Is Satisficing Absorbable?
An Experimental Study

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Abstract

We experimentally investigate whether the satisficing approach is absorbable, i.e., whether it still applies after participants become aware of it. In a setting where an investor decides between a riskless bond and either one or two risky assets, we familiarize participants with the satisficing calculus applied to specific portfolio selection tasks. After experiencing this calculus repeatedly, participants are free to use it or to select their portfolio freely. The results support, to some extent, the absorbability of the satisficing approach.

Keywords: Theory absorption; Satisficing behavior; Portfolio selection

JEL Classification: C91; D81; G11

1 Introduction

A behavioral theory is absorbable if it survives its apprehension (see Güth and Kliemt, 2004). Thus, after decision makers became aware of the theory describing their behavior, they still (want to) behave in theory-consistent ways. In particular, in decision theoretic tasks without strategic uncertainty, theory absorption supposes that decision makers know the "theory" of their behavior, and postulates that they rely on it. In this study, we want to explore whether the central idea of bounded rationality theory, namely the "satisficing" approach (see Simon, 1955), is absorbable.

The satisficing approach predicts to form aspirations, to search for options satisficing them, and to adapt aspirations in the light of experience. In general, it does not offer a well-developed theory, but only an intuitive terminology. To render it applicable, we rely on portfolio selection tasks where aspirations are state-specific, i.e., dependent on the possible state of nature (see Fellner et al., 2005). Such state-specific aspirations are said to be consistent when they define a non-empty set of satisficing portfolios.

We consider two treatments: one with two states of nature, and the other with three states. Both treatments comprise two phases with six investment tasks each. In the first phase, participants are familiarized with the concept of consistent return aspirations, and forced, via a so-called *decision aid*, to revise their aspirations until they are consistent. Once this has been achieved, participants can freely choose their portfolio, being however informed of whether it satisfies their return aspirations or not. In such a way, we can directly test whether satisficing is absorbable since we do not oblige participants to choose a portfolio satisficing all their aspirations. In the second phase, participants are free to keep on using the decision aid or select their portfolio at once without having to determine consistent return aspirations. Thus, in this phase, also the consistency of aspiration levels, as predicted by the satisficing approach, may be violated.

The paper proceeds as follows: Section 2 introduces the portfolio selection tasks and the satisficing approach. Section 3 is devoted to the experimental design. The experimental results are analyzed in Section 4, and Section 5 presents some concluding remarks.

2 Decision tasks and satisficing portfolios

The decision tasks, previously studied by Fellner et al. (2005) without inducing and testing for theory absorption, are financial investment tasks with state-specific return rates, and states that can be ordered from the worst to the best. We allow for two or three equally probable states of nature.

Participants face a credit line e (> 0) up to which they can borrow without paying interest. They can leave money idle, although this is not even boundedly rational because they can invest it in a riskless bond with a return rate r exceeding 1.

In case of only two states, the second option is a risky asset yielding a low return rate l in bad state 1, and a high return rate h in good state 2. We invariably impose $0 < l < 1 < r < h$ and $l + h > 2r$. The latter inequality implies that a risk-neutral investor prefers the risky option over the riskless bond.

In case of three states, occurring with probability 1/3 each, the risky option mentioned above yields the low return rate l in bad state 1 and the high return rate h in good states 2 and 3. There exists, however, an even riskier option with returns L in states 1 and 2 and H in the best state 3, where $0 < L < l < 1 < r < h < H$, and $H + 2L > 2h + l > 3r > 3$ hold. Thus, a risk-neutral investor would prefer the riskiest option over the other risky option, and the latter over the riskfree bond.

Let b be the amount invested in the riskless bond, i the amount invested in the (less) risky option in the case of (three) two states, and j the amount invested in the riskiest option in the three-state case. For two states and return aspirations A_1 in state 1 and A_2 in state 2, the investment portfolio (b, i), with $b, i \geq 0$ and $b + i \leq e$, is satisficing if

(C.2) $b(r-1) + i(l-1) \geq A_1$, and $b(r-1) + i(h-1) \geq A_2$.

For three states and state-specific return aspirations A_1, A_2, and A_3, the portfolio (b, i, j), with $b, i, j \geq 0$ and $b + i + j \leq e$, is satisficing if

(C.3) $b(r-1) + i(l-1) + j(L-1) \geq A_1$, $b(r-1) + i(h-1) + j(L-1) \geq A_2$, and $b(r-1) + i(h-1) + j(H-1) \geq A_3$.[1]

We assume the satisficing approach (cf., Simon, 1955) to prescribe:

(i) consistent return aspirations in the sense that all conditions in (C.2) or (C.3) are fulfilled, and

(ii) the choice of an investment portfolio satisficing all state-specific return aspirations, i.e., in line with (C.2) or (C.3).

Our main goal is to check whether participants "absorb" the satisficing approach. Most previous research on aspirations and satisficing behavior has advanced the modelling of aspiration adaptation, and explored its role in bilateral interactions (see, e.g., Tietz et al., 1978; Tietz, 1992; 1997; Selten, 1998). Fellner et al. (2005) apply the satisficing approach to investment decisions by employing a free mode: participants in their experiment are free to choose inconsistent aspirations. What is distinctive in our study is that, in

[1] More generally, the set of satisficing portfolios is the intersection of n linear half-spaces, where n is the number of different states of nature. An aspiration vector $\mathbf{A} = (A_1, \ldots, A_n)$ is consistent if this set is non-empty.

order to test for absorbability of satisficing, we firstly *enforce* prescription (i) by means of a routine that we name "decision aid". Only when participants achieve consistency, they are free to choose their portfolio, knowing whether it is in line with prescription (ii) or not (i.e., whether their selected portfolio satisfies their aspirations). If satisficing is absorbable, investors should not make choices at odds with their return aspirations. Subsequently, we give subjects the possibility of deciding whether they want to use the routine or not, thereby enabling them to violate prescription (i) as well. Investors who have absorbed the satisficing approach may refuse the aid, but must then comply with both prescription (i) and prescription (ii).

