Task Transcending Satisficing - An Experimental Study

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Abstract

The paper explores the applicability of the satisficing approach. In particular, we investigate whether basic principles of aspiration formation and satisficing behavior are transferable between similar situations. Individuals are sequentially confronted with two risky investment tasks, a simple and a more complex one. Initially elicited state-contingent aspirations can be used to predict actual portfolio selection in both tasks. We explore whether individual characteristics of satisficing apply to both scenarios. Results indicate that stated aspirations frequently cannot be fulfilled. However, aspiration formation itself is highly transferable between tasks.

Keywords: bounded rationality; aspirations; investment decisions

JEL-codes: C91; D81; G11

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1 Introduction

As human cognitive capacities are limited, decision making almost necessarily falls short of the axioms of rationality. This opens the need for developing and advancing theories of bounded rationality. Building on the terminology of Simon (1955), we undertake the attempt to rigorously define satisificing and to examine its prescriptive applicability. More specifically, we are interested in how generalizable and stable aspirations are across similar tasks. To do so, we generalize the approach of previous work by Fellner, Güth, and Maciejovsky (2005) who investigated the congruence of aspirations and subsequent decision making in the financial area.

The grounds for the persistent success of rational choice theory is that a given cardinal utility function can be applied to all well-specified decision problems (neglecting computational problems). In contrast, knowing how aspirations are formed and satisfied in one decision task does not naturally reveal how to apply the satisficing approach to a different task. Thus, analyzing choices in the bounded rationality tradition may result in case-by-case theorizing (see, for instance, the review by Selten, 1998).

Both, the satisficing and the rational choice approach, need bold assumptions to render themselves applicable. The rational choice approach does only offer a specific prediction, e.g. in terms of an optimal portfolio, if the (functional) type of the investor's risk preference is specified. The satisficing approach, on the other hand, requires to state aspirations numerically and to interpret them in a specific way in order to use them analytically. We introduce aspirations in a way that is intuitive and simple, albeit challenging enough for boundedly rational investors with limited cognitive capabilities. The partly new type of data may, however, suggest other specifications and interpretations of aspirations.

When developing the theory of bounded rationality one should not simply impose structural assumptions of the rational choice approach. Especially, the separation of preferences on the one hand and of choice alternatives on the other hand may not be valid. A boundedly rational decision maker will in all likelihood develop goals and means of achieving them in one cognitive effort. Especially, an aspiration level combines both, an achievement goal as well as a behavioral aspect, due to its limitation of the choice set. If aspirations are feasible, e.g., if the set of possible portfolios respecting all aspirations is non-empty, one should select a feasible satisficing action. Otherwise, a boundedly rational investor should revise his aspirations to guarantee their feasibility.

It may be that a trade-off between applying natural categories of decision making on the one hand and generalizability on the other hand may justify maintaining the rational choice tradition in economics: the hard-core rational choice theorist could concede that assuming cardinal utilities is unrealistic but that they can be universally applied whereas the natural categories of bounded rationality lead to case specific theorizing. Here we abstain from broadly discussing this issue philosophically but use experimental data to explore whether and, if so, how the natural categories of bounded rationality theory like aspiration formation, satisficing and adaptation can be transferred from one decision problem to another. Will – at least in structurally similar tasks – satisficing behavior of an individual in one task allow to predict her satisficing in another task? To answer the question we have performed stochastic investment experiments eliciting state specific aspirations. Analyzing how satisficing in one task translates to another task (for this class of decision problems) may provide a basis for further studies of more general classes of decision problems. This may be a very first step in testing the universality of bounded rationality theory.

In section 2, we discuss the problem of task transcending satisficing in more detail. Section 3 defines the stochastic investment experiments on which our analysis is based. Section 4 describes the hypotheses and experimental protocol and section 5 reports our experimental findings. Section 6 concludes.

2 Task Transcending Satisficing

One great advantage of the rational choice-approach is that a given (cardinal) utility specification can be applied to all decision tasks without further ado. After observing, for instance, that the behavior of an investor is in line with the cardinal utility function $U(\cdot)$, it is more or less implicitly assumed that this function $U(\cdot)$ will govern behavior in other tasks as well. Of course, generating a prediction in such ways will often fail.[1] But – and that is the

[1] When experimentally eliciting risk attitudes, social concerns, etc., such idiosyncratic attitudes are not always in line with the behavior in a follow-up task (see Güth, Krahnen,

true advantage of the rational choice-approach – one can at least generate an umambigous prediction, even if it may fail practically.

For the bounded rationality approach the possibility to predict satisficing in a new task, based on observed satisficing in other, e.g. previous, decision problems is less obvious. What can be claimed so far – in the light of supporting evidence – is that the principles of

- aspiration formation,
- satisficing and
- aspiration adjustment

will apply generally. But how to transfer a satisficing approach, based on observing these three processes in a specific task, to a different task (or class of tasks) remains largely unexplored.

Consider, for instance, that satisficing has been successfully applied to searching for an apartment. For the very same decision maker, whose search for an apartment has been well explained by the categories of satisficing, one now wants to predict financial investment behavior. The main difficulty is to transfer observations of forming aspirations for an apartment[2] to the process of forming aspiration for portfolios.[3]

The relative importance of the three processes mentioned above may, for instance, differ between tasks. Whereas apartment search typically requires aspiration adjustment to early experiences before actually renting or buying an apartment, financial portfolios can be easily restructured over time.[4] Thus, in financial affairs, aspiration formation and adjustment can evolve over time and react to satisfaction with earlier choices.

How to resolve this difficulty in general is one of the great challenges for the theory of bounded rationality. In contrast,the rational choice-approach[5]

and Rieck, 1997; Shaked, 2005; Fehr and Schmidt, 2005).

[2]How many components has an aspiration vector like size, location, rent, etc, how many levels does one distinguish for each component?

[3]How fine or coarse is the state space? How many aspiration levels does one distinguish for each state?

[4]Actually the evidence of churning suggests that there is too much restructuring of portfolios, especially by professional managers of investment funds (see, for instance Odean, 1999; Brown, 1996).

[5]There is, of course, a lot of ad-hoc-specificity involved: If one relies on risk aversion in finance why not in family economics? If one relies on inequity aversion in distribution conflicts why not in finance? One relies on hyperbolic discounting to explain neglect of the

at least offers the chance to apply a given utility specification to another setting without facing the problems just described. In this paper, we do not even try to resolve this difficulty in full generality, e. g. by trying to speculate about task transcending satisficing between searching for an apartment and financial investments. Rather we restrict ourselves to structurally related decision tasks for which we want to discuss how satisficing in one task can be connected to satisficing in the other. Our theoretical speculation is inspired and supported by experimental data. More specifically, we consider stochastic investment scenarios where aspirations are naturally state specific, i.e. they specify a desired monetary return for each state of the world. The experimental data include not only aspiration data but also decision data. Let us first turn to the general setup of the investment situation.

