (task 2) and then informed subjects about the possibility to choose one of the previously experienced approaches in each round. A new graph representing the rational choice approach was provided for task 2. At the beginning of phase 3, participants again had to answer control questions.

At the end of each round the occurring state was revealed (state 1 with return rate l or state 2 with return rate h for the risky asset) as well as the resulting payoff. For final payment, one round for each phase of the experiment was randomly selected. The net investment return of these three periods (money at the end of each round minus credit) was converted to Euros and paid out. To ensure that investment decisions are considered seriously, subjects were informed beforehand that they would have to compensate losses by completing an additional task after the experiment. The task comprised searching and marking letters in a text. Finally, a questionnaire had to be answered (see Appendix) that provides more insights into the subjective perception of both approaches and the motivation to choose one approach over the other in phase 3.

3 Results

Before looking at the most innovative feature of our experiment – the choice between the satisficing and the rationality approach – we first provide an overview of the general performance of subjects. This may help to better understand participants' preferences with respect to the two approaches as well as their answers in the questionnaire. As described above, the frequency and scale of adjustments indicate how easy it is to cope with the satisficing or rational-choice approach, respectively.

3.1 Descriptive overview of the first two phases

Let us first consider the *satisificing* approach. If $\underline{i} \leq \bar{i}$ the stated aspirations $\underline{A}$ and $\overline{A}$, defining $\underline{i}$ and $\bar{i}$, are consistent. In 77% of all cases (423 out of 549) high and low aspirations had to be specified only once, i.e. the first stated aspirations $\underline{A}$ and $\overline{A}$ are already consistent. This indicates that the majority of aspirations were stated in a realistic way. In around 10% of all cases (57 of 549), participants made unsolicited changes of their aspirations, e.g. they were not content with the proposed investment amount or interval. Aspirations had to be changed due to their unattainability in around 13% (69) of all cases. Three or more modifications of aspirations were observed in 6.0% (33) of all cases. The maximum number of changes was 18. When asking later on in the questionnaire why aspirations were changed so often, both discontent with the suggested investment as well as necessity were claimed. However, the proportion of changes due to dissatisfaction decreases over periods. Hardly anybody adapted already consistent aspirations after the sixth round.

Next, we are interested to which extent subjects adjusted their aspirations. Figure 2 shows the variations of $\underline{A}$ and $\overline{A}$ as proportion of the credit taken. The main variations of aspirations were minor, i.e. less than 20% of the credit amount. In around 11% of cases adjustments were rather big, i.e. above 50% of the credit. The large changes in aspirations mainly originate from an insufficient comprehension of what aspirations mean in the particular situation what inspired random experimentation (trial and error). A few participants with illusionary aspirations needed some time to form reasonable aspirations.

It is important to mention that in some cases the proposed interval was barely helpful. In around 30% (161) of the cases, the length $\bar{i} - \underline{i}$ of the proposed interval did not essentially restrict the decision alternatives. This results instance, when aspirations are rather unreasonable, e.g. much too

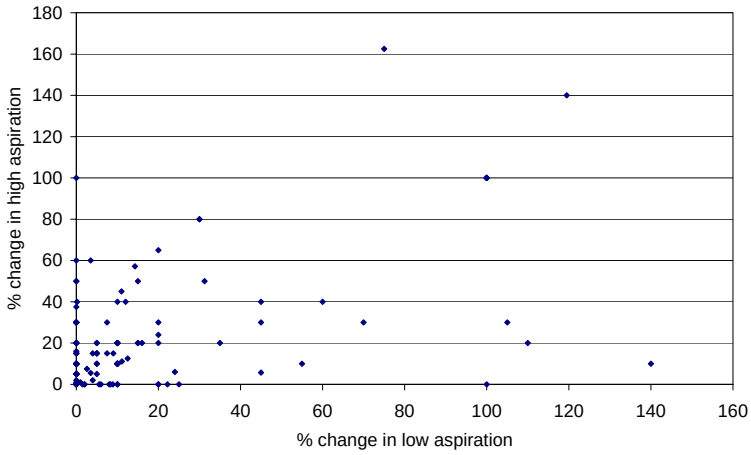

Figure 2: Adjustments of aspirations

low.[7] If, for example, both aspirations are lower than le, every invested amount i with $0 \leq i \leq e$ would fulfill these aspirations. We found that 32 of 63 subjects experienced this situation at least once. Of these 32 subjects, 20 faced it at least six times.

