Target return as efficient driver of risk-taking

Catherine D'Hondt, Rudy De Winne and Aleksandar Todorovic
LIDAM-Louvain Finance, UCLouvain, Mons, Belgium

Received 14 September 2022
Revised 20 February 2023
Accepted 27 February 2023

Abstract

Purpose – This paper examines whether target returns act as specific goals that impact risk-taking when individuals make investment decisions.

Design/methodology/approach – Using an experimental setting, the authors assign either a low or a high target return to participants and ask them to make independent investment decisions as the risk-free rate fluctuates around their target return and, for some of them, becomes negative.

Findings – Building on cumulative prospect theory, the authors find that the prevailing reference point of participants is the target return, regardless of the level of the risk-free rate. This result still holds even when the risk-free rate is negative, suggesting that (1) the target return drives risk-taking more than does a zero-threshold and (2) negative rates are limited as a tool to stimulate appetites for risk. In a follow-up study, the authors show that these conclusions remain valid when the target return is endogenously determined.

Originality/value – The authors' original approach, which pioneers the use of target returns in both the positive and negative interest rate contexts, provides insightful results about the "reach for yield" among regular people.

Keywords Risk-taking, Target return, Reference point, Negative interest rates

Paper type Research Article

1. Introduction

Low interest rates are typically associated with increased risk-taking by institutional investors, who "reach for yield" (Choi and Kronlund, 2018). This relationship has been confirmed when interest rates are negative [1]. For example, institutional investors in money market funds must take more risks because negative interest rates (NIRs) prevent them from earning positive returns through safe investments (Maggio and Kacperczyk, 2017). The impact of NIRs on bank risk-taking is, however, more puzzling since banks in countries where the monetary authority has implemented NIRs have decreased their risk-taking behavior instead of increasing it (Boungou, 2020) [2].

What about the "reach for yield" among regular people? Past research is limited but provides supportive evidence for such behavior. When analyzing fund flows among mutual funds, Leung and Zhu (2018) show that retail investors allocate their funds according to the performance of the mutual fund managers when interest rates are assumed to be normal (i.e., neither zero nor negative). Nevertheless, as interest rates fall to extraordinarily low levels, retail investors allocate their funds toward mutual funds with a risky benchmark. In the same vein, Ganzach and Wohl (2018) examine the impact of a decrease in the risk-free rate on individual allocations of investment between a risk-free asset and a risky asset. While holding the risk premium constant, they find that decreasing

JEL Classification — G11, G21, G40, G41, G51

The authors gratefully acknowledge financial support from the Belgian French-speaking community (ARC grant 18/23- 089). They thank the associate editor and an anonymous referee for insightful comments which helped improve the paper. The authors also thank MH. Broihanne, O. Corneille and S. Trautmann for useful suggestions as well as participants at the 37th Spring International Conference of the French Finance Association and the EFMA 2021 annual conference. Any errors are the full responsibility of the authors.

Review of Behavioral Finance
Vol. 16 No. 1, 2024
pp. 130-166

1940-5979
DOI 10.1108/RBF-09-2022-0216

the rate on the risk-free asset leads to an increase in risk-taking (i.e., more individuals opt for the risky asset when the interest rate on the risk-free asset decreases). Lian *et al.* (2018) obtain similar findings and report that low interest rates are linked to higher allocations of funds to stocks and lower allocations to cash.

The specific case of zero or negative rates and their impact on the appetites of individuals for risk is, however, ambiguous. Bracha (2020) compares investment decisions under both positive interest rates (PIRs) and NIRs and finds no significant difference in risk-taking behavior. By contrast, Baars *et al.* (2020) indicate that the sign on the interest rate plays a key role in risk-taking. That is, a reduction in interest rates does not affect risk-taking in general; risk-taking increases significantly only if the interest rate drops below zero. Using a series of lab experiments analyzing both borrowing and investment behavior under PIRs and NIRs, David-Pur *et al.* (2020) find that a zero interest rate has the strongest impact on individuals' investment decisions. Based on this result, the authors conclude that zero interest rates are more efficient than NIRs at encouraging individuals to either borrow money or take risks. In addition, David-Pur *et al.* (2020) report no significant difference between the effect of PIRs and that of NIRs on changes in the allocation of risky assets in investment portfolios, although the level of the allocation to risky assets does increase when interest rates decrease.

In the abovementioned literature, the fact that a zero interest rate acts as a seemingly natural reference point might explain increased risk-taking with NIRs. Based on prospect theory (Kahneman and Tversky, 1979; Tversky and Kahneman, 1992), in which the current level of wealth is considered to be a reference point, individuals increase their risk-taking when the risk-free rate becomes negative in order to maintain their current level of wealth and avoid losses. The concept of diminishing sensitivity from prospect theory might also explain why the impact of a change is starker closer to the zero-threshold than farther from it (Ganzach and Wohl, 2018). Accordingly, a risk premium of 4% on a stock is more meaningful when the risk-free rate is 0% than when the risk-free rate is 10%.