3 The general problem space

The stochastic environment is captured by a finite state set $I = \{S_1, ..., S_m\}$ with $m \geq 2$, and an objectively or subjectively given probability assessment[6] $w = (w_1, ..., w_m)$ with $w_j > 0$ $(j = 1, ..., m)$ and $w_1 + ... + w_m = 1$.[7]

The investor has a monetary endowment $e(> 0)$ that can be used to buy a portfolio of different financial assets $A = \{A_1, ...A_n\}$ with $n \geq 2$.

In the experiment, the endowment e is implemented as a credit line for interest-free lending. Without loss of generality, the constant prices of the n assets are set equal to 1 which can be achieved by appropriately redefining their units. Thus, if the investor buys a portfolio $a = (a_1, ..., a_n)$ with $a_i \geq 0$ $(i = 1, ..., n)$ the budget constraint is given by $\sum_{i=1}^{n} a_i \leq e$.

The return for each feasible portfolio is determined by the randomly chosen state via the reward matrix

far-away future in intertemporal consumption choice but why not when trying to explain investment in preventive care, e.g. health care?

[6]States S_j with $w_j = 0$ are neglected.

[7]The probability assessment w is used only to generate behavioral benchmarks like ‘maximizing expected monetary returns’. For the satisficing approach it is not needed since this is non-Bayesian.

$$R_{m,n} = \underbrace{\begin{bmatrix} r_{11} & .. & .. & .. & r_{1n} \\ .. & .. & .. & .. & .. \\ .. & .. & .. & .. & .. \\ r_{m1} & .. & .. & .. & r_{mn} \end{bmatrix}}_{\text{assets}} \left.\vphantom{\begin{bmatrix} r \\ r \\ r \\ r \end{bmatrix}}\right\} \text{states} \tag{1}$$

with elements $r_{ij} \geq 0$. In state j the portfolio a pays

$$U_j(a) = \sum_{i=1}^{n} (r_{ij} - 1)a_i \tag{2}$$

and the a priori expected return is

$$E(a) = \sum_{i=1}^{m} w_j \sum_{i=1}^{n} (r_{ji} - 1)a_i = \sum_{j=1}^{m} w_j U_j(a) = (w_1, ..., w_m) R_{m,n} \begin{pmatrix} a_1 \\ .. \\ .. \\ a_n \end{pmatrix} \tag{3}$$

for all feasible portfolios a. $E(a)$ would be the evaluation criterion of a risk-neutral investor. In general, evaluation might rely on both, transformations $V(U_j(a))$ of (deterministic) monetary returns $U_j(a) = \sum_{i=1}^{n} (r_{ji} - 1)a_i$, as soon as one of the states $S_j \in I$ has been selected and on probability transformations $W(w)$ determining (in case of objectively given probabilities w_j) the subjectively perceived likelihood (see Kahneman and Tversky, 1979). In case of expected utility theory, one relies only on a monotonic function $V(\cdot)$.[8]

Our experiment relies on two different investment situations: A simple one, with two states of the world and three investment options (i.e. $m = 2$ and $n = 3$, conveniently referred to as $R_{2,3}$-**task**)[9] and a more complex one with 3 states of the world and 4 investment alternatives ($m = 3$ and $n = 4$, the $R_{3,4}$-**task**). In the following, the investment decisions are explained in more detail.

[8](Cumulative) Prospect theory, in addition, requires $V(\cdot)$ to be convex (concave) in the loss (gain) region and allows the probability transformation $W(\cdot)$ to differ from identity. The maximin criterion does not rely on summing up weighted evaluations of deterministic returns but applies the minimum operator instead.

[9]See also the earlier study of Fellner, Güth, and Maciejovsky (2005).

3.1 Investment situation $R_{2,3}$

The reward matrix of the simple $R_{2,3}$ task with two states is displayed in following:

$$R_{2,3} = \begin{bmatrix} 1 & r & l \\ 1 & r & h \end{bmatrix} \text{with } 0 < l < 1 < r < h$$

The investor receives a monetary endowment e in form of a credit line that can be used to

- leave some money idle (by not fully exploiting the credit), yielding a return rate of 1.
- invest in a risk-less bond with a return rate $r\,(> 1)$.
- invest in a risky asset yielding a low return rate l with $0 < l < 1$ in state 1 and a high return rate $h\,(> r)$ in state 2.

Both states are equally likely ($w_1 = w_2 = 1/2$).[10] Clearly, even a boundedly rational investor will not keep money idle so that every (boundedly) rational portfolio can be simply described by the amount $a_3 \in [0, e]$ invested in the risky asset meaning that $e - a_3$ is invested in the riskless bond.

In the investment scenario with two states of the world, there are only two state-specific return aspirations, namely the return aspiration $\underline{A}$ for the bad state 1 and $\overline{A}$ for the good state 2.

The aspiration for the bad state should guarantee a subsistence level of income that is met in any case

$$a_3 l + (e - a_3) r \geq \underline{A} \tag{4}$$

The aspiration for the good state defines a success level of income when the economic conditions are at best.

$$a_3 h + (e - a_3) r \geq \overline{A} \tag{5}$$

Clearly, a high success aspiration requires riskier investment and implies accepting a lower income in the bad state, and vice versa. Given the two aspirations, the set of satisficing portfolios is[11]

[10] Equal probabilities are suitable to justify the neglect the non-identity probability transformation $W(w)$.

[11] See also Fellner, Güth, and Maciejovsky (2005).

$$a_3 \in \left[\underline{a_3}, \overline{a_3}\right] \text{ with } \underline{a_3} = \frac{\overline{A} - er}{(h-r)} \text{and } \overline{a_3} = \frac{er - \underline{A}}{(r-l)}. \tag{6}$$

where the interval $\left[\underline{a_3}, \overline{a_3}\right]$ may, of course, be empty.

3.2 Investment situation $R_{3,4}$

For the $R_{3,4}$ task the reward matrix is

$$R_{3,4} = \begin{bmatrix} 1 & r & l & L \\ 1 & r & h & L \\ 1 & r & h & H \end{bmatrix} \text{with } L < l < 1 < r < h < H.$$

Analogously to the previous investment situation, the investor has the possibility to

- leave some money idle with a return rate of 1.
- invest in a risk-less bond with a return rate $r\,(> 1)$.
- invest in a risky asset yielding a low return rate l with $l < 1$ in state 1 and a high return rate $h\,(> r)$ in states 2 and 3.
- invest in a even riskier asset yielding a low return rate L with $L < l < 1$ in states 1 and 2 and a high return rate $H\,(> h)$ in state 3.