A different picture arises for the *rational choice* approach. In 88% of all observations the risk parameter $\tilde{\alpha}$ was specified only once. In only 2% of cases (16 of 788) the risk parameter was adjusted at least three times per round. No-one changed the risk parameter more than 6 times. Figure 3 shows that also the risk-parameter was adjusted only slightly. In 60% of changes, the variation of $\tilde{\alpha}$ were less than 0.2. More drastic adjustments of α, for example in the interval from 0.5 to 1.0 had to be expected if subjects are very risk shy, since the function $\alpha(i)$ increases sharply (especially for task 2). Thus, choices of α leading to unexpected suggestions occur easily. The analysis of the questionnaire will shed more light on the reasons for adjusting one's personal parameters.

Table 3 displays an overview of the accumulated earnings over all rounds

[7] We refer to behavior as unreasonable if the condition $le \leq \underline{A} \leq er \leq \overline{A} \leq he$ is not met (see also Fellner, Güth, and Maciejovsky, 2005).

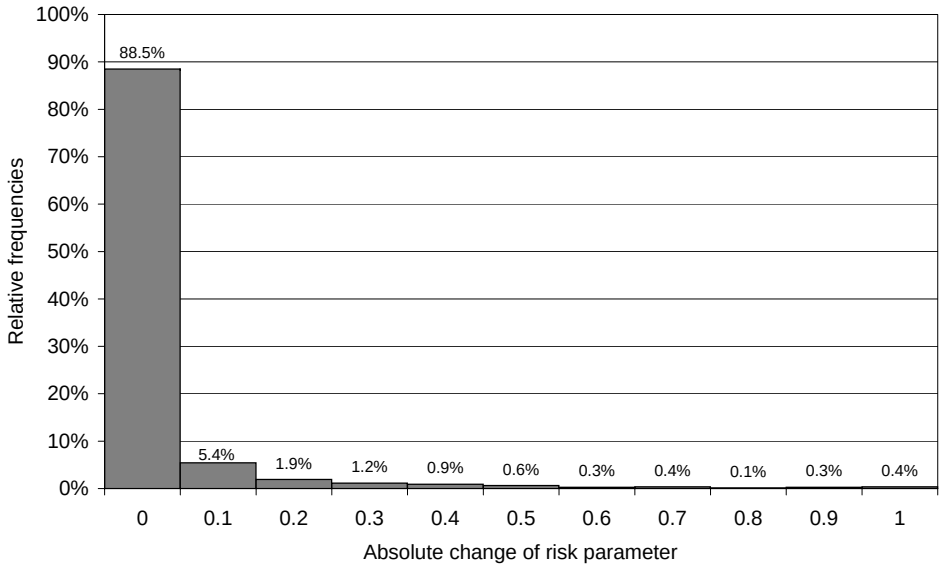

Figure 3: Adjustments of the risk parameter α

Table 3: (Accumulated) average earnings in phase 1 and 2 in Euro

order	S	RC
S-RC	5.1 (2.1)	4.9 (1.9)
RC-S	5.5 (1.8)	5.5 (2.2)
total	5.3 (2.0)	5.2 (2.0)

Note: Standard deviation in parantheses.

in phase 1 and 2 depending on the choice mode.[8] No significant differences in earnings between the different approaches can be found when they are exogenously implemented.

[8]Please note that only one period of each phase was randomly chosen for final payoff. Nevertheless, to compare the relative investment success over both choice modes, the (potential) earnings are aggregated over all periods in the particular phase.

3.2 The choice: satisficing versus optimizing

In phase 3, subjects could freely choose between the satisficing and the rational choice approach in each of the 7 rounds. In total, satisficing was chosen 171 times (38%), whereas the rational choice approach was chosen 270 times (62%). We found that 16 subjects always opted for the satisficing approach, while 31 subjects constantly chose the rational choice mode.[9] Both satisficing and rational choice was at least once selected by another 16 subjects. Judging from these results, the rationality approach was clearly favoured. Possible reasons are presented in the following section when analyzing the results from the post-experimental questionnaire.

A further interesting aspect concerns the relative investment success of individuals who endogenously choose the approach to rely on. Table 4 reveals that subjects who choose the satisficing approach earn significantly more than subjects who rely on rational choice (Wilcoxon rank-sum test: $z = 1.92$, $p = .05$).