In this paper, we contribute to this stream of literature on what stimulates the appetites of individuals for risk when making investment decisions. The novelty of our approach is the introduction of a new variable of interest, that is, the target return. According to Payne *et al.* (1980), a target return can be defined as "the predetermined benchmark return used by a decision-maker to translate monetary outcomes into gains and losses". Because the target return represents the expected return that an investor wants to achieve, it is likely to impact risk-taking behavior (Shefrin and Statman, 2000). Unlike the above papers, which implicitly use the zero interest rate as the reference point (Ganzach and Wohl, 2018; Lian *et al.*, 2018; Baars *et al.*, 2020; Bracha, 2020; David-Pur *et al.*, 2020), we run an experiment in which explicit target returns are set and randomly assigned to participants. First, using cumulative prospect theory (CPT), we are able to check whether the target return serves as a reference point and meaningfully impacts the risk-taking behavior of individuals when they make investment decisions. Next, and more importantly regarding NIRs, we determine whether the target return is still the prevailing reference point when the risk-free rate drops below zero.

Broadly speaking, we can relate target returns to mere goals, which are defined as a specific level of performance (e.g. Heath *et al.*, 1999; Rechenberg *et al.*, 2016) [3]. This paper builds on both Heath *et al.* (1999) and Larrick *et al.* (2009), who postulate that goals incorporate the three main principles of prospect theory, namely, the use of a reference point, loss aversion and diminishing sensitivity. When target returns are explicitly set, we posit that they act as goals that alter the psychological value of outcomes and impact appetites for risk. To test this conjecture within the context of investment decisions, we derive several hypotheses based on goal-setting effects that predict changes in risk preferences, and we test them in an experiment of our own design.

Our experiment has a mixed design allowing us to manipulate the target return to test its impact on risk-taking. Specifically, we use two conditions: a high target return condition wherein the target return is set at 6% and a low target return condition wherein the target return is at 2%. Participants are randomly assigned to one of these conditions and are subsequently requested to make five independent investment decisions. Two financial assets are available to all participants: a risk-free asset (i.e., a deposit account that pays the risk-free rate) and a risky asset (i.e., a stock index fund with a constant risk premium – 3% above the risk-free rate). We manipulate the risk-free rate to set it both above and below the target returns. These variations in the risk-free rate are similar in both conditions. However, participants in the high-target return condition face risk-free rates that are always positive, while participants in the low-target return condition face both positive and negative risk-free rates. Participants are informed that the fluctuations in the interest rates on the deposit account depend on the monetary policy of the Central Bank, while the returns to the stock index fund vary with current market conditions. After making their investment decisions, participants are asked to complete a short questionnaire. The latter allows us to collect individual information about the participants' actual target returns, their subjective risk-taking inclinations, and whether they own or have owned a savings account or an actual portfolio of financial assets.

Our original approach, which pioneers the use of target returns in both the PIR and NIR contexts, provides insightful results about the "reach for yield" among regular people. First, we show that explicit target returns drive risk-taking in investment decisions to a significant extent. Building on Heath *et al.* (1999) and Larrick *et al.* (2009), our findings confirm that the target return is used as a reference point by participants when making investment decisions. This holds regardless of the level of the target return, i.e., in both the high- and low-target return conditions. In accordance with the pattern of optimal allocations derived from CPT values, participants invest meaningfully more in the stock index fund when the risk-free interest rate is below their target return than when it is above their target return. Consistent with loss aversion, participant reactions to the risk-free rate falling below their target return (i.e., increases in their risk-taking) exceed their corresponding reactions when the risk-free rate goes above their target return.

Of particular interest is our result for the specific case in which the risk-free rate drops below zero in the low-target return condition. Comparing the average increases in risk-taking across similar shifts in the risk-free rate in both conditions (i.e., from 0% to −2% in the low-target return condition and from 4% to 2% in the high-target return condition), we find no significant difference. This implies that the target return still acts as the prevailing reference point among participants who face a negative risk-free rate. In other words, the risk-free rate dropping below zero does not especially affect risk-taking when people have an explicit target return (that differs from zero); people continue to adjust their allocations to the risky asset based on the distance between the risk-free rate and their target return. We conclude that the movement of the risk-free rate into negative territory does not activate any additional (i.e., extra) risk-taking.

When we further investigate the impact of the target return on risk-taking using panel data regression models, the expected risk-seeking behaviors are confirmed when the risk-free rate is below the target return. Controlling for the level of the target return, allocations to the risky asset significantly increase when the risk-free rate is below the target return. Such increases are both statistically and economically significant. Furthermore, when adding an interaction variable that captures situations in which participants in the low-target return condition face a negative risk-free rate, our results confirm that the target return still plays the crucial role of reference point and drives risk-taking.