3 Experimental protocol

The computerized experiment was conducted at the laboratory of the Max Planck Institute in Jena (Germany) in April 2006. The experiment was programmed using the z-Tree software (Fischbacher, 1999). Overall, we ran two sessions with a total of 61 participants, all being students at the University of Jena. Thirty-one participants faced the decision tasks with only one risky asset (henceforth, two-state treatment), and thirty-two the decision tasks with two risky assets (henceforth, three-state treatment) in a between-subject design.

In each session/treatment, participants were confronted with 12 investment decisions with changing parameters. The experiment extended, therefore, over 12 periods. Table 1 lists the parameter constellations used in each treatment.[2] In each period, participants received an endowment e of 1000 ECU (Experimental Currency Unit) that they could invest in either two or three alternatives depending on the treatment. The exchange rate between

[2] Choices were elicited in a random order so as to exclude ordering effects.

ECU and Euro was 20 to 1, i.e., 20 ECU corresponded to 1 Euro.

Insert Table 1 about here

Each experimental session consisted of two phases, with six periods/decision tasks each.[3] In phase 1, participants went through the following steps.

1. First, they learned about the investment task, and answered a few control questions (see the instructions in Appendix A).
2. Then, they were asked for their return aspirations in each state, i.e., they had to specify the monetary return they aimed to achieve in each of the possible states.
3. They were informed, via the "decision aid", whether their return aspirations were consistent or not. If they were not, aspirations had to be revised until they were consistent.[4]
4. When the latter had been achieved, participants could determine their portfolio choices, either (b, i) or (b, i, j) depending on the treatment, with the possibility of leaving money idle. Participants were informed whether their investments satisfied their return aspirations, but could choose their portfolio without restrictions (i.e., regardless of compliance with stated aspirations).

In phase 2, the first decision that participants had to take was whether they wanted to rely on the "decision aid" ($\delta = 1$) or not ($\delta = 0$). If they decided to keep on using the decision aid, the experiment proceeded with the steps described above. Otherwise, participants could choose their portfolio straight away (without having to design consistent return aspirations). Also in this case, we asked for aspirations.

[3] Due to a software breakdown, data on aspirations and investments in periods 7 and 12 of the three-state treatment got lost.

[4] The algorithms to check the consistency of aspiration vectors are reported in Appendix B.

To ensure the financial salience of the investment task, three means were taken. First, only one period was randomly selected for payment. Second, the credit taken for investment had to be paid back after each period, so that subjects only earned their (positive or negative) investment return. Third, subjects were instructed that possible monetary losses would have to be compensated by completion of a task after the experiment (see instructions in Appendix A). The task consisted of searching and marking specific symbols in a text. Each Euro lost was equivalent to half a page of work load.

4 Experimental results

In reporting our results, we proceed as follows. First, we present a descriptive overview of elicited aspiration levels and investment behavior. Then we turn to our main question, and try to establish whether participants who rely on the satisficing routine either obligatorily (as in phase 1) or voluntarily (as in phase 2) choose satisficing portfolios, and whether participants who refuse the routine comply with both requirements prescribed by the satisficing approach.

4.1 General results

Table 2 provides descriptive statistics on profits, stated aspiration levels and investment decisions over all 12 periods.

Insert Table 2 about here

The average profit is positive in both the two-state and the three-state treatments. Subjects are, on average, quite risk-averse: the average amount b invested in the riskless bond is, indeed, significantly higher than investments i

and j in the risky asset(s); in the three-state scenario, just few of the available resources are directed towards the riskiest option. On average, almost all subjects make full use of their credit allowance: only a negligible fraction of investment choices (2.71% in the two-state treatment, and 4.22% in the three-state treatment) did not fully utilize the credit line of 1000 ECU.[5]

Table 3 separates data according to phase. Regardless of the treatment, profits are, on average, significantly higher in phase 2 than in phase 1 ($p < 0.001$ for both treatments, two-sided Wilcoxon signed-rank tests). Return aspirations A_1 and A_2 in states 1 and 2 are also significantly higher in the second half of each treatment ($p < 0.001$ for A_1 or A_2 in phase 1 vs. A_1 or A_2 in phase 2; two-sided Wilcoxon signed-rank tests). Aspirations in the best state 3 are, instead, not significantly different across phases ($p = 0.404$). Wilcoxon signed-rank tests comparing investments in the riskless bond and in the risky asset over the first and the last six periods of the two-state treatment reveal that subjects invest significantly more in the risky asset in the second phase ($p = 0.004$ for i in phase 1 vs. i in phase 2).[6] As regards the three-state treatment, there is no statistically detectable difference in individual portfolio choices between phases ($p > 0.05$ for all comparisons of b, i and j in phase 1 and phase 2).[7]

<u>Insert Table 3 about here</u>

Do return aspirations in the worst and best state change with the experimental parameters? In the two-state treatment, the differences between

[5]These observations are kept in the analysis. Dropping them does not alter results.