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All three states are equally likely ($w_1 = w_2 = w_3$). A boundedly rational (no idle money) portfolio is sufficiently described by the amounts $a_3(\geq 0)$ invested in the less risky asset and $a_4(\geq 0)$ invested in the more risky asset, with $e - a_3 - a_4$ remaining for the riskless bond.

With three states, we assume a minimum aspiration $\underline{A}$ with $eL <\underline{A}\leq er$ that the investor does not want to miss, i.e., the portfolio (choice vector) (a_3, a_4) should guarantee a return of at least $\underline{A}$ even in the worst state 1, i.e.

$$a_3(l-1) + a_4(L-1) + (e - a_3 - a_4)(r-1) \geq \underline{A}. \tag{7}$$

Another aspiration concerns the lucky state 3 when both risky assets yield high returns. The highest aspiration $\overline{A}$ defines what the investor wants to get when being lucky, i.e. the return in state 3. The success aspiration level $(eH \geq)\overline{A}(> er)$ would be satisfied in state 3 if

$$a_3(h-1) + a_4(H-1) + (e - a_3 - a_4)(r-1) \geq \overline{A}. \tag{8}$$

The intermediate aspiration level A with $\underline{A} < A < \overline{A}$ defines a satisfactory return one wants to guarantee in the intermediate state 2 when only the less risky asset wins. Clearly, er is the upper bound for $\underline{A}$ and any risky investment will aim at returns exceeding er, implying the condition $\overline{A} \geq A \geq er$. For satisficing A in state 2 one needs a return

$$a_3(h-1) + a_4(L-1) + (e - a_3 - a_4)(r-1) \geq A. \tag{9}$$

If aspirations meet the restrictions (7) to (9) and the feasability condition $a_3 + a_4 \leq e$, the set of satisficing portfolios are half-spaces whose corners define the intersection of minimum and maximum investment amounts $\overline{a_3}$, $\underline{a_3}$ and $\overline{a_4}$, $\underline{a_4}$. Figure 1 sketches one such satisficing set, assuming that the credit line is fully exploited ($e = 1000$). Figure 1 also illustrates how aspirations, if interpreted as above, do not only express achievement goals but also seriously narrow the choice set.

Formally, the limitations for satisficing portfolios are $a_3 \in [\underline{a_3}, \overline{a_3}]$ and $a_4 \in [\underline{a_4}, \overline{a_4}]$, where

$$\begin{array}{ll} \underline{a_3} = \frac{A(H-r)+\overline{A}(r-L)+er(L-H)}{(H-L)(h-r)}, & \overline{a_3} = \frac{\underline{A}(H-r)+\overline{A}(r-L)+er(L-H)}{r(h-H-l+L)+Hl-hL} \\ \underline{a_4} = \frac{\underline{A}(r-h)+\overline{A}(l-r)+er(h-l)}{r(h-H-l+L)+Hl+hL}, & \overline{a_4} = \frac{\underline{A}(r-h)+A(l-r)+er(h-l)}{(h-l)(L-r)} \end{array} \tag{10}$$

and the feasibility condition $a_3 + a_4 \leq e$ is satisfied. The set of satisficing portfolios can of course be empty.

When exploring "task transcending satisficing", we thus focus on well defined tasks, namely to select a portfolio $a = (a_1, ..., a_n)$ out of a number of alternatives, and on how to transfer characteristics from one task, e.g. with $m = 2$ and $n = 3$, to another, e.g. with $m = 3$ and $n = 4$.[12] Both decision tasks rely on a natural ordering of states from worst to best, offer a riskless bond that is superior to leaving money idle, rely on equal probabilities of

[12]The transfer has, of course, two possible directions, i.e. to use $R_{2,3}$-behavior to predict the choice for $R_{3,4}$, and $R_{3,4}$ observations to predict $R_{2,3}$ choice behavior.

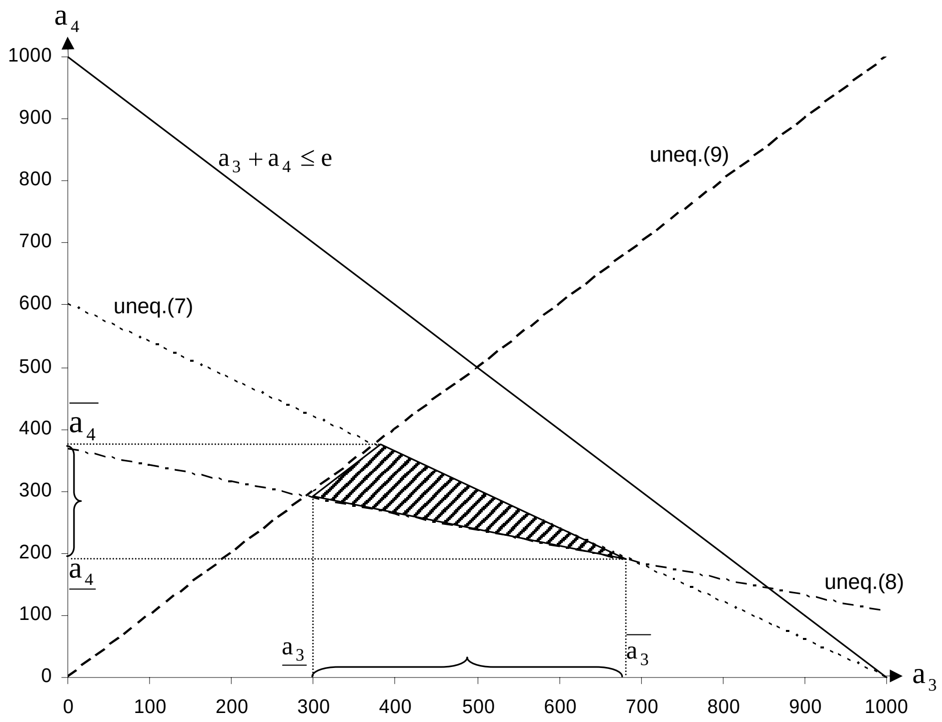

Figure 1: Example of the set of satisficing portfolios in $R_{3,4}$

all states (to avoid effects of probability transformations), and present investment options that can be ordered according to their riskiness and their monetary expectations, due to $\frac{l+h}{2} > r > 1$ in $R_{2,3}$ and $\frac{H+2L}{3} > \frac{2h+l}{3} > r > 1$ in $R_{3,4}$. In the following, we will refer to $R_{m,n}$ scenarios with such structure as well-ordered $R_{m,n}$ scenarios.

4 Experimental Setup

This section presents the experimental protocol, the parameter setup of the investment decision as well as some theoretical considerations guiding our hypotheses on task transcending satisficing.

4.1 Experimental Protocol and Parameters

Overall we run two experiments. Both were computerized and conducted at the experimental laboratory of the Max Planck Institute in Jena using the software z-Tree (Fischbacher, 1999). The 160 participants were undergraduate students from different disciplines at the University of Jena, recruited via the online system ORSEE (Greiner, 2004).