In our experimental design, the target return is exogenously determined, although people are, in reality, asked to declare their target return before making investment decisions.

We therefore conduct a follow-up study to check whether using an endogenous target return provides results similar to the ones obtained in the experiment using exogenous target returns. All the findings of this follow-up study confirm that the target return serves as a reference point and meaningfully impacts risk-taking behaviors.

The remainder of the paper is organized as follows. Section 2 reviews the relevant literature. Section 3 describes our experimental setting. Section 4 presents our hypotheses. Section 5 reports the results of the main study. A follow-up study is reported in Section 6. Section 7 concludes the paper.

2. Literature

Target returns and reference points represent variations on the general concept of an aspiration level, an old idea in theories of decision-making (Payne *et al.*, 1980). This concept, which refers to the use of a predetermined "benchmark value" by a decision-maker to translate monetary outcomes into gains and losses, has been popularized by two well-known theories of choice under uncertainty: CPT (Kahneman and Tversky, 1979; Tversky and Kahneman, 1992) and SP/A theory (Lopes, 1987). Both theories emerge from a nonlinear modification of the expected utility model, sometimes coined as the "decumulatively weighted utility" model. In a nutshell, these theories both model the process by which decision-makers integrate probabilities and values by a (de)cumulative weighting rule, and they both include a point on the value dimension that has special significance to decision-makers (Lopes and Oden, 1999) [4]. A large body of past research in finance has used these theories or one of them to better explain attitudes to risk in a number of empirical facts related to investment decisions (e.g., Benartzi and Thaler, 1995; Shefrin and Statman, 2000; Barberis and Huang, 2008; Barberis *et al.*, 2016).

In this paper, we build our approach on Heath *et al.* (1999) and Larrick *et al.* (2009), two papers from the psychology literature on motivation. In both papers, the authors postulate that goals serve as reference points and change the value of outcomes as prospect theory predicts. We therefore focus on CPT to formalize the impact of target returns on risk-taking behavior.

2.1 Cumulative prospect theory

CPT entails a value function derived from changes in wealth rather than total wealth [5]. CPT is often summarized in terms of its three core principles: the use of a reference point, loss aversion and diminishing sensitivity.

The crucial notion of reference points implies that the value of any outcome is a function of both the individual's reference point (e.g., his/her current position) and deviations (either positive or negative) from it. In short, this value function is concave for gains (positive shifts) and convex for losses (negative shifts). In addition, outcomes are multiplied by decision weights, which refer to the transformation of probabilities in CPT. More precisely, the probability weighting function is an increasing backward S-shaped function, such that small (large) probabilities are overweighted (underweighted), while those in the middle approximately match the decision weights.

Loss aversion is usually encapsulated in the expression "losses loom larger than gains", meaning that the negative subjective value given to a loss is higher than the positive subjective value given to an equivalent gain [6]. Using the shapes of both the value function and the probability weighting function, Tversky and Kahneman (1992) highlight the following key patterns: risk aversion occurs in the face of highly probable gains and/or certain gains, risk-seeking in the face of highly probably losses and/or certain losses, risk-seeking in the face of gains with low probability, and risk aversion in the face of losses with low probability.

The third core principle of prospect theory is diminishing sensitivity; i.e., the marginal value of both gains and losses decreases with their magnitude. Consistent with a concave value function, an increase from 100 to 200 has a bigger impact than an increase from 1,000 to 1,100. Similarly, an increase in loss from 100 to 200 has a bigger impact than an equivalent increase in loss from 1,000 to 1,100, which is consistent with a convex value function.

2.2 Goals as reference points

Heath *et al.* (1999) focus on "mere" goals, which are defined as specific levels of performance with no discrete or discontinuous payoff [7]. To check whether these goals serve as reference points and change the value of outcomes as prospect theory predicts, Heath *et al.* (1999) use several short experiments in which scenarios depicting people who have predetermined workout plans with different goals are presented. When asking participants different questions about the emotions of the people depicted in these various situations, Heath *et al.* (1999) demonstrate not only that goals, like reference points, divide outcomes into regions of good and bad (i.e., success and failure) but also that the valuation of outcomes relative to a goal can be explained by loss aversion and diminishing sensitivity. Furthermore, Heath *et al.* (1999) show that the principles of the value function are sufficient to explain a wide range of empirical findings in the goal-setting literature on motivation.

Building on Heath *et al.* (1999), Larrick *et al.* (2009) focus on how goals induce risk-taking in two empirical contexts, namely, negotiation and decision-making. In particular, Larrick *et al.* (2009) insist that specific goals serve as reference points, creating a region of perceived loss for outcomes below that goal. To test whether specific goals increase risk-taking, the authors run three experiments in which they compare a "do your best" condition to a "specific, challenging goal" condition [8]. Their first two experiments show that goal-setting leads to more risk-taking in simple distributive bargaining tasks. They find consistent results in their third experiment, in which the impact of goal-setting is tested in a one-shot gambling task with clearly stated probabilities and payoffs. Larrick *et al.* (2009) conclude that all their findings point to increased risk-taking when specific goals are set, supporting their predictions based on prospect theory.