[6]To check whether the different aspirations and investments in the second phase of the two-state treatment are due to the use of the decision aid, we performed Wilcoxon rank sum tests (two-sided) comparing aspirations and portfolio choices in case of $\delta = 0$ and $\delta = 1$. No significant influence of the aid on any of the considered variables was observed ($p > 0.140$ for each comparison).

[7]For the three-state scenario, variables b and i are found to differ significantly when participants require the decision aid ($p = 0.004$ for both i when $\delta = 1$ vs. i when $\delta = 0$ and j when $\delta = 1$ vs. j when $\delta = 0$).

A_1 and A_2 are unrelated to the differences between the two possible return rates (l and h) of the risky option: the Spearman correlation coefficient between $A_2 - A_1$ and $h - l$ is 0.033 ($p = 0.529$). In contrast, in the three-state treatment, the spread $A_3 - A_1$ is significantly and negatively related to the spread $H - L$ (Spearman $\rho = -0.137$, $p = 0.014$); hence, more discrepancy in return rates lowers the spread of aspirations. It seems that a large $H - L$-discrepancy frightens participants and weakens their desire for improvement.

Looking at the spread of aspiration levels over time, we find that the gap between return aspirations stays rather constant over time in case of two states (the Spearman correlation coefficient between $A_2 - A_1$ and *period* is 0.004, $p = 0.94$), whereas the gap between A_3 and A_1 shrinks significantly in case of three states (Spearman $\rho = -0.206$, $p < 0.001$). A feature of our design is that participants could reach consistency of aspirations by setting $A_1 = A_2$ or $A_1 = A_2 = A_3$. Hence, it may be argued that the just reported results may be due to people equalizing their aspiration levels throughout the experiment. We checked for this and found that a few subjects always report $A_2 = A_1$ or $A_3 = A_2 = A_1$ (16.13% in case of two states and 18.75% in case of three states).

4.2 Compliance with the satisficing approach

We now investigate if participants fulfill the two requirements of the satisficing approach, i.e.: (i) consistent return aspirations, and (ii) investment choices satisficing the stated aspirations. To address the issue, data need to be separated depending on whether or not participants (either mandatorily or deliberately) rely on the "decision aid". In fact, if they rely on the aid, they not only are forced to revise their aspirations until consistency is attained but also know, before deciding on their portfolio, if this satisfies their stated aspirations.

Over all six periods of phase 2, the requests for the decision aid are 44 out of 186 in the two-state treatment, and 26 out of 192 in the three-state treatment.[8] Figure 1 displays the percentage of participants who *want to* rely on the aid in each period of phase 2 separately for the two treatments. In case of two states, the proportion stays rather constant over time, whereas in case of three states the distribution exhibits a mode in periods 9 and 10.

<u>Insert Figure 1 about here</u>

Participants refusing the aid, after having experienced it, are deemed to have "absorbed" the satisficing approach if their aspirations and investment choices are in line with requirement (i) and requirement (ii), respectively. Thus, a first check of the absorbability of the satisficing approach concerns those who, without using the available routine, are able to set consistent return aspirations as well as to choose portfolios in line with their aspirations.

On average, 76.80% (73.10%) of the subjects declining help fulfil requirement (i) in the two- (three-)state treatment. Out of these, 55% (62%) respect also requirement (ii). Overall, compliance with both requirements is observed 42.25% of the times (60 out of 142 observations) for the two states, and 45.37% of the times (49 out of 108 observations) for the three states. Hence, regardless of the treatment, nearly half of the choices not supported by the decision aid in phase 2 are consistent with the satisficing approach.

Figure 2 shows the proportion of subjects meeting both requirements for satisficing behavior in either treatment. In the case of two states, this proportion remains fairly constant across periods: a (one-sided) Wilcoxon

[8] The difference in requests between treatments is only weakly significant ($p = 0.083$, two-sided Wilcoxon rank sum test).

signed-rank test confirms that there is no statistically detectable difference in frequency of $\delta = 0$-choices complying with conditions (i) and (ii) between the first and the last period of phase 2 ($p = 0.258$). As to the three-state scenario, the proportion of choices in line with satisficing behavior increases noticeably from period 8 (the first available period) to period 9, but then it stabilizes at 50% so that choices respecting (i) and (ii) are only weakly significantly higher in period 11 (the last available period) than in period 8 ($p = 0.090$, one-sided Wilcoxon signed-rank test).

Insert Figure 2 about here

Let us now turn to portfolio choices supported by the satisficing routine so as to investigate if they comply with requirement (ii), i.e., if they are in line with stated aspirations. Recall that, when the routine is present, participants are informed, before deciding on their portfolio, if this satisfies their stated aspirations. Overall, 66% and 52% of investments made by participants employing the decision aid are in line with their aspirations in case of two and three states, respectively. Figure 3 displays these proportions in each period of either treatment.

Insert Figure 3 about here

According to the figure, whatever the number of states, portfolios in line with stated aspirations are more frequent when subjects *voluntarily* rely on the aid, i.e., in phase 2. Wilcoxon signed-rank test comparing choices obeying requirement (ii) in phase 1 and in phase 2 when $\delta = 1$ confirm that, in both treatments, participants tend to choose "satisficing" investment significantly more often in phase 2 ($p < 0.001$ for the two-state treatment, and $p = 0.029$ for the three-state treatment). Thus, it seems that participants "learn" over time to choose portfolios in agreement with their aspirations.