4.1.1 Experiment A

Experiment A consisted of 3 sessions, each with 32 participants. The first session is a pilot-session, where subjects confronted only one task, namely $R_{2,3}$. In contrast, session 2 and 3 consisted of two phases. In one phase, subjects were confronted with the investment situation $R_{2,3}$ of two assets (a riskless and a risky one) and in the other phase with the investment situation $R_{3,4}$ of three assets (a riskless and two risky ones). To avoid order effects, the order was counterbalanced, i.e. participants of session 2 encountered $R_{2,3}$, and then $R_{3,4}$; for participants of session 3 the order was reversed. Participants knew that there would be two phases, however, they did not know any details on phase 2 when being instructed on phase 1.

Participants were instructed that each phase would last for at least 15 rounds with a continuation probability of 80% in every subsequent round.[13] To guarantee maximum comparability the actual number of rounds was determined once for all sessions according to this continuation probability. Table 1 gives an overview about the actual number of rounds per session and phase, including the resulting number of observations.

Table 1: Design of Experiment A

session	phase	number of assets	number of rounds	number of participants	number of investment decisions
1	1	2	17	32	544
2	1	2	17	32	544
2	2	3	15	32	480
3	1	3	15	32	480
3	2	2	16	32	512

Subsequently, subjects learned about the specific details of the particular investment task and had to correctly answer control questions to ensure that they understand of the investment situation before the experiment starts.

At the beginning of the first round in each phase, participants were asked for their aspirations, i.e. what they want to obtain in the two, respectively three possible states. Participants had to specify aspirations for the return

[13]See also the sample instructions in the Appendix.

from investment for each state, i.e., they had to choose a low ($\underline{A}$) and a high aspiration ($\overline{A}$) for the bad, respectively good state in task $R_{2,3}$ and three aspirations $\underline{A}, A, \overline{A}$ with $\underline{A} \leq A \leq \overline{A}$ for the bad, intermediate and good state in task $R_{3,4}$.[14] When specifying aspirations in $R_{2,3}$, for instance, participants were asked which return they at least want to achieve in the bad, respectively good state. Since the choice of aspiration levels $(\underline{A}, A, \overline{A})$ is not payoff relevant, they were elicited only once, in the first round of $R_{2,3}$ and $R_{3,4}$.

Afterwards, individuals could decide how much of their endowment, implemented as credit line of $e = 1000$ ECU,[15] to leave idle and how much to invest in the alternative options. Leaving money idle was clearly suboptimal due to $r > 1$. Specifically, the two investment tasks were

$$R_{2,3} = \begin{bmatrix} 1 & 1.1 & 0.8 \\ 1 & 1.1 & 1.6 \end{bmatrix}$$

and

$$R_{3,4} = \begin{bmatrix} 1 & 1.05 & 0.9 & 0.8 \\ 1 & 1.05 & 1.3 & 0.8 \\ 1 & 1.05 & 1.3 & 2 \end{bmatrix}$$

The first column refers to leaving money idle (yielding a return rate of 1); the second column specifies the riskless bond involving no risk at all but yielding a higher return rate (of 1.1, respectively 1.05) than idle money (with a return rate of 1). The remaining columns with state dependent return rates describe risky assets. The state of the top row is always worst and the state of the bottom row always best. Due to the equal probabilities of all states, the expected return of asset k with $1 < k \leq n$ exceeds the one of asset $k - 1$.

At the end of each period, the actual state was randomly determined and displayed on screen. Subjects were informed about their investment balance and their net return (the credit is deducted from their investment returns.) For final payment, one round for each task, $R_{2,3}$ and $R_{3,4}$ was randomly selected. The net investment return of these two periods was

[14]The maximum riskfree return er was used to delineate the range of aspirations, by $el \leq \underline{A} \leq er \leq \overline{A} \leq eh$ and $eL \leq \underline{A} \leq er \leq A \leq \overline{A} \leq He$, repsectively, where we rely on the general notation used in sections 3.1 and 3.2.

[15]One experimental currency unit (1 ECU) translates to 0.08 Euros.

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 a task after the experiment ended. The task was to search and mark letters in a text.

4.1.2 Experiment B

To explore the transferability of aspiration formation between investment tasks with the same number of states but different parameters, experiment B was conducted.

Experiment B consisted of 2 sessions, each with 32 participants, and was also composed of two phases. In both phases subjects were confronted with an $R_{2,3}$-situation. However, the specification of the decision task $R_{2,3}$ differed between phases. We refer to the two decision tasks as $R^{'}_{2,3}$ and $R^{''}_{2,3}$, respectively. The two sessions differed only with respect to the order in which the two tasks were encountered.

Table 2: Design of Experiment B

session	phase	number of assets	number of rounds	number of participants	number of investment decisions
1	1	2	17	32	544
1	2	2	15	32	480
2	1	2	15	32	480
2	2	2	17	32	544

To closely mirror the conditions of experiment A, the number of rounds was fixed at 17 for the $R^{'}_{2,3}$-investment situation and at 15 rounds for the $R^{''}_{2,3}$-investment situation. Specifically, the two investment tasks were[16]

$$R^{'}_{2,3} = \begin{bmatrix} 1 & 1.1 & 0.8 \\ 1 & 1.1 & 1.6 \end{bmatrix}$$

and

$$R^{''}_{2,3} = \begin{bmatrix} 1 & 1.05 & 0.7 \\ 1 & 1.05 & 1.8 \end{bmatrix}$$

[16]Note that investment task $R^{'}_{2,3}$ of experiment B is identical to the task $R_{2,3}$ of experiment A. To avoid confusion in the results section, however, we denote this task in experiment B by $R^{'}_{2,3}$.

In all other respects, the procedure of experiment B corresponds to experiment A. Table 2 gives a summary of experiment B.

4.2 Hypotheses

The two experimental scenarios $R_{2,3}$ and $R_{3,4}$ rely both on a natural ordering of states, namely from worst to best. In $R_{2,3}$ these are the only states; in $R_{3,4}$ there exists an intermediate state. The subindex m of $R_{m,n}$ refers to the number of states. Thus, in all tasks of this type, there always exists

- $\underline{A}$, the (minimum) aspiration for the worst state,
- $\overline{A}$, the (success) aspiration for the best state.

One can explore on an aggregate level how the different features of the aspiration data for one R_m-class relate to similar features for another $R_{m'}$-class with $m \neq m'$ (Experiment A) or for the same class with different parameters (Experiment B). Is, for instance, the sum $\overline{A} + \underline{A}$ of the largest and the smallest aspiration for (m) closely related to the same sum for (m')? In a first step of our data analysis, we investigate such possible correlations in individual aspiration data for $R_{2,3}$ and $R_{3,4}$ situations in a purely explorative way to learn about possible interrelations and to suggest empirically promising hypotheses for further studies of task transcending satisficing.