In the present paper, we consider a typical goal in the context of investment decisions, that is, the target return. The target return can be defined as the outcome toward which an individual strives when making investment decisions among risky choices. According to Payne *et al.* (1980), such a goal provides any investor with the opportunity to perceive the outcome of his/her investment as a gain or a loss. Hence, all outcomes above (below) the target should be perceived as gains (losses). When target returns are explicitly set, we posit that they act as specific goals that alter the psychological value of the outcomes and impact appetites for risk. To test this conjecture, in Section 4, we formulate several hypotheses based on goal-setting effects and expected changes in risk preferences based on CPT.

3. Experimental setting

We use oTree (Chen *et al.*, 2016) to implement our experiment, which includes one between and two within factors. The between factor is the target return condition to which each participant is randomly assigned. The target return is set to 6% in the high-target return condition and to 2% in the low-target return condition (see Table 1). Regardless of its level, this target return is kept constant throughout the whole experiment. All participants are informed that they must make several independent investment decisions, with two alternatives available: a deposit account and a stock index fund. The riskiness of both options is explicitly explained: the deposit account is presented as the risk-free asset and the stock index fund as the risky asset. The two within factors are therefore the interest rate on the deposit account (i.e., the risk-free rate) and the stock index fund return. Participants are

Decision	TR	R_F	R_F -TR	$E(R_s)$	RP_s	STD_s
Panel A: High-target return condition						
1	6%	10%	4%	13%	3%	6.67%
2	6%	8%	2%	11%	3%	6.67%
3	6%	6%	0%	9%	3%	6.67%
4	6%	4%	−2%	7%	3%	6.67%
5	6%	2%	−4%	5%	3%	6.67%
Panel B: Low-target return condition						
1	2%	6%	4%	9%	3%	6.67%
2	2%	4%	2%	7%	3%	6.67%
3	2%	2%	0%	5%	3%	6.67%
4	2%	0%	−2%	3%	3%	6.67%
5	2%	−2%	−4%	1%	3%	6.67%

Note(s): This table describes the investment alternatives across decisions in the high- and low-target return conditions (Panel A and Panel B, respectively). *TR* refers to the target return, R_F refers to the interest rate on the deposit account (i.e. the risk-free rate), R_F *-TR* is the difference between the risk-free rate and the target return, $E(R_s)$ is the expected return on the stock index fund, *RPs* is the risk premium on the stock index fund, and *ST Ds* refers to the standard deviation of the stock index fund returns distribution
Source(s): Authors' own creation/work

Table 1. Investment alternatives across decisions

informed that (1) the interest rate on the deposit account can be either positive or negative, depending on the monetary policy set by the Central Bank and (2) the stock index fund return fluctuates depending on market conditions. The currency in this experiment is the ECU (Experimental Currency Unit), and the exchange rate with the US dollar ($) is 1:1. Figure A1 provides a screenshot of these introductory instructions in Appendix 1.

In total, each participant is asked to make five independent investment decisions. For each decision, the participants in the low-target return (high-target return) condition must allocate 40 (20) ECU between the two available assets [9]. For each decision, the total share invested must equal 100%; i.e., the participants need to invest all their money. Figure A2 in Appendix 1 illustrates these instructions in the low-target return condition. After each investment decision, the participants are informed about their performance. More specifically, the participants are provided with information about the global performance of both assets in both absolute and relative terms, as well as about the performance of each asset separately.

Table 1 shows how the risk-free rate fluctuates across investment decisions. In each condition, two risk-free rates exceed the target return (see the first two rows in each panel), one risk-free rate just matches the target return (see the third row in each panel), and two risk-free rates fall short of the target return (see the last two rows in each panel). In the high-target return condition, the risk-free rate is set to 10%, 8%, 6%, 4 and 2%, while it is set to 6%, 4%, 2%, 0% and −2% in the low-target return condition. Notably, in both conditions, each of these values is randomly assigned to a given investment decision [10]. Depending on the risk-free rate, the expected return on the stock index fund also varies across investment decisions, with a constant risk premium of 3% (see the penultimate column in Table 1) [11]. For example, when the risk-free rate decreases by 2%, the expected return on the stock index fund decreases by 2%. The realized return on the stock index fund within each investment decision takes on one of the five possible outcomes as illustrated in Figure A4 when the expected return is equal to 13% (see Appendix 1). Two outcomes exceed the expected return (i.e., 18 and 23%), one outcome just matches it (i.e., 13%), and two outcomes fall short of it (i.e., 8 and 3%). The standard deviation of the stock index fund returns distribution is kept constant at 6.67% across investment decisions in both conditions (see the last column in Table 1).