One way to verify whether learning effects are actually present is to observe how long participants need in order to achieve consistent aspirations and be therefore able to choose their portfolio. The average seconds necessary for reaching consistency (overall, 16.80 in case of two states vs. 17.16 in case of three states) decline significantly over time: Spearman rank correlation coefficients between "periods" and "seconds needed to reach consistent aspirations" are -0.402 in the two-state treatment and -0.456 in the three-state treatment ($p < 0.001$ in each treatment). The seconds spent in order to choose portfolios in line with stated aspirations show a downward trend as well ($\rho_{\text{two states}} = -0.247$, $\rho_{\text{three states}} = -0.072$), but this is significant only in case of two states ($p = 0.001$ with two states; $p = 0.321$ with three states), meaning that subjects' ability to comply with requirement (ii) does not significantly change in case of three states.

Since some participants are found to set equal aspirations whatever the return rates, it is worthwhile to distinguish them from those stating different aspirations so as to verify whether steady aspirations actually imply saving time and effort. The data indicate that subjects with constant aspirations are significantly faster than others both to achieve consistency and to choose satisfactory investments ($p < 0.05$ for each comparison, Wilcoxon rank sum tests), thereby confirming their tendency to economize on time by behaving in a routinized fashion.

Do subjects who fulfil bounded rationality requirements differ from others with respect to their investment success measured by average earnings? Starting from subjects who do not want to rely on the routine in phase 2, we find that those who have "absorbed" the satisficing approach (in the sense of complying with both prescriptions) earn significantly more than those who do not have absorbed it in the two-state treatment ($p < 0.001$, two-sided

Wilcoxon rank sum test), but not in the three-state treatment ($p = 0.5340$). As regards subjects relying on the aid and choosing portfolios in agreement with their aspirations, their average earnings are not significantly different from those who do not comply with requirement (ii), whatever the number of states ($p > 0.673$ in both treatments; two-sided Wilcoxon rank sum tests). The latter result is in line with that by Fellner et al. (2005), who found no significant difference in average earnings between subjects who comply with bounded rationality requirements and others.

5 Conclusions

Our concern has been to investigate whether the main idea of bounded rationality theory, namely the concept of satisficing, is "absorbable", i.e. survives its apprehension. Following Fellner et al. (2005), we have rendered the satisficing approach applicable relying on portfolio selection tasks with state-specific return aspirations. In this endeavor, people are assumed to behave in a satisficing manner if their return aspirations are consistent (i.e., define a non-empty set of satisficing portfolios), and their investment decisions are in line with the stated aspirations.

Differently from Fellner et al. (2005), we have not employed a free mode: in a first phase, we enforced the use of a device (called "decision aid") allowing participants to freely choose their portfolio only once they had stated consistent aspirations, and informing them whether their portfolio was satisficing their (consistent) aspirations or not. After having experienced the device repeatedly, participants could voluntarily decide to rely on it or not; if not, they could select their portfolio straight away. Our claim is that, if satisficing is absorbable, people should choose satisficing portfolios when relying (either obligatorily or voluntarily) on the aid, and should both set consistent aspirations and choose satisficing portfolios when refusing the aid.

To study whether complexity affects behavior, we have considered two treatments, which differed only with respect to the number of states of nature (either two or three) faced by the subjects.

The overall findings are, to some extent, encouraging. Nearly 50% of the participants who refuse the aid after having experienced it make nevertheless satisficing choices, regardless of the treatment. Furthermore, most aid-assisted investments are in line with stated aspirations, especially in case of two states and voluntary request for aid. However, there emerged a subset of subjects (16% in the two-state scenario and 19% in the three-state scenario) with a sort of routinized behavior (cf., Egidi and Narduzzo, 1997): these subjects equalized their aspirations throughout the experiment so as to save time and effort.

More complexity (three rather than two states) renders learning more difficult or slowly: in the three-state scenario participants mainly learn only to be less interested in improvement, as measured by the spread $A_3 - A_1$ of aspirations. Compared to this, aspirations (A_1 and A_2) and risky investments (i) increase significantly over time (from phase 1 to phase 2) for the simpler two-state scenario. This illustrates that we are by no means born as satisfiers, but have to learn it, possibly in complex scenarios by using artifacts resembling the "decision aid" provided in the experiment.

Further work needs to be done in order to be confident about the implications of these findings for the theory of bounded rationality. But the experimental evidence garnered here is suggestive of people's ability to absorbe the satisficing approach.

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Appendix A: Translated instructions

In this appendix we report the instructions and control questions for the two-state treatment. Those for the three-state treatment were adapted accordingly.

Welcome and thanks for participating in this experiment. Please read the following instructions carefully. From now on any communication with other participants is forbidden. If you have any questions or concerns, please raise your hand. We will answer your questions individually.
The experiment allows you to earn money. How much you will earn depends on your own decisions, which are anonymous and cannot be traced to your name.

DETAILED INFORMATION ON THE EXPERIMENT

In this experiment, you can invest money. For this reason, we introduce the currency ECU. The exchange rate between ECU and Euro is 20 to 1, i.e., 20 ECU correspond to 1 Euro. For your investment decisions, we grant you a credit limit of 1000 ECU. As a first step, you have to decide how much of this credit you want to take. You can take only integer amounts (i.e., 0, 1, 2, 3, . . ., until 1000 ECU). The credit is *interest-free*, i.e., you must pay back the money that you borrow without any extra charge.
Once you have taken a certain amount of your credit, you have to decide how to use it. You can invest this credit in two alternatives: A and B.