Table 4: (Potential) earnings (in Euro) and median of relative risky investment in phase 3

	Earnings (in Euros)	Investments
always satisficing	6.1 (1.8)	40.14%
always rational choice	5.2 (1.6)	17.67%
mixed	4.8 (1.8)	40.72%

Testing for differences in relative risky investments (i.e. investment in percentage of the credit) using non parametric statisticsdoes not reveal significant differences (Mann-Whitney rank sum test: z=1.446, p=0,1483). However, a making use of disaggregated data in a Tobit panel regression confirms

[9] 10 subjects revealed in the post-experimental questionnaire that they do not have a strict preference for either approach but chose always rational choice in phase 3 since choosing the risk parameter was less effort than choosing two aspiration levels. Therefore, the decision of 10 subjects for rational choice can not be interpreted as a true preference for the method.

that subjects who constantly chose rational choice in the third phase invest less risky. Table 5 displays the results of the regression for phase three, using the relative risky investment as a dependent variable and the dummies Order RC-S (1 if rational choice experienced in first phase, satisficing in second phase), TypeR (1 if constantly choosing rational choice in third phase), TypeM (1 if mixed choices in third phase), Lagged earnings (earnings or losses in the previous round), and the interaction dummies TypeR*Lagged earnings and TypeM*Lagged earnings as independent variables.

Table 5: Panel Tobit Regression on relative risky investment in phase 3

Variable	Coefficient	Std. Err.	p
Constant	0.485	0.076	.00
Order RC-S	-0.106	0.046	.82
TypeR	-0.273	0.083	.00
TypeM	0.117	0.912	.20
Lagged earnings	-0.001	0.000	.57
TypeR*Lagged earnings	0.001	0.000	.30
TypeM*Lagged earnings	-0.001	0.000	.38
σ_u	0.474	0.032	.00
σ_e	0.211	0.009	.00
ρ	0.835	0.020	
nr. left-censored obs.		111	
nr. uncensored obs.		280	
nr. right-censored obs.		50	

One potential explanation for this result is that the satisficing approach attracts subjects who are are less risk averse. However, median investments in the first two phases of those subjects who always chose satisficing in the third phase are not significantly different from individuals who always chose rational choice (Mann-Whitney rank sum test: z=0.687, p=0.49). Another possible explanation is that the satisficing approach generally inspires more risky investments. This should be reflected in investment differences across the first two phases already. Table 6 shows the median risky investment as

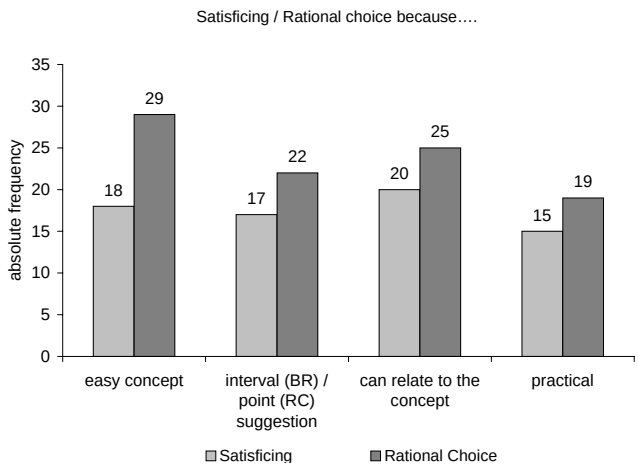

Figure 4: Reasons for preference of approach

a proportion of the credit taken in the first two phases, separately for the two orders. Descriptives reveal that investments are higher in the satisficing treatment, however the differences are not significant according to a Wilcoxon signed rank test displayed in column three.

Table 6: Median risky investment (in % of credit) in phase 1 and 2

order	BR	RC	significance
BR-RC	41.67%	32.39 %	z=0.84 p=0.40
RC-BR	50.00%	44.69%	z=-0.10 p=0.92

This evidence suggests a third interpretation on behalf of self-selection: satisficing seems to induce slightly more risky investments and especially more so, when satisficing concurs with participants' own preferences.

3.3 Post-experimental questionnaire

The questionnaire is to be found in the Appendix. Here, we present the most important results with respect to the evaluation and direct comparison of both, the satisficing and the rational choice approach.

As a first question, subjects were asked which of the two approaches they prefer. 25 participants (39.7%) chose the satisificing approach , 26 (41.3%) the rational choice approach and 12 (19.0%) stated that they have no preference. The correlation between their preference (coded in 0='no preference', 1='satisficing', 2='rational choice') and what they actually chose in phase 3 (number of satisificing choices) is highly significant (Spearman-$\rho = .42$, $p < .01$), underlining the quality of questionnaire answers.[10]

When asked for the reasons for their particular preference, subjects who chose the rational choice approach showed more agreement with all predefined reasons than did subjects who chose the satisficing approach (see Figure 4). The main argument of individuals who prefer the rational choice approach seems to be that it is an easy concept, followed by 'can relate to it' and 'it makes a point suggestion'. The advocates of satisificing state that they 'can relate to it' as the main merit, followed closely by 'easy concept' and gives 'interval suggestion'.