To help participants understand the investment alternatives available in each decision, we provide them with graphical representations similar to Figures A3 and A4 available in Appendix 1. Figure A3 shows the interest rate on the deposit account as well as the probability of earning that rate (which is always equal to 100%). Figure A4 presents the possible returns on the stock index fund with their respective probabilities. These figures should help participants directly compare the possible outcomes and the probability of their occurrence [12].

Our experiment is incentivized, with a reward system composing a fixed payout of $1.50 plus a premium. The former is received by each participant, regardless of the results of his/her decisions. By contrast, the premium is an additional amount of money that depends directly on the participant's average performance across the five investment decisions. The size of this premium is simply equal to the average realized return multiplied by $40 in the low-target return condition or $20 in the high-target return condition. For example, if a participant in the low-target return condition earns an average realized return equal to 4%, his/her reward would be $3.10, which consists of a premium of $1.60 plus the fixed amount ($1.50). The same average realized return in the high-target return condition leads to a premium of $0.80 ($\$20 \times 4\%$) and a total reward of $2.30. In case the average realized return is negative, the premium is set to zero [13]. It is noteworthy that this incentive mechanism is not dependent on whether participants achieve their target return. This choice is consistent with considering target returns as "mere" goals (see Section 2.2) in the context of investment decisions. Since we aim at examining increased risk-taking in response to mere goals, we avoid any direct links between the participant's target return and his/her payoff to capture the psychological phenomenon (Heath *et al.*, 1999) [14].

After making their decisions, participants are requested to answer a hypothetical question about what would be their own target return in reality. Specifically, we ask them to declare the target return they would set if they had an actual portfolio of financial assets. The motivation behind this question is to check for any anchoring toward the target returns of 6 and 2% in the high- and low-target return conditions, respectively. Finally, participants are asked to answer a small questionnaire made of three parts. The first part elicits their subjective risk-taking inclinations with the domain-specific risk-taking (DOSPERT) scale (Blais and Weber, 2006), restricted to the six questions about gambling and investing (details are available in Appendix 2). The second part of the questionnaire inquires about the actual savings behavior of the participants, namely, whether they currently have or have had in the past any money in a savings account. The last question focuses on whether participants currently hold or have held in the past an actual portfolio of financial assets. Our main purpose is to check whether such individual-level information helps explain the heterogeneity in behavior across participants.

4. Theoretical predictions

Figure A5 (in Appendix 4) represents three similar value function curves based on prospect theory when considering only the risk-free rate outcomes in our experimental setting. While these curves differ by the reference point, they are all S-shaped in accordance with the three core principles described in Section 2.1 [15]. However, what is depicted in Figure A5 does not properly fit our experimental setting since participants can combine the risk-free asset (that delivers the risk-free rate) with the risky asset (i.e., the stock index fund). To formulate predictions consistent with both this specific setting and the abovementioned goal-setting effects, we need to compute optimal allocations derived from CPT values.

4.1 Optimal allocations based on CPT

For our purpose, we use the CPT of Tversky and Kahneman (1992) with their function specifications [see Equations (5) and (6) on page 309, also available in Appendix 3] and their parameters:

(1) $\lambda = 2.25$, the loss aversion parameter

(2) $\alpha = \beta = 0.88$, powers for gains and losses

(3) $\gamma = 0.61$ and $\delta = 0.69$, probability weighting for gains and losses, respectively

Let us illustrate our approach for the low-target return condition. For participants in this condition, the target return is equal to 2% and the risk-free interest rate takes randomly the following values: -2%, 0%, 2%, 4 and 6%. For each of these interest rates, there are five possible outcomes for the stock index fund return. As shown in Table 1, these outcomes ensure that both the risk premium on the stock index fund and the standard deviation of its returns are constant.

For each of the five risk-free interest rates, we consider all the possible allocations of the money between the risk-free asset and the stock index fund. In practice, we make the weight allocated to the risky asset vary from 0% to 100% by increments of 1%. This leads to 101 possible allocations for each level of risk-free interest rate. More precisely, each allocation may result in gains, in losses, or in both gains and losses, depending on the stock index fund return picked at random according to the probability distribution. Since there are five possible outcomes for the stock index fund return, there are also five possible outcomes of a nonzero allocation in this risky asset. Once the 101 allocations are determined for a given risk-free interest rate, we compute the CPT values associated to each of them. The optimal allocation is then identified as the one with the highest CPT value.