A is a **risk-free bond** that allows you to obtain "r" times the invested amount *for sure*, where "r" is greater than 1. Thus, if you invest a ECU in this alternative, you get a *sure* return of r times a from your investment. Since you have to pay back the amount a that you have taken from your credit line, your 'NET' return from A is:

$$\textit{Net return from } A \quad = \quad (r \times a) - a = (r - 1) \times a$$

B is a **risky asset** with two possible outcomes, which depend on the scenario that occurs.

- If scenario 1 occurs, you obtain "l" times the amount invested in B, where "l" is smaller than 1. Hence, in scenario 1, you get a negative return.
- If scenario 2 occurs, you obtain "h" times the amount invested in B, where "h" is greater than r. Hence, in scenario 2, you get a positive return which is greater than the return from the risk-free bond.

The two scenarios are equally likely: with 50% probability you obtain "l" times the amount you invested in B, and with 50% probability you obtain "h" times the amount you invested in B. Thus, if you invest b ECU in the risky alternative, your 'NET' return from B is

$$\textit{Net return from } B = (l \times b) - b = (l - 1) \times b \quad \text{in scenario 1,}$$

$$\textit{Net return from } B = (h \times b) - b = (h - 1) \times b \quad \text{in scenario 2.}$$

Your two investment alternatives and their rate of return in each scenario are summarized in the following table:

Alternative	Scenario	Probability	Return rate
A	1	1/2	r
	2	1/2	r
B	1	1/2	l
	2	1/2	h

You have to divide your credit fully between A and B. This means that you can invest in each of the two alternatives any amount ranging from 0 ECU to the total credit you have taken, provided that the sum of your investment in A and your investment in B equals the credit you have taken.

In the experiment, you will make this investment decision several times, where each time reflects one round. Every round, you will be granted a credit of 1000 ECU. The values of r, l and h will be changing every round, but they will always be such that:

- the return rate of B in the case of scenario 1 (i.e., l) is lower than 1, and

- the return rate of A (i.e., r) is greater than 1, and lower than the return rate of B in the case of scenario 2 (i.e., h).

You will learn the values of r, l, and h at the beginning of each round.

The decision aid

The decision aid is designed to help you decide how to invest your credit in a given round, and make “satisfactory” decisions, i.e., decisions allowing you to achieve your desired TOTAL net return in each scenario.

Once you have decided how much of your credit you want to take, but *before* you decide how to use it, the decision aid will guide you through the following steps.

a. First, it will ask you to specify the total net return (i.e., net return from A + net return from B) you wish to guarantee yourself in each of the two scenarios. In particular, you will have to answer the following two questions:
   - Which net return from A and B do you aspire to in scenario 1?
   - Which net return from A and B do you aspire to in scenario 2?

   In the following, we will refer to the total net returns you aspire to as your *return aspirations.* Note that in the worst-case scenario, you may be willing to accept a loss. Hence, in scenario 1, your return aspiration may be negative.

b. Then, the decision aid will inform you whether your stated return aspirations can be achieved simultaneously or not, i.e., whether there exists a way to divide your credit between the risk-free bond and the risky asset satisfying your return aspirations in each scenario.

c. If your stated return aspirations *cannot* be achieved simultaneously, the decision aid will ask you to revise them.

d. Only when your return aspirations can be achieved simultaneously, you can decide how to divide your credit between the two investment alternatives.

e. The decision aid will inform you whether the way in which you decide to use your credit is in line with your aspired net returns. That is, you will get to know if your investment decision satisfies your aspirations for net return in each scenario.

f. You can revise your investment decision as many times as you want, and you can stop at any time regardless of whether your selected investments satisfy your aspired net returns or not.

The decision aid will assist you in every round.

In the first rounds, you are "forced" to use the decision aid. This means that you *must* go through all the steps mentioned above, and cannot decide how to use your credit until the net returns you wish to achieve in each scenario are possible simultaneously.

In later rounds, you can decide whether you want to use the decision aid or not.

- If you decide to use it, you have to go through all the steps mentioned above.
- If you decide not to use it, you can make your investment decision straight away.

Also in this latter case, you have to specify the total net return that you would like to achieve in each scenario.

The information you receive at the end of each round

At the end of each round, you will be informed about the result of your investment decision. That is, in each round you will get to know the net return you get from the amounts you invested in the risk-free bond and in the risky asset.

Your final earnings

At the end of the experiment, one of the rounds will be randomly selected for payment. The credit you have taken in this round has to be paid back fully. The investment return exceeding the credit you have taken (i.e., the net return from your investment in A and B) will be converted to euros and paid out. Please note that your investment return may fall short of your credit amount. In this case, you have to cover your losses by completing an additional task at the end of the experiment. The additional task requires to search and mark specific symbols in a text. By doing so, you can compensate 1 Euro loss by completing half a page.

Before the experiment starts, you will have to answer some control questions to ensure your understanding of the investment task, and the functioning of the aid.

Please remain quiet until the experiment starts and switch off your mobile phone.

If you have any questions, please raise your hand now.

Control questions (transcript of computer screens)

Screen 1

Choose how much of your credit you want to take: ...

Choose your investment in the risk-free bond A: ...

Choose your investment in the risky asset B: ...

Screen 2

You have chosen to take ... ECU from your credit line.

You have chosen to invest ... ECU in alternative A.

You have chosen to invest ... ECU in alternative B.

Assume that $l = 0.8$, $r = 1.1$, and $h = 1.6$. Assume also that scenario 1 occurs.