Figures 5 and 6 provide an overview of the evaluation of both approaches with respect to questions of how simple, useful, coherent, practical, sensible and comprehensible the respective method was. Answers were given on a five-point Likert scale, the endpoints being 1='applies not at all' and 5='applies fully'. Additionally, participants had to answer whether they considered their parameters well or not.

The difference in the evaluation profiles of both approaches is not very pronounced. There is only one clear-cut significant difference in average scores: satisificing is perceived more sensible than the rational choice approach (Wilcoxon signed ranks test: $z = 1.60, p = .05$). In one other respect the average evaluation differs at least tendentiously. Optimality is considered as simpler ($z = 1.42, p = .08$) than satisficing. Subjects subjectively have put slightly more effort in deriving the risk parameter than in considering

[10]Reducing the sample to those who actually stated a clear preference in the questionnaire (n=51) rises the correlation to $\rho = .84$ ($p < .01$).

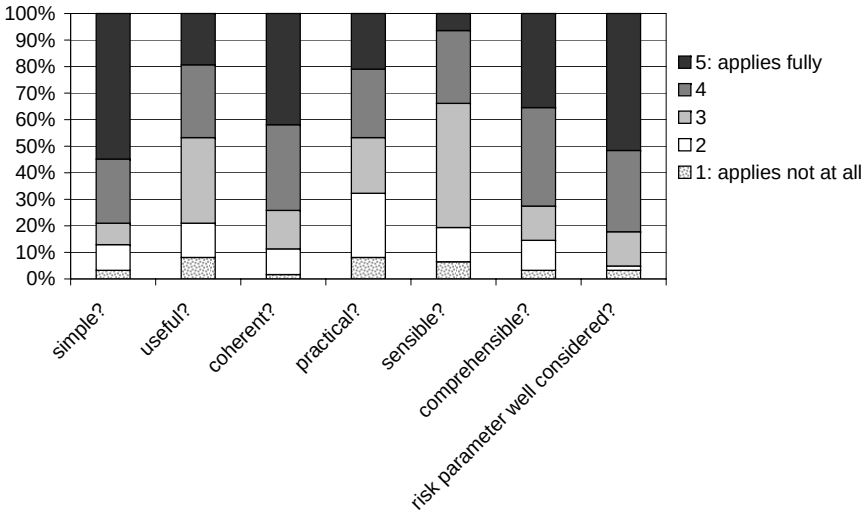

Figure 5: Evaluation of the rational choice approach

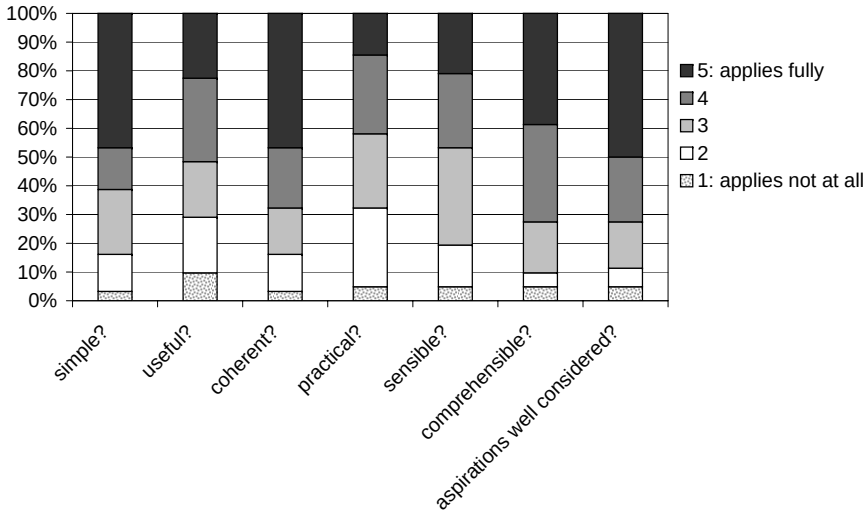

Figure 6: Evaluation of the satisficing approach

their aspirations ($z = 1.47, p = .07$).