The difference between highest and lowest aspiration $(\overline{A} - \underline{A})$, may not be directly transferable from one task to another, e.g. from $m = 2$ to $m^{'} = 3$, since the states and their (perceived) likelihood may differ between tasks. By relating $\overline{A} - \underline{A}$ to the difference between the highest feasible return $\overline{U}$ and the lowest feasible return $\underline{U}$ the **relative spread** of the return aspirations

$$\Delta := \frac{\overline{A} - \underline{A}}{\overline{U} - \underline{U}}. \tag{11}$$

becomes comparable over tasks. In scenario $R_{2,3}$ with $\overline{U} = h \cdot e$ and $\underline{U} = l \cdot e$ the spread is, for instance, $\Delta = \frac{\overline{A} - \underline{A}}{(h-l)e}$, whereas for $R_{3,4}$ with $\overline{U} = H \cdot e$ and $\underline{U} = L \cdot e$ it is $\Delta := \frac{\overline{A} - \underline{A}}{(H-L)e}$.

Our first hypothesis on task transcending satisficing claims

Conjecture 1 ***(Relative) Spread Constance***: *If for one participant the spread Δ is smaller than for another participant in one well-ordered $R_{m,n}$ task, then it will be also smaller in another well-ordered $R_{m',n'}$ task.*

One can also consider how the action spaces are delineated by aspirations. In terms of portfolio choice the action space is a set of satisfactory choices that, in case of illusionary aspirations, may be empty (see subsection 3.1 and 3.2). When comparing the width of action spaces between different tasks, one may simply use the (Lebesgue-) measure of the set S of satisfactory portfolios. Thereby (relative) width persistence can be evaluated [17]

- *either within a given task set $R_{m,n}$, i.e., for given m, whether a (relatively) larger set S in one such task implies a (relatively) larger set S in another such task,*
- *or by asking whether a (relatively) large set S in one class $R_{m,n}$ implies a (relatively) large set S in another class $R_{m',n'}$, e.g., one with $m' > m$.*

In the $R_{2,3}$ scenario, the Lebesque-measure is defined by the length of "interval " $\left[\underline{a_3}, \overline{a_3}\right]$, which is

$$\frac{er\,(h-l)-(h-r)\,\underline{A}-(r-l)\,\overline{A}}{(h-r)\,(r-l)}. \tag{12}$$

When comparing different $R_{2,3}$ scenarios (Experiment B), one can standardize length comparisons by dividing equation (12) by the difference of highest and lowest possible return,$\overline{R}-\underline{R}=(h-l)\,e$, so that "width" w of the satisficing action space becomes comparable over tasks R_2:[18]

$$W_{2,3} := \frac{r}{(r-l)(h-r)} - \frac{\underline{A}}{e\,(h-l)\,(r-l)} - \frac{\overline{A}}{e\,(h-l)\,(h-r)}. \tag{13}$$

[17] When comparing "width" of different (m) constellations, one may rely on other indicators for the size of the portfolio space like the difference of maximal and minimal return rate or absolute returns or may even refrain from standardizing "width" at all, e.g. by just comparing $\overline{A}-\underline{A}$ without any weighting.

[18] In the special case, when $h-r=r-l$, only the sum of lowest and highest aspiration determines the width of the satisficing choice set, otherwise the width can vary without changing the sum $\underline{A}+\overline{A}$.

The Lebesgue-measure is more complex in the $R_{3,4}$ scenario, since we have to consider the set of boundaries for 2 dimensions, namely a_3 and a_4. In this case width is determined by the area enclosed by the inequalities (7) to (9) and the feasibility condition $a_3 + a_4 \leq e$ as exemplified by the shaded area in Figure 1. Due to the fixed slope but variable intercepts of the first three inequalities, the action space can be of triangle shape, shrink to one point or be empty.

It might be that the (relative) size of the satisficing set is an invariant characteristic in the sense that someone with a smaller W than someone else in one task will exhibit a smaller width in another such task as well. Thus, we formulate our second hypothesis of task transcending satisficing as follows:

Conjecture 2 ***(Relative) Width Persistence:*** *If for one participant the width W is smaller than another participant's width in one well-ordered $R_{m,n}$ task, it will be also smaller in another well-ordered $R_{m',n'}$ task, where m and m' as well as n and n' can differ.*

5 Data analysis

In this section, we report (i) percentages of observations in the specific behavioral categories (non-rational investors, potential and actual satisficers), and more importantly (ii) the consistency of aspiration formation throughout different investment tasks.

5.1 Behavioral categories and descriptive statistics

Let us first consider a very broad classification of behavior with respect to the stated aspirations and the invested amounts. The following, very basic assumptions made previously in the theoretical part of the paper define minimum requirements for reasonable aspiration formation. In case they are not met, we speak of **unreasonable** behavior:

$$\begin{array}{llllll} le & \leq \underline{A} & \leq er & \leq \overline{A} & \leq he & \text{for } R_{2,3}\text{-tasks} \\ Le & \leq \underline{A} & \leq er & \leq A & \leq \overline{A} \quad \leq He & \text{for the } R_{3,4}\text{-task} \end{array}$$

If, however, aspirations are reasonably stated and are realistic in that the action space satisfying these aspirations is non-empty (see equations (6) and (10)), behavior is classified as **potentially satisficing**. If, additionally, observed investment behavior fulfills all aspirations, we speak of **actual satisficing** behavior.

As described in section 4.1.1 *experiment A* consisted of one pilot-session (32 subjects), where participants faced only a $R_{2,3}$ scenario, and 2 sessions (64 subjects), where participants confronted both tasks ($R_{2,3}$ and $R_{3,4}$), subsequently. Aspirations, $\underline{A}$ and $\overline{A}$ for the $R_{2,3}$ scenario and aspirations $\underline{A}$, A and $\overline{A}$ for the $R_{3,4}$ scenario, were specified only once, whereas decisions about the credit amount and investments were made repeatedly in each round.[19] The average credit remained fairly constant over time and amounts to about 963 ECU ($SD = 28.89$). Thus a considerable number of subjects does not fully exploit the credit line as would be rational.

In experiment A, only a fraction of 20.9% of all observations (334 out of 1600 observations) in $R_{2,3}$ could be classified as potentially satisficing. These observations arise mostly from a few people who were potential satisficers in all rounds.[20] 210 out of these 334 observations (62.9 %) could additionally be classified as actually satisficing.

When considering only the two sessions where subjects encountered both tasks subsequently, 13 of 64 participants (20.3%) were potential satisficers in all rounds of $R_{2,3}$, 1 subject only in one round. All 13 constant potential satisficirs at least once chose a satisficing portfolio in $R_{2,3}$, and 9 have chosen a satisficing portfolio in at least half of the rounds.