Please calculate:

Your net return in ECU from the risk-free bond ...

Your net return in ECU from the risky asset ...

Your total net return ...

Note: Clicking on the apposite icon, you can use the computer's calculator.

If you have answered all questions correctly, a click on the "OK"-button will bring you to the next screen.

Screen 3

You have chosen to take ... ECU from your credit line.

You have chosen to invest ... ECU in alternative A.

You have chosen to invest ... ECU in alternative B.

Assume that $l = 0.8$, $r = 1.1$, and $h = 1.6$. Assume now that scenario 2 occurs.

Please calculate:

Your net return in ECU from the risk-free bond ...

Your net return in ECU from the risky asset ...

Your total net return ...

If you have answered all questions correctly, a click on the "OK"-button will bring you to the next screen.

Screen 4

The following control questions verify your understanding of the "return aspirations" and the decision aid.

Assume that $l = 0.8$, $r = 1.1$, and $h = 1.6$. Assume also that you have taken all 1000 ECU from your credit line. If you aspire to a total net return of 100 in scenario 1, which is the return aspiration that you can simultaneously achieve in scenario 2?

Screen 5

Assume that $l = 0.8$, $r = 1.1$, and $h = 1.6$. Assume also that you have taken all 1000 ECU from your credit line, and that your stated return aspirations are 40 in scenario 1 and 200 in scenario 2. Please calculate the amount that you have to invest in A and B so as to satisfy these return aspirations.

Amount to invest in A: ...

Amount to invest in B: ...

Appendix B: Algorithm to check whether aspirations are consistent

Let us assume that there is no idle money, i.e., $b + i = e$ or $b + i + j = e$, as required by bounded rationality.

In case of (C.2), for an aspiration vector (A_1, A_2):

1. check whether $\bar{A}_1 \geq b(r-1) + (e-b)(l-1) = b(r-l) + e(l-1)$.
2. If the inequality above is satisfied, calculate b^* which solves $\bar{A}_1 = b^*(r-l) + e(l-1)$, yielding
$$b^* = \frac{\bar{A}_1 + e(1-l)}{r-l}.$$
3. Substitute b^* in $b(r-1) + (e-b)(h-1) \leq \bar{A}_2$. If the inequality holds, the two return aspirations $\bar{A}_1$ and $\bar{A}_2$ are consistent.

In case of (C.3), the algorithm works in a similar way:

1. Check whether $\bar{A}_1 \geq (e-i-j)(r-1) + i(h-1) + j(L-1)$ and $\bar{A}_2 \geq (e-i-j)(r-1) + i(l-1) + j(L-1)$.
2. If the inequalities in 1) are satisfied, use them as equalities and solve for i^* and j^*.
3. Substitute i^* for i and j^* for j in $\bar{A}_3 \geq (e-i-j)(r-1) + i(h-1) + j(H-1)$. If the inequality holds, then $\mathbf{A} = (\bar{A}_1, \bar{A}_1, \bar{A}_3)$ is consistent.

Table 1: Experimental parameters in the 12 decision tasks of each treatment

Treatment	*Two-state*			*Three-state*				
Decision	l	r	h	L	l	r	h	H
1	0.8	1.02	1.3	0.5	0.8	1.02	1.3	2.5
2	0.7	1.02	1.4	0.5	0.6	1.02	1.4	2.5
3	0.9	1.02	1.3	0.4	0.8	1.02	1.3	2.7
4	0.8	1.02	1.4	0.4	0.6	1.02	1.4	2.7
5	0.9	1.02	1.5	0.6	0.9	1.05	1.5	2.8
6	0.8	1.02	1.6	0.6	0.7	1.05	1.6	2.8
7	0.9	1.05	1.3	0.5	0.9	1.05	1.5	3
8	0.8	1.05	1.4	0.5	0.7	1.05	1.6	3
9	0.9	1.05	1.5	0.6	0.9	1.1	1.5	2.8
10	0.8	1.05	1.6	0.6	0.7	1.1	1.6	2.8
11	0.9	1.10	1.5	0.5	0.9	1.1	1.5	3
12	0.8	1.10	1.6	0.5	0.7	1.1	1.6	3

Table 2: Descriptive statistics on aspiration levels and investment decisions overall periods in each treatment

Treatment	N^a	Variable	Mean	Median	Std. deviation
Two-state	372	Profit	75.90	37.50	166.78
		A_1	12.52	0.00	208.84
		A_2	143.94	60.00	187.96
		b	623.08	800.00	380.53
		i	349.91	200.00	379.17
Three-state	320*	Profit	103.43	50.00	269.89
		A_1	−15.76	1.00	236.09
		A_2	92.64	30.00	183.17
		A_3	179.13	50.00	302.94
		b	641.14	800.00	359.67
		i	236.69	120.00	314.53
		j	79.98	0.00	191.53

[a] N denotes the number of observations.

* Due to a software breakdown, data in periods 7 and 12 got lost.