Let us stay within the low-target return condition and take a numerical example. When the risk-free interest rate is equal to 4%, the return of the stock index fund can take the following values:

(1) −3% with a probability of 17%

(2) 2% with a probability of 21%

(3) 7% with a probability of 24%

(4) 12% with a probability of 21%

(5) 17% with a probability of 17%

In this specific case, if we invest the whole amount of money (40 ECU) in the risky asset, there is a probability of 17% that the target return (2%) is not reached (i.e., a loss compared to this reference point). Using the abovementioned functional specifications, the optimal allocation in that case is 27% in the risky asset and 73% in the risk-free asset, and the portfolio return will be equal to 2.11% in the worst scenario.

This approach is repeated twice for each decision participants face in the experiment (i.e., five levels of risk-free interest rate per target return condition) to consider two scenarios when computing the CPT values: (1) the reference point is the target return and (2) the reference point is the zero-threshold.

Table 2 provides the results, depending on whether the reference point is set to the target return (Panel A) or zero (Panel B). As expected, these optimal allocations differ because of the reference point. In Panel A, the pattern of optimal allocations depending on the risk-free rate is similar, regardless of the target return condition. When the risk-free rate is below the target return, the optimal allocation consists in investing all the available money (i.e., 100% of the amount at stake) in the risky asset. When the risk-free rate matches the target return, the optimal allocation to the risky asset falls to zero. Less intuitively, when the risk-free rate exceeds the target return, the optimal allocation to the risky asset is positive and even increases as the risk-free rate shifts away from the target return. This phenomenon, which might be surprising at first glance, is essentially related to the role of loss aversion when

Risk-free rate Condition	−2%	0%	2%	4%	6%	8%	10%
Panel A: When reference point = target return							
High-target return			100	100	0	27	54
Low-target return	100	100	0	27	54		
Panel B: When reference point = 0%							
High-target return			27	54	82	100	100
Low-target return	100	0	27	54	82		

Note(s): This table presents the optimal share of money allocated to the risky asset (i.e. the stock index fund with a constant risk premium of 3%) based on the values from CPT using the value and weighting functions in Tversky and Kahneman (1992) as well as their set of parameters. For each risk-free rate in the high-target return condition and the low-target return condition, these optimal allocations are computed considering either the target return (Panel A) or the zero-threshold (Panel B) as the reference point
Source(s): Authors' own creation/work

Table 2. Optimal allocations to the risky asset (in %) based on CPT values

computing CPT values. As soon as the risk-free rate exceeds the target return by 2%, the loss associated with the stock index fund in the worst possible outcome is compensated by the gain obtained on the risk-free asset. This specificity explains the increasing optimal allocations to the risky asset above the target return. In other words, when the risk-free rate is at 2% or 4% above the target return, participants might be risk-seeking provided that the biggest potential losses on the stock index fund are offset by the positive difference between the risk-free rate and the target return.

In Panel B of Table 2, the patterns of optimal allocations depending on the risk-free rate differ between the two conditions. For the high-target return condition, the risk-free rate is always above the reference point (i.e., the zero-interest rate level). Therefore, the optimal allocation to the risky asset monotonically increases as the risk-free rate moves up. Specifically, once the risk-free rate reaches 8%, the optimal allocation to the risky asset is equal to 100%. By contrast, in the low-target return condition, the pattern of optimal allocations depending on the risk-free rate is similar to the one identified in Panel A. Indeed, in that condition, the range of values for the risk-free rate includes the zero-interest rate that is the reference point.

4.2 Hypotheses

A perfect match between the optimal allocations reported in Table 2 and the actual decisions made by the participants is not expected. This would be possible only if participants really behave exactly as prospect theory predicts based on the set of parameters from Tversky and Kahneman (1992). Nevertheless, the noticeable patterns of optimal allocations depending on the risk-free rate and the reference point are insightful to formulate our hypotheses.

Building on the primary role of the reference point (i.e., flagging outcomes as gains or losses), risk aversion should occur when the risk-free rate exceeds the target return and risk-seeking should occur when the risk-free rate drops below the target return. However, this reflection effect [16] does not perfectly appear in Panel A of Table 2 since, as mentioned earlier, risk-seeking in our experimental setting should also emerge when the risk-free rate is above the reference point, but to a lesser extent than when the risk-free rate is below the reference point. Hence, our first hypothesis is that risk-seeking is higher when the risk-free rate drops below the target return than when the risk-free rate exceeds the target return. Interestingly, based on Panel B of Table 2, the opposite would be true in the high-target return condition if the reference point is the zero level (i.e., risk-seeking below 6% is lower than above 6%.). Our first formal hypothesis is defined as follows:

H1. The allocation to the risky asset (that is a proxy for risk-seeking) is higher when the risk-free rate drops below the target return than when the risk-free rate exceeds the target return.