In the more complex investment situation $R_{3,4}$, only 45 out of 960 observations can be classified as potentially satisficing. These result from 3 participants, who were potential satisficers in all 15 rounds of the $R_{3,4}$-investment situation. One of these three also chose investments that were actually satisficing.

In total, only 2 subjects were always potential satisficers in both investment scenarios. 11 subjects were potential satisficers in $R_{2,3}$ but not in $R_{3,4}$, and 1 subject was potential satisficer in the more complex $R_{3,4}$-situation but not in $R_{2,3}$. Only one subject exhibited almost always (except for three rounds in $R_{2,3}$) actual satisficing in both investment tasks. Since

[19]Although aspirations were only stated once at the beginning of each investment scenario, the behavioral classifications take all rounds into account as the credit amount could vary.

[20]In the in $R_{2,3}$-task, 20 subjects are classified as potential satisficers in all (16 and 17, respectively) rounds whereas 1 subject is a potential satisficer in only one round.

we did not allow to learn how to specify mutually consistent aspirations, delineating a non-empty set of satisfactory portfolios, the low number of potential and actual satisficers is disappointing but not totally unexpected.

In *experiment B*, a similar pictures emerges. The average credit line (986.3 ECU, SD=83.74) is again below 1000 which reflects unexploited profit potential.

In $R'_{2,3}$ 255 out of 1088 observations (23.4%) can be regarded as potentially satisficing, wheres in the $R''_{2,3}$ the fraction is 269 of 960 observations (28.0%). Actual investment behavior in line with aspirations (actual satisficing behavior) accounts for only 13.9% of the data in task $R'_{2,3}$ and 16.7% of the data in task $R''_{2,3}$.

Regarding individual types instead of decisions, 16 of the 64 subjects (25%) were potential satisficers in task $R'_{2,3}$ and 18 (28.1%) were in $R''_{2,3}$. Thereof, 13 subjects exhibited actual satisficing behavior at least once in the $R'_{2,3}$-task and 14 did at least once in the $R''_{2,3}$-task. In total, 4 subjects were always actual satisficers in $R'_{2,3}$ and 5 were in $R''_{2,3}$. Considering the consistency of individual behavior throughout both tasks of experiment B, 11 of the 64 subjects (17.2%) were potential satisficers in both tasks and 8 (12.5%) were actual satisficers in both tasks. Since, confirmation of the satisficing hypothesis is poor, we concede

Observation 1 *Without incentivizing aspiration choices and/or allowing to learn consistent aspiration formation, few participants are potential satisficers and few portfolio choices are actually satisficing.*

Since Fellner, Güth, and Maciejovsky (2005) did not find a growing share of potential satisficers when participants had to determine aspirations anew in each round (of 17 in total), experience alone may not promote satisficing very much. In our view, to observe more potential or actual satisficing, one therefore should do both, incentivize aspiration choices (by committing participants to revise them if mutually inconsistent and choose finally some actually satisficing portfolio) and allow for learning to render one's aspirations mutually consistent.

We now turn to our main – albeit explorative – analysis of task transcending satisficing.

5.2 Task transcending satisficing

In order to explain an agent's behavior in different tasks it is necessary to explore the generally applied principles of the satisficing approach: aspiration formation, satisficing and aspiration adjustment. Thus, we focus our analysis on aspiration formation in the two different investment tasks rather than focusing only on satisficing behavior as in Fellner, Güth, and Maciejovsky (2005). Of course, this can only be a first step to learn information about individual satisficing behavior in different tasks.

5.2.1 Relating aspiration formation in different tasks

Participants chose the following aspiration levels:

- $\underline{A}$ and $\overline{A}$ in $R_{2,3}$, $R^{'}_{2,3}$ or $R^{''}_{2,3}$
- $\underline{A}$, A and $\overline{A}$ in $R_{3,4}$.

Let us compare the low and high aspiration levels ($\underline{A}$ and $\overline{A}$) that are specified by each participant in both investment tasks.

In a first step, we answer the question whether and how the aspiration levels of a person in one investment task are related to the aspiration levels of that person in the other investment task. In experiment A, aspirations in $R_{2,3}$ are related to aspirations in $R_{3,4}$, and in experiment B, aspirations in $R^{'}_{2,3}$ are related to aspirations in $R^{''}_{2,3}$. We do not only explore the relation of the aspiration levels $\underline{A}$ and $\overline{A}$ directly but also of the sum $\underline{A}+\overline{A}$ as well as of the difference $\underline{A}-\overline{A}$. Table 3 and Table 4 show the corresponding Spearman rank correlations for experiment A and experiment B, respectively.

Table 3: Spearman rank correlation of aspiration measures across tasks in experiment A

	$R_{3,4}$			
$R_{2,3}$	$\underline{A}$	$\overline{A}$	$\underline{A}-\overline{A}$	$\underline{A}+\overline{A}$
$\underline{A}$	$0.82^{\star\star}$	$0.73^{\star\star}$	0.28	$0.76^{\star\star}$
$\overline{A}$	$0.60^{\star\star}$	$0.73^{\star\star}$	$0.46^{\star\star}$	$0.72^{\star\star}$
$\underline{A}-\overline{A}$	0.02	$0.29^{\star}$	$0.44^{\star\star}$	$0.26^{\star}$
$\underline{A}+\overline{A}$	$0.67^{\star\star}$	$0.81^{\star\star}$	$0.48^{\star\star}$	$0.80^{\star\star}$

Note: ⋆⋆ and ⋆ denote significance on the 1% and 5% level, respectively.

Table 4: Spearman rank correlation of aspiration measures across tasks in experiment B

	$R''_{2,3}$			
$R'_{2,3}$	$\underline{A}$	$\overline{A}$	$\underline{A}-\overline{A}$	$\underline{A}+\overline{A}$
$\underline{A}$	0.65**	0.44**	-0.04	0.52**
$\overline{A}$	0.43**	0.71**	0.43**	0.71**
$\underline{A}-\overline{A}$	-0.03	0.39**	0.56**	0.34**
$\underline{A}+\overline{A}$	0.50**	0.68**	0.36**	0.70**

Note: ** denote significance on the 1%

Observation 2 *The aspiration levels $\underline{A}$ and $\overline{A}$ as well as the sum of aspiration levels $\underline{A}+\overline{A}$ of both tasks are significantly positively correlated, whereas the difference of aspiration levels $\overline{A}-\underline{A}$ is positively correlated to all aspiration variables except for the lowest aspiration ($\underline{A}$).*

The high correlations between the aspiration levels $\underline{A}$, $\overline{A}$, and their sum $\underline{A}+\overline{A}$ in the two different tasks suggest that knowing about individual aspiration-formation in one task can help to predict aspiration formation in another, related task. The weaker relation of the difference $\overline{A}-\underline{A}$ in both tasks to other aspiration variables is not surprising. The difference of aspirations may not be directly transferable from one problem to the other (e.g., from $R_{2,3}$ to $R_{3,4}$), since the states and their (perceived) likelihood differ between tasks.