In another part of the questionnaire subjects had to express their agreement with some statements concerning investment behavior in general. Figure 7 shows the mean responses (1='applies not at all', 5='applies fully')

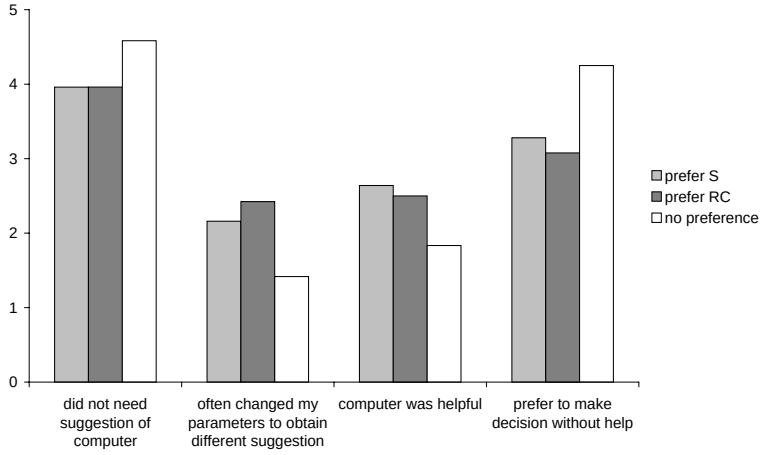

Figure 7: Mean responses on investment behavior with respect to preference

separately for subjects who stated a preference for the satisificing (S) approach, the rational choice (RC) approach or neither. This may reveal different investment styles of types. Statistical comparison of mean responses shows significantly different answers for subjects without a preference for either approach: For instance, compared to subjects who have a preference for rational choice, they regard the advice as less helpful (Mann Whitney U-test, $p = .04$), more strongly prefer to decide on their own ($p = .01$), and less think that they need the suggestion of the computer ($p = .04$).

Finally, we asked some general questions about the experiment. Subjects apparently feel that they understood the experiment very well (average score of 4.8 on a scale ranging from 1='not understood' to 5='fully understood'). They perceived the experiment as relatively easy (average score of 4.2, 1='complex' to 5='easy'), and declared that they tried to earn as much as possible (average score of 4.2, 1='applies not at all' to 5='fully applies). They were less satisfied with their final earnings (score of 3.4, 1='not at all satisfied', 5='fully satisfied'), but no significant difference is found in satisfaction with respect to which approach they preferred.

4 Discussion

This study aims at a direct comparison of the applicability of satisficing on the one hand and optimality on the other hand for assisting simple investment decisions. Individuals in the experiment first could familiarize themselves with both approaches and afterwards choose which approach to rely on when taking an investment decision in a new situation. Choices reveal that the rational choice approach was favored (62%) over the satisficing approach (38%). In a post-experimental questionnaire administered to investigate subjects' motivations, equally many individuals state a preference for satisficing and for rational choice. A small fraction of individuals is indifferent.

The questionnaire indicates that a self selection process is at work: subjects who prefer satisificing like that its suggestion comprises an interval suggestion, whereas subjects, who prefer rational choice, like it to receive an exact point suggestion for risky investment.

Moreover, in contrast to previous studies on aspiration formation and subsequent investment decisions (see Fellner, Güth, and Maciejovsky, 2005; Fellner, Güth, and Martin, 2006), we find that aspirations are very well reflected. It seems that, if aspirations serve as a basis for investment advice, they are considered much more seriously.

Although the rational choice approach appears to be the more attractive decision aid to participants, there are strict limits to the possibilities of explaining and presenting the relation of a utility function and risky investments. Already with two risky alternatives instead of one, a simple figure would be not sufficient to explain this interrelation that soon gets very complicated. The attractiveness of the rational choice approach in this experiment lies in the provision of a simple way to make the relevance of the risk parameter visible. This makes it clearly appealing. However, it is less evident how to visualize the relation of investments and risk (expressed in a cardinal utility function) when it comes to more complex situations.

The satisficing approach on the other hand is viewed by many partici-

pants as more sensible: not only does it deliver an investment advice but it already implies the outcome to be expected. However, it seems that aspirations and their adaptation are less natural than believed: some individuals have to explicitly learn what aspirations mean in specific task. Still, aspiration formation and satisficing behavior can be more readily applied to more complex situations (see, for instance, Fellner, Güth, and Martin, 2006), and has more potential in educating and guiding decision makers in the real world.

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A Appendix

A.1 Instructions of the Experiment (Order Satisficing - Rational Choice)

Welcome and thank you for participating in this experiment! Please read the following instructions carefully and do not talk to fellow participants from now on! If you have any questions, please raise your arm. We will answer your questions individually.
The experiment consists of three parts. Each part of the experiment will continue for at least 5 rounds. The probability that after the fifth round the respective part continues with a 6th round is 80%. Likewise, the probability that there is a 7th round after the 6th one is 80% and so on.

Your will receive special instructions for each part. For now, you receive instructions for part 1. Instructions for part 2 will be handed out after finishing part 1. Instructions for part 3 will be handed out after finishing part 2.
For your final payment at the end of the experiment, your results in all three parts will be summed up. Please do not that in this experiment it is possible to make losses. In this case, you will have to compensate your losses by completing an additional task at the end of the experiment. In this additional task, you will have to search and mark specific symbols in a text. You can compensate a loss of 1 Euro by correctly completing half a page. Please note also, that this additional task can only be used to compensate losses, but not to increase your earnings.

General setting

In this experiment, you can invest money. There are two investment possibilities: a riskless asset A, bearing a fixed interest rate, and a risky asset B. At the time of your investment, you will not know how asset B will develop

in the future. You know, however, that two different states of the world are possible.
In state 1 (probability $\frac{1}{2}$) asset B loses. In state 2 (probability $\frac{1}{3}$) asset B wins. The following table provides an overview:

	State 1 (prob. $\frac{1}{2}$)	State 2 (prob. $\frac{1}{2}$)
riskless asset A	fixed interest rate	fixed interest rate
risky asset B	loses	wins

Investment Decision

We introduce the currency ECU for all decisions in this experiment. The exchange rate is the following: 50 ECU = 1 Euro. For your investment decision you are endowed with a maximum credit of 1000 ECU.
In your first decision, you determine how much of the credit (any amount from 0 to 1000 ECU) you want to take. In your second decision you determine, how you use the credit. You have to divide your credit entirely between the two assets. It is also possible to invest the whole credit amount in one asset. The two assets have the following properties:

1. riskless asset A: fixed interest rate of +20% of the invested amount in both future states

2. risky asset B: leads to a gain of +80% of the invested amount in future state 2 and (probability $\frac{1}{2}$) or to a loss of -10% of the invested amount in future state 2 (probability $\frac{1}{2}$).

The following table provides a detailed overview:
In the experiment you will repeatedly make this investment decision, whereby every decision constitutes one round. After you have made your decision, the computer will determine via a random process which of the future states (1 or 2) actually arrives in the particular round. At the end of each round you

	State 1 (prob. $\frac{1}{2}$)	State 2 (prob. $\frac{1}{2}$)
riskless asset A	+20%	+20%
risky asset B	−10%	+80%

will be informed about your investment success. In the following, we denote the amount after adding your gain to the invested amount of after subtracting your loss from the invested amount as final amount.

Adviser In this experiment, the computer acts as an adviser for your investment decision. To give you individual advice, it needs some personal parameters on how to make the investment. On the basis of your personal parameters, the software will calculate borders within which your investments should lie to guarantee a satisfying result. Specifically, the software suggests particular amounts to be invested in assets A and B or gives intervals for these investments.

Each round therefore consists of the following 4 steps:

- Step 1: You decide, how much credit to take.
- Step 2: You are asked for your personal parameters.
- Step 3: The computer gives you investment advice.
- Step 4: You decide what amounts to invest in assets A and B.

With respect to your personal parameters in step 2, that are used to calculate investment suggestions, you will experience 3 different procedures – a different one in each part of the experiment. You will receive detailed information on each procedure in the specific instructions for each part.

Final Payment

At the end of the experiment, three rounds in total are randomly chosen for payment, i.e. one round of each part of the experiment. The investment success in these selected rounds determines your earnings. Your earnings in every round are calculated your final amount in this round minus the credit taken in this round.

Investment success =	Final amount	- Credit taken

You made a gain, if the total amount invested in this round has increased. You made a loss if the total amount invested in this round has decreased. Please note that it is possible that your final amount in the particular round is smaller than the credit taken. Losses in one part of the experiment can be compensated by earnings in other parts. Are the losses of part 1 not compensated by earnings in part 2 or part 3, you have to compensate your losses by completing and additional task as already described.

Before the experiment starts, you have to answer control questions to guarantee that you have well understood the investment situation. As soon as all participants have completed these control questions, the more specific instructions for the first part of the experiment will be handed out to you.

Please switch off your mobile phones now and remain quiet until the experiment starts. In case you have a question, please raise your arm.

Instructions for part I: Procedure A

As mentioned above, each round consists of 4 main steps. In the following you receive detailed information about these 4 steps when the software applies

procedure A to give you investment advice.

Step 1: Choice of credit

Step 2: Personal parameters

In this part of the experiment, the advice for your investment decision relies on minimum expectations for your investment success. Please think about and answer the following questions carefully!

When you make your investment decision, you do not know which scenario will arrive in the particular round. Therefore, your investment should bring about a satisfactory result in both scenarios.