Our second hypothesis is driven by loss aversion, i.e., the fact that losses loom larger than gains. Based on the optimal allocations to the risky asset reported in Panel A of Table 2, we expect the increase in the share of funds invested in the risky asset when the risk-free rate implies a given loss (e.g., −2%) to be higher than the increase in the share invested when the risk-free rate implies a gain of similar magnitude (e.g., +2%). Put differently, the fact that the risk-free asset is less attractive when it implies a loss should lead the increase in the amount invested in the risky asset to be larger than the corresponding increase in the amount invested in the risky asset when the risk-free asset implies a gain. Our second formal hypothesis is defined as follows:

H2. The increase in the allocation to the risky asset (that is a proxy for risk-seeking) when the risk-free rate implies a given loss is higher than the increase in that allocation when the risk-free rate implies a gain of similar magnitude.

Our last hypothesis posits that the target return is the prevailing reference point even when the risk-free rate is negative. Looking at optimal allocations in Panel A of Table 2, we need to compare the change in the share of money invested in the risky asset when the risk-free rate drops from 0% to −2% in the low-target return condition with the change in the share of money invested in the risky asset when the risk-free rate drops from 4% to 2% in the high-target return condition. In both situations, the risk-free rate is below the target return, and the distance between the risk-free rate and the target return is the same. If the target return still prevails as the reference point when the risk-free rate drops below zero, participants in both target return conditions should exhibit similar risk-seeking behavior; i.e., the amount invested in the risky asset should increase by the same proportion. Our last formal hypothesis is defined as follows:

H3. The increase in the allocation to the risky asset (that is a proxy for risk-seeking) when the risk-free rate drops from 0% to −2% in the low-target return condition does not significantly differ from the increase in that allocation when the risk-free rate drops from 4% to 2% in the high-target return condition.

5. Results

5.1 Descriptive statistics

We recruited 197 participants [17] via Prolific Academic, which is a crowdsourcing platform for online research. Using the available prescreening options, participants were required to be US citizens whose first language is English and who were between 18 and 65 years old.

Table 3 provides descriptive statistics for the full sample as well as separately for the participants in the high-target return and low-target return conditions. In the full sample, the average age of our participants is 32.41 (with a median of 31). The sample is rather balanced, with 58.88% male (and 41.12% female). About 16% of the participants are students. On average, our participants report that they would set their target return at approximately 15% in reality. The median, however, is much lower at 8%. The average risk tolerance across all participants is approximately 3.22 on a scale ranging from 0 (extremely unlikely to take a risk) to 7 (extremely likely to take a risk) [18]. This indicates that the typical participant is somewhat risk-averse. Interestingly, almost 89% of the participants own an actual deposit account, while almost 65% of them also own an actual portfolio of financial assets.

Table 3.
Descriptive statistics for the sample of participants

Variable	Full sample N = 197 Mean	median	Q1	Q3	High-target return condition N = 100 Mean	median	Q1	Q3	Low-target return condition N = 97 Mean	median	Q1	Q3
Age	32.41	31	25	37	32.35	31	25.5	37.5	32.46	32	24	37
Male (in %)	58.88				56.00				61.86			
Student (in %)	16.24				15.00				17.53			
Target return in reality (%)	15.23	8.00	5.00	15.00	15.36	8.00	6.00	15.00	15.09	6.00	4.00	20.00
Risk tolerance (0–7 scale)	3.22	3.17	2.50	3.83	3.14	3.17	2.50	3.75	3.31	3.17	2.33	3.83
Deposit account owner (in %)	88.83				90.00				87.63			
Owner of financial assets (in %)	64.47				69.00				59.79			

Note(s): This table reports cross-sectional descriptive statistics (mean, median, and lower and upper quartiles) for the participants in the sample. These statistics are computed both across the full sample and within the high-target return and low-target return conditions separately. “Target return in reality” refers to the target return that participants would set if they had an actual portfolio of financial assets. “Risk tolerance” refers to subjective risk-taking preferences as measured by the six questions about gambling and investing from the DOSPERT scale. This measure of risk tolerance is calculated as the average of the scores on these questions on a scale ranging from 0 (extremely unlikely to take a risk) to 7 (extremely likely to take a risk). “Deposit account owner” is a binary variable set to one for participants who currently have or have had in the past money in a savings account. “Owner of financial assets” is another binary variable set to one for participants who currently hold or have held in the past an actual portfolio of financial assets. “N” provides the sample size, i.e. the number of participants
Source(s): Authors’ own creation/work

Since participants are randomly assigned to the high- or low-target return condition, the two subsamples are overall similar in terms of age, gender and status. Notably, however, the high-target return condition counts slightly less males (56%) than the low-target return condition (61.86%). Participants in the high-target return condition declare on average a higher actual target return (15.36 versus 15.09%). Nevertheless, our manipulation did not really lead to some anchoring since this difference is not statistically significant [19]. For risk tolerance, the average score is somewhat lower in the high-target return condition (3.14 versus 3.31), [20] while the medians are identical (3.17). On average, 90% (87.63%) of participants in the high- (low-) target return condition own a real deposit account. More than half of the participants in both conditions (69% in the high-target return condition and 59.79% in the low-target return condition) actually invest in financial assets.