Alternatively, one can examine the relation between aspirations in the two tasks by relying on median splits of the respective variables. We distinguish observations of the variables $\underline{A}$, $\overline{A}$, $\underline{A}-\overline{A}$, $\underline{A}+\overline{A}$ of both tasks above and below (or at) the median. Table 5 and Table 6 display the cross-tables of observations in experiment A and B. A χ^2-test for all cross-tables rejects the null-hypothesis of independence ($p < .05$ for all variables).

Observation 3 *The classification of aspirations in above and below (or at) the median in the two investment tasks is highly interdependent.*

Again, this result indicates that if one agent has a relatively high (low) aspirations in one task, he also has relatively high aspirations in another related task.

Table 5: Crosstables of observations below and above the median for aspiration data of experiment A

		$\underline{A}$ in $R_{2,3}$					$\overline{A}$ in $R_{2,3}$		
		$\leq x_{0.5}$	$> x_{0.5}$	Total			$\leq x_{0.5}$	$> x_{0.5}$	Total
$\underline{A}$ in	$\leq x_{0.5}$	29	3	32	$\overline{A}$ in	$\leq x_{0.5}$	26	3	29
$R_{3,4}$	$> x_{0.5}$	4	26	30	$R_{3,4}$	$> x_{0.5}$	3	29	32
	Total	32	32	64		Total	30	29	64
		$\underline{A}+\overline{A}$ in $R_{2,3}$					$\overline{A}-\underline{A}$ in $R_{2,3}$		
		$\leq x_{0.5}$	$> x_{0.5}$	Total			$\leq x_{0.5}$	$> x_{0.5}$	Total
$\underline{A}+\overline{A}$	$\leq x_{0.5}$	29	3	32	$\overline{A}-\underline{A}$	$\leq x_{0.5}$	21	6	27
in $R_{3,4}$	$> x_{0.5}$	3	29	32	in $R_{3,4}$	$> x_{0.5}$	9	21	30
	Total	32	32	64		Total	30	27	64

Table 6: Crosstables of observations below and above the median for aspiration data of experiment B

		$\underline{A}$ in $R''_{2,3}$					$\overline{A}$ in $R''_{2,3}$		
		$< x_{0.5}$	$> x_{0.5}$	Total			$< x_{0.5}$	$> x_{0.5}$	Total
$\underline{A}$ in	$< x_{0.5}$	28	5	33	$\overline{A}$ in	$< x_{0.5}$	29	7	36
$R'_{2,3}$	$> x_{0.5}$	4	27	31	$R'_{2,3}$	$> x_{0.5}$	3	25	28
	Total	32	32	64		Total	32	32	64
		$\underline{A}+\overline{A}$ in $R''_{2,3}$					$\overline{A}-\underline{A}$ in $R''_{2,3}$		
		$< x_{0.5}$	$> x_{0.5}$	Total			$< x_{0.5}$	$> x_{0.5}$	Total
$\underline{A}+\overline{A}$	$< x_{0.5}$	26	6	32	$\overline{A}-\underline{A}$	$< x_{0.5}$	13	19	32
in $R'_{2,3}$	$> x_{0.5}$	6	26	32	in $R'_{2,3}$	$> x_{0.5}$	2	30	32
	Total	32	32	64		Total	15	49	64

5.2.2 Relative consistence of the spread of aspirations across tasks

Let us consider the data of both experiments in the light of Conjecture 1 of '(relative) spread constance'. Since we compare the relative spread of subjects across tasks, we exclude session 1 of experiment A, where subjects experienced only one task. For all subjects who confronted both tasks, we computed the relative spreads, as defined in section 4.2, for each round of $R_{2,3}$ and $R_{3,4}$ in experiment A and $R'_{2,3}$ and $R''_{2,3}$ in experiment B.[21] From the data we computed an average spread for each person and both tasks.

For experiment A, Kendall's rank correlation test yields that 27.03% (545 of 2016) of aspiration spread comparisons between $R_{2,3}$ and $R_{3,4}$ are in line with Conjecture 1 (Kendall's tau-a: 0.2703, p=.002). In experiment B, even 42.86% (864 of 2016) of comparisons between $R'_{2,3}$ and $R''_{2,3}$ confirm Conjecture 1 (Kendall's tau-a: 0.4286, $p < .001$). Although the spread constance measured between tasks of the same $R_{m,n}$-class (experiment B) seems to be higher, the difference of the two correlations is not significant (Test based on Fisher transformation: z=1.0659, $p = .14$).

Observation 4 *Subjects' relative spreads are highly consistent across tasks. Furthermore, there is no difference in the spread constance between tasks of the same complexity and tasks with different complexity.*

5.2.3 Relative width persistence across tasks

Finally, we examine Conjecture 2 of '(relative) width persistence' by using again data of both experiments. As proposed in section 4.2, the width is calculated as the Lebesgue-measure of the set of satisficing actions determined by the aspirations. In the simple case of $R_{2,3}$-tasks, this is simply the length of the satisicing set. Similar to the relative spread of aspirations, the width is averaged over rounds for each subject.[22]

In *experiment A*, only three subjects exhibited potentially satisficing behavior in both the $R_{2,3}$ and $R_{3,4}$ tasks. To calculate correlations of width

[21]Separate calculation of the relative spread in each round was necessary, since subjects could decide about their credit (e), on which the relative spread relies, every round. The other possibility to use the full credit line regardless whether or not it was fully exploited is not applied since it would restrict our analysis to cases with no unused credit.

[22]Of course, width can only be calculated for non-empty action spaces, i.e. when aspiration data is classified as potentially satisficing.

relying on only three observations is futile. Therefore, data of experiment A cannot be used to answer Conjecture 2.

In *experiment B*, 11 subjects were always potential satisficers, so that their aspiration data may serve to compare width over tasks $R'_{2,3}$ and $R''_{2,3}$. The Kendall rank correlation test indicates that a significant relation of action space width in the two different tasks cannot be confirmed (Kendall's tau-a: 0.146, $p = .54$).

Unfortunately, the low number of participants, who consistently exhibited potentially satisficing behavior, makes it difficult to conclusively settle the issue whether consistency in satisficing behavior can be found for width as determined by aspirations.

Observation 5 *The width of subjects' satisficing sets does not seem to be correlated. However, the low number of observations that can effectively be used does not allow to draw strong conclusions.*

6 Discussion

This study presents a first step toward a more generalized application of the satisficing approach. While the advantage of expected utility theory lies in its general applicability to all well-specified decision problems, it is not equally obvious how satisficing would perform in explaining behavior across different tasks. Bounded rationality theory therefore runs the risk to be case-specific fostering doubts on its success as a useful concept.