Table 3: Descriptive statistics on aspiration levels and investment decisions separately for phase 1 (periods 1–6) and phase 2 (periods 7–12)

Treatment	Phase	N^a	Variable	Mean	Median	Std. deviation
Two-state	1	186	Profit	51.38	20.00	153.47
			A_1	−43.61	0.00	104.51
			A_2	109.87	30.00	157.44
			b	632.80	800.00	392.15
			i	333.33	200.00	387.52
	2	186	Profit	100.42	56.25	176.12
			A_1	68.64	0.00	264.97
			A_2	178.01	100.00	209.12
			b	613.36	800.00	369.35
			i	366.48	200.00	370.93
Three-state	1	192	Profit	65.65	30.00	253.51
			A_1	−82.16	0.00	148.98
			A_2	73.20	20.00	184.39
			A_3	185.91	40.00	322.03
			b	626.35	750.00	361.05
			i	232.27	100.00	312.381
			j	84.61	0.00	198.82
	2	128*	Profit	160.08	100.00	284.36
			A_1	83.84	10.00	299.94
			A_2	121.80	100.00	178.08
			A_3	168.95	80.00	272.71
			b	663.31	800.00	357.87
			i	243.34	120.00	318.85
			j	73.04	0.00	180.57

[a] N has the same interpretation as in Table 2.

[*] Observations in periods 7 and 12 are missing.

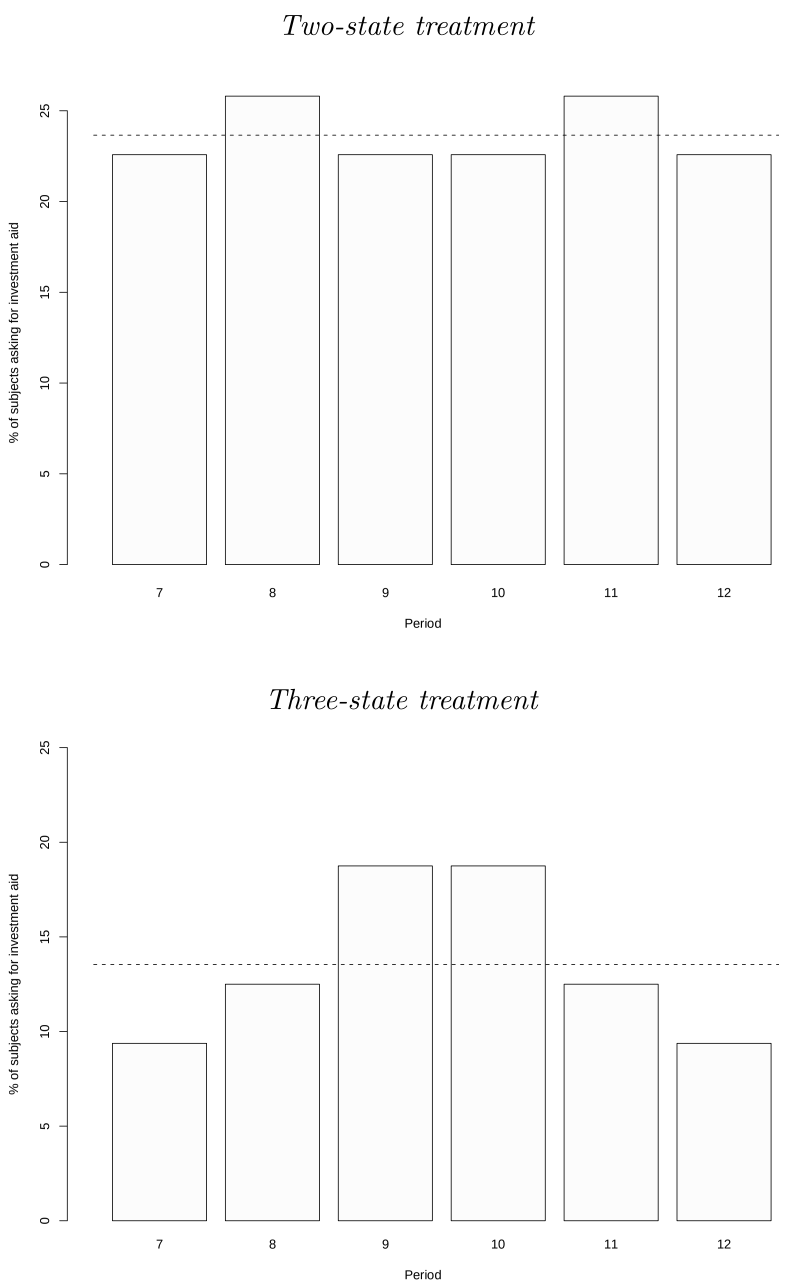

Figure 1: Percentage of subjects asking for the decision aid in each period of phase 2