As expected, participants in the low-target return condition invest on average more in the risky asset (55.82%) than participants in the high-target-return condition (47.45%). Table 4 provides further information on the average share of money allocated to the risky asset depending on the risk-free rate in each condition. In the high-target return condition, the average share invested in the risky asset ranges from 39.95% when the risk-free rate is equal to 10% to 57.30% when the risk-free rate is set at 2%. The average shares range across somewhat higher values in the low-target return condition, in which the highest average share allocated to the risky asset is 69.25% when the risk-free rate is negative (−2%), while the lowest average share is 45.46% when the risk-free rate is set to 6%. The average allocation to the risky asset does not increase monotonically as the risk-free rate decreases, though an upward trend is noticeable in both conditions. The corresponding median allocations (reported in brackets) exhibit somewhat similar patterns [21].

Unsurprisingly, the actual average risky allocations in Table 4 do not exactly correspond to the optimal allocations reported in Table 2, whatever the reference point. At first glance, we notice that the actual average allocations to the risky asset exhibit an upward trend as the risk-free rate decreases.

5.2 Univariate testing of our hypotheses

Our first hypothesis postulates that risk-seeking is higher when the risk-free rate drops below the target return than when the risk-free rate exceeds the target return. Accordingly, participants in both conditions are expected to invest significantly more in the risky asset when the risk-free rate falls short of their target return than when the risk-free rate exceeds it. To test this hypothesis, we conduct two-sided paired t-tests to compare the means of the share of money allocated to the risky asset when the risk-free rate is both 2 and 4% below and above the target return. We report the results in Table 5; in Panel A, the risk-free rate is set at 2% below and above the target return, and in Panel B, the risk-free rate is set at 4% below and above the target return. All the findings confirm our first hypothesis: participants in both conditions invest significantly more in the risky asset when the risk-free rate is below their target return than when it is above. When the risk-free rate is 2% below the target return, participants in the high- (low-) target return condition invest on average 14.70% (14.43%)

	Risk-free rate						
Condition	−2%	0%	2%	4%	6%	8%	10%
High-target return			57.30 (60.00)	55.00 (50.00)	44.70 (40.00)	40.30 (40.00)	39.95 (42.50)
Low-target return	69.25 (75.00)	65.49 (75.00)	47.86 (50.00)	51.06 (50.00)	45.46 (50.00)		

Note(s): This table presents the average share of money allocated to the risky asset (i.e. the stock index fund with a constant risk premium of 3%) for each risk-free rate in the high-target return condition and low-target return condition. The corresponding medians are provided in brackets
Source(s): Authors' own creation/work

Table 4. Allocations to the risky asset (in %)

	High-target return condition	Low-target return condition
Panel A: 2% above and 2% below		
R_F is 2% below	55.00	65.49
R_F is 2% above	40.30	51.06
Difference	14.70*** (<0.0001)	14.43*** (0.0003)
N	100	97
Panel B: 4% above and 4% below		
R_F is 4% below	57.30	69.25
R_F is 4% above	39.95	45.46
Difference	17.35*** (<0.0001)	23.79*** (<0.0001)
N	100	97

Note(s): This table reports the average share of money invested in the risky asset (expressed in %) when the risk-free rate (R_F) is above or below the target return, the differences between these average shares, and the corresponding level of significance from two-sided paired t-tests. Panel A presents the results for situations in which the risk-free rate is 2% above or below the target return, while Panel B presents the results for situations in which the risk-free rate is 4% above or below the target return. *$p < 0.05$; **$p < 0.01$; ***$p < 0.001$. N provides the sample size, i.e. the number of participants, and p-values are reported in brackets
Source(s): Authors' own creation/work

Table 5. Risk-taking when the risk-free rate is above/below the target return

more in the risky asset than when the risk-free rate is 2% above the target return. These differences are stronger when the risk-free rate is 4% below the target return, i.e., 17.35% (23.79%) in the high- (low-) target return condition [22].

Our second hypothesis is related to loss aversion. To test it, we need to consider the variation in risk-taking (instead of raw allocations to the risky asset). In our particular setting, the increase in the share of funds invested in the risky asset when the risk-free rate implies a given loss (e.g., −2%) is expected to be higher than the increase in the share invested when the risk-free rate implies a gain of similar magnitude (e.g., +2%), as shown by the changes in optimal allocations in Table 2. Practically, this hypothesis can be tested in two situations: when the risk-free rate shifts near the target return (± 2%) and when it shifts far from the target return (± 4%). Table 6 reports the results of two-sided paired t-tests to compare the means of the variations in the allocation to the risky asset when the risk-free rate moves below or above the target return. We find significant evidence of loss aversion in both conditions. In Panel A, when the risk-free rate drops 2% below the target return, participants in the low-target return condition increase