Please, think now of

1. the worst case (scenario 1), where the risky asset loses. What final amount would you be satisfied with in this case?
2. the best case (scenario 2), where the risky asset wins. What final amount would you be satisfied with in this case?

Step 3: Investment advice by the computer

After having answered these questions, the software calculates for you whether there are any investment amounts that guarantee these two desired final amounts in both scenarios.

If there are, the computer displays the intervals in which both investment amounts have to lie in order to guarantee these final amounts. You are requested to make your investment decision and proceed to step 4.

If there are no investment amounts to guarantee the desired final amounts in both scenarios, you are requested to change your parameters. Therefore, you return to step 2.

Step 4: Investment decision

Please do now decide, which amounts to invest in assets A and B. Please note, that the software will only accept investment amounts that lie within the calculated intervals. If you like to invest different amounts, you can only do this by going back to step 2 and change your personal parameters. Your decision is not accepted until it coincides with the interval the computer has calculated for you.

In total, there will be at least 5 rounds. The probability of continuing with round 6 after round 5 is 80%. The probability of continuing with an additional round after round 6 is also 80%, and so on.

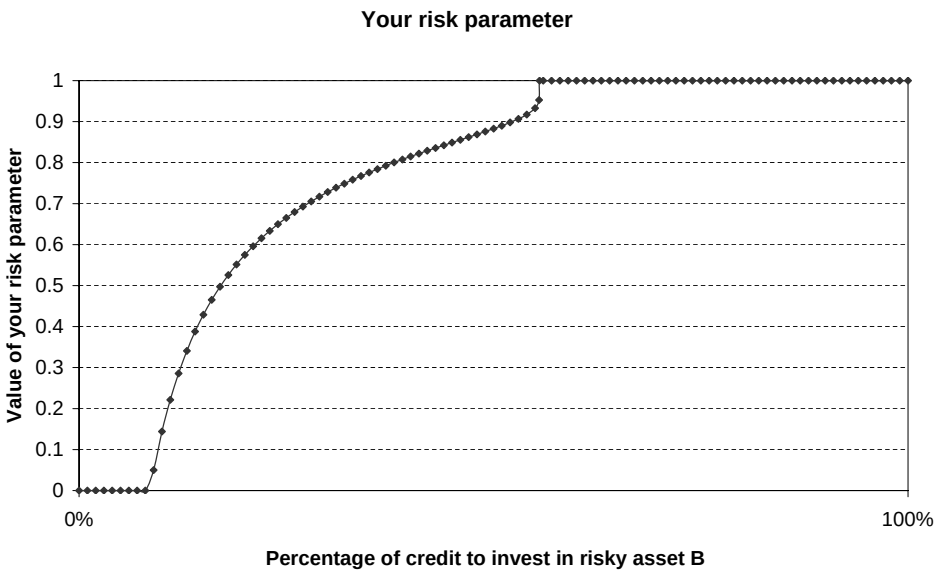
Instructions for part II: Procedure R

As mentioned above, each round consists of 4 main steps. In the following you receive detailed information about these 4 steps when the software applies procedure A to give you investment advice.

Step 1: Choice of credit
Step 2: Personal parameters

In this part of the experiment, the advice for your investment decision relies on your personal risk attitude when investing. Please think about and answer the following questions carefully!

We denote your personal risk attitude by the risk parameter α. Your risk parameter α can only take values from 0 to +1. A high α (close to +1) means that you rather dare to take risk. A small α (close to 0) means that you rather avoid risks. In the following graph you see the relation between risk parameterα and the percentage of credit that is accordingly invested in the risky asset B.



With the help of this sketch, please appraise your personal risk parameter in the interval of 0 to 1.

Step 3: Investment advice by the computer

On the basis of the appraisal of your risk parameter, the software calculates the exact amounts for you to invest in asset A and asset B.

Step 4: Investment decision

Please do now decide, which amounts to invest in assets A and B. Please note, that the software will only accept investment amounts that correspond exactly to the suggested amounts. If you like to invest different amounts, you can only do this by going back to step 2 and change your personal risk parameter. Your decision is not accepted until it coincides with the amounts the computer has calculated for you.

In total, there will be at least 5 rounds. The probability of continuing with round 6 after round 5 is 80%. The probability of continuing with an additional round after round 6 is also 80%, and so on.

Instructions for part III: Choice of procedure

The general instructions of parts I and II of this experiments continue to apply. However the properties of the two assets A and B change in the following way.

1. riskless asset A: fixed interest rate of +25% of the invested amount in both future states
2. risky asset B: leads to a gain of +90% of the invested amount in future state 2 and (probability $\frac{1}{2}$) or to a loss of -20% of the invested amount in future state 2 (probability $\frac{1}{2}$).

The following table provides a detailed overview:

	State 1 (prob. $\frac{1}{2}$)	State 2 (prob. $\frac{1}{2}$)
riskless asset A	+25%	+25%
risky asset B	−20%	+90%

Just like before, each round consists of the following 4 steps:

- Step 1: You decide, how much credit to take.
- Step 2: You are asked for your personal parameters.
- Step 3: The computer gives you investment advice.

- Step 4: You decide what amounts to invest in assets A and B.

Step 2: Personal parameters

In this part of the experiment you can decide on which procedure the software shall base the investment advice. More specifically, you can decide in each round whether you want to apply procedure A of part I or procedure R of part II for this altered investment situation. Please click the respective button (procedure A or procedure R) on screen and follow the instructions.

Whenever you decide to use procedure R (of part II), please appraise your personal risk parameter with the help of the new sketch handed out to you an a separate sheet.

Step 3 and Step 4: as before in parts I or II, respectively

In total, there will be at least 5 rounds. The probability of continuing with round 6 after round 5 is 80%. The probability of continuing with an additional round after round 6 is also 80%, and so on.

Before the experiment starts, you have to answer control questions to guarantee that you have well understood the new investment situation. As soon as all participants have completed these control questions, part III of the experiment starts.

At the end of part III your investment success in all rounds will be listed. You will learn, which 3 rounds have been randomly determined for payoff and what your final earnings are, before the experiment concludes with a short questionnaire.

A.2 Post-experimental questionnaire

Screen 1: Introduction

The following questionnaire serves as an evaluation instrument of the experiment. Please answer the questions honestly and accurately. Your answers may help to develop methods for assisting investment decisions in the future. The questionnaire will take about 5 to 10 minutes. During this time, we will prepare your payment. The payment does not start before all participants have filled in the questionnaire.
Thank you very much for your cooperation.

Screen 2: General statements to method A and method R

Which method for calculating your investment amounts did you like more?

Method A (aspirations) Method R (risk parameter) Both equally

Why? .....

Screen 3: Statements on method A

Please think now about method A, where you had to state aspirations for scenario 1 and scenario 2.
Please judge method A with respect to the following criteria:

Complex	- - - - -	Simple
Useless	- - - - -	Useful
Incoherent	- - - - -	Coherent
Impractical	- - - - -	Practical
Senseless	- - - - -	Sensible
Incomprehensible	- - - - -	Comprehensible

I considered my aspirations very well

Applies not at all - - - - - Fully applies

Screen 4: Statements on method R

Please think now about method A, where you had to specify your risk parameter.

Please judge method R with respect to the following criteria:

Complex	- - - - -	Simple
Useless	- - - - -	Useful
Incoherent	- - - - -	Coherent
Impractical	- - - - -	Practical
Senseless	- - - - -	Sensible
Incomprehensible	- - - - -	Comprehensible

I considered my risk parameter very well

Applies not at all - - - - - Fully applies

Screen 5: Comparison of both methods

If you ever chose method A in phase III of the experiment, please state why (multiple answers possible) or tell us why in your own words:

Easy concept
Suggests interval
Can relate to aspirations
Practical

Other reasons:.....

If you ever chose method R in phase III of the experiment, please state why (multiple answers possible) or tell us why in your own words:

Easy concept
Suggests interval
Can relate to aspirations
Practical

Other reasons:.....

Screen 6: Questions on investment behavior

I already had a specific investment amount in mind and therefore did not need the suggestion of the computer.

Applies not at all - - - - - Fully applies

I often returned to step 2 and adjusted my personal settings to obtain a different investment suggestion.

Applies not at all - - - - - Fully applies

In general, it was helpful that the computer gave investment advice.

Applies not at all - - - - - Fully applies

I rather do not want assistance of the computer when I make my investment decisions.

Applies not at all - - - - - Fully applies

Screen 7: General questions on the experiment

How well did you understand the rules of the experiment?

Not at all - - - - - Fully

The experiment was...

complex - - - - - easy

I wanted to earn as much money as possible.

Applies not at all - - - - - Fully applies

I am satisfied with my total earnings.

Applies not at all - - - - - Fully applies

Screen 8: Demographics (your data remains anonymous!)

Gender: female male

Age:

Do you have any other message for us regarding this experiment?

.....

Screen 9: End

This is the end of the experiment.

Please keep seated until your cabin number is called for.

Thank you for participating and have a nice day!