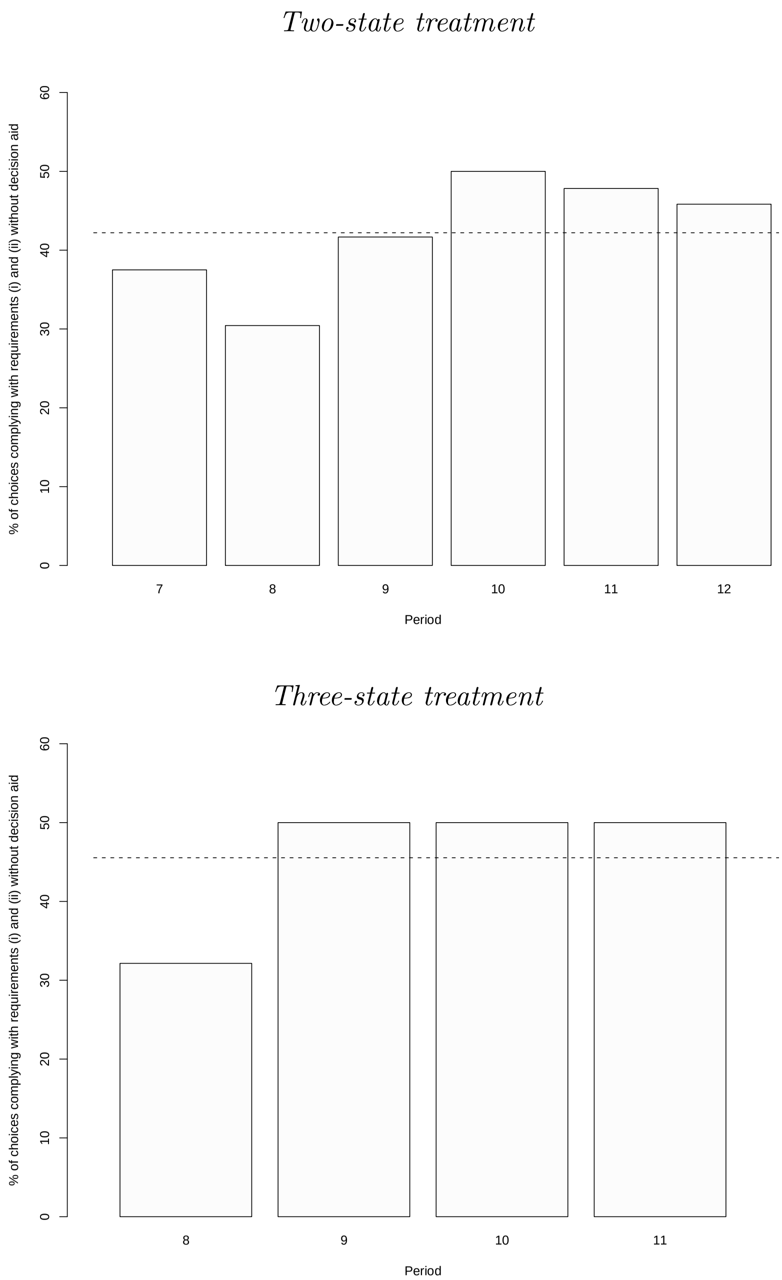

Figure 2: Frequency of choices not supported by the decision aid, which comply with both requirements for satisficing behavior in each period of phase 2

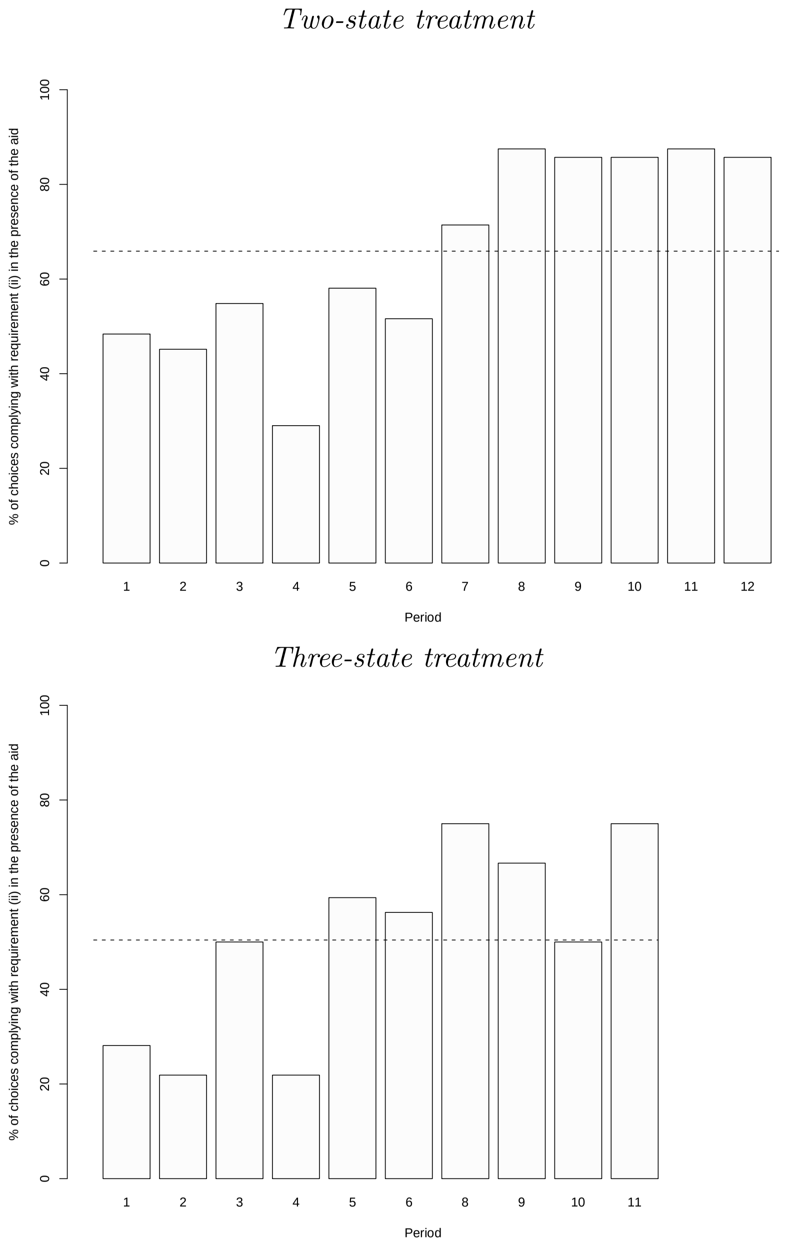

Figure 3: Frequency of choices supported by the decision aid, which are consistent with stated aspirations in each period of the experiment