To possibly advance bounded rationality theory with respect to its general applicability, we investigate how basic principles of aspiration formation can be transfered from one task to another. Relying on simple investment tasks, we compare aspiration formation between similar and both equally or unequally complex tasks. In order to do so, we establish and present two genuine measures that allow general comparisons of aspirations and the set of satisficing actions across different tasks.

Results suggest that aspiration formation is highly consistent across tasks. Unfortunately, width determined by stated aspirations, could not be well compared over tasks due to a low number of consistent potential satisficers. We can, however, tentatively conclude that knowing aspirations in one task helps to predict aspiration formation in other tasks.

In contrast, evidence on actual satisficing behavior is rather discouraging. Without incentivizing aspiration choices and without providing opportunities for learning, participants in the experiment frequently exhibit unrealistic aspirations or do not seem to consider aspirations very well. When participants are frequently not potentially and even less often actually satisficing, one might conclude that satisficing as a bounded rationality concept is not impulsively used but has to be propagated as something that is adequate without overburdening the decision-maker cognitively.[23] Like rationality also bounded rationality may require teaching and learning but unlike rationality theory we are capable to apply what is taught.

Another possible explanation of the low predictive power of aspirations for actual investment choices could be that individuals are quite heterogeneous in their ways of perceiving aspirations as useful for decision making.[24]

The high consistency of aspirations across tasks, however, indicates that subjects do not state their aspirations randomly. Allowing to learn how to adjust aspirations and investment decisions at the same time may result in even more consistency of aspirations and actual behavior. In future research one should therefore investigate how well bounded rationality performs in what is to be its main virtue: helpfully guiding individuals' decision making process.

[23]This questions, of course, the implicit claim of the heuristics approach,(e.g. Gigerenzer and Todd, 2000), that we are mostly well adapted in the sense of "ecological rationality".

[24]Students who have learned the capital asset portfolio model might even reject the aspiration approach because they learned that something is optimal.

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A Appendix

Sample instructions for experiment A (first task $R_{2,3}$, then $R_{3,4}$)

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 two parts. 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.
For your final payment at the end of the experiment, your earnings in both 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.

Part I of the experiment

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 risky asset B	fixed interest rate loses	fixed interest rate wins

Investment Decision

We introduce the currency ECU for all decisions in this experiment. The exchange rate is the following: 12.5 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 +5% of the invested amount in both future states

2. risky asset B: leads to a gain of +100% 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	+5%	+5%
risky asset B	−20%	+100%

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 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. In total, there will be at least 15 rounds. The probability of continuing with round 16 after round 15 is 80%. The probability of continuing with an additional round after round 16 is also 80%, and so on.

Payoff Calculator. *As a decision aid, we provide you a PAYOFF CALCULATOR that allows you to calculate your expected final amounts before* *making your final decision in each round. To start the payoff calculator, please press the button "Calculate final amounts" on screen. Type in, which amounts you want to invest in the two assets. The payoff calculator tells you the earnings you can expect with these investments in both states.*

Final Payment

At the end of the first part of the experiment, one round is randomly chosen for payment. The investment success in this round determines your earnings in part 1. Your earnings are calculated by your final amount in this round minus the credit taken in this round.

$$\boxed{\text{Investment success} = \text{Final amount} - \text{Credit taken}}$$

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. This loss can be compensated by your earnings in part 2 of the experiment. Are the losses of part 1 not compensated by earnings in part 2, you have to compensate your losses by completing and additional task as already described.

Before the experiment starts, you will receive control questions to guarantee that you have well understood the investment situation. As soon as all participants have completed these control questions, the experiment will start for everyone at the same time.

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

Part II of the experiment

General setting

In the second part of the experiment, you can also invest money. There are now 3 investment possibilities: a riskless asset A bearing fixed-interest and two risky assets B and C. At the time of your investment, you will not know how assets B and C will develop in the future. You know, however, that three different states of the world are possible.

In state 1 (probability $\frac{1}{3}$) both assets B and C lose. In state 2 (probability $\frac{1}{3}$) asset B wins while asset C loses. In state 3 (probability $\frac{1}{3}$) both assets B and C win. The following table provides an overview:

	State 1 (prob. $\frac{1}{3}$)	State 2 (prob. $\frac{1}{3}$)	State 3 (prob. $\frac{1}{3}$)
riskless asset A	fixed interest rate	fixed interest rate	fixed interest rate
risky asset B	loses	wins	wins
risky asset C	loses	loses	wins

Investment decision

For your investment decision you are again endowed with a maximum credit of 1000 ECU, where 2.5 ECU = 1 Euro.
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 three assets. It is also possible to invest the whole credit amount in one asset.
The three assets have the following properties:

1. riskless asset A: fixed interest rate of +5% of the invested amount in all three future states

2. risky asset B: leads to a gain of +30% of the invested amount in future states 2 and 3 (probability $\frac{2}{3}$) or to a loss of -10% of the invested amount in future state 1 (probability $\frac{1}{3}$).

3. risky asset C: leads to a gain of +100% of the invested amount in future state 3 (probability $\frac{1}{3}$) or to a loss of -20% of the invested amount in future states 1 and 2 (probability $\frac{2}{3}$).

The following table provides a detailed overview:

	State 1 (prob. $\frac{1}{3}$)	State 2 (prob. $\frac{1}{3}$)	State 3 (prob. $\frac{1}{3}$)
riskless asset A	fixed interest rate	fixed interest rate	fixed interest rate
risky asset B	-10%	+30%	+30%
risky asset C	-20%	-20%	+100%

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, 2 or 3) actually arrives in the particular round. At the end of each round you will be informed about your investment success. We denote the amount after adding your gain to the invested amount of after subtracting your loss from the invested amount as final amount.
In total, there will be at least 15 rounds. The probability of continuing with round 16 after round 15 is 80%. The probability of continuing with an additional round after round 16 is also 80%, and so on.

Payoff Calculator. *As a decision aid, we provide you a PAYOFF CALCULATOR that allows you to calculate your expected final amounts before making your final decision in each round. To start the payoff calculator, please press the button "Calculate final amounts" on screen. Type in, which amounts you want to invest in the three assets. The payoff calculator tells you the earnings you can expect with these investments in all three states.*

Final payment

At the end of the second part of the experiment, one round is again randomly chosen for payment. The investment success in this round determines your earnings in part 2. Your earnings are calculated by your final amount in this round minus the credit taken in this round.

Investment success =	Final amount	- Credit taken

You have made a gain, if the total amount invested in this round has increased. You have 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. This loss can be compensated by your earnings in part 1 of the experiment. Are the losses of part 2 not compensated by earnings in part 1, you have to compensate your losses by completing and additional task as already described.
Please switch off your mobile phones now and remain quiet until the experiment starts. In case you have a question, please raise your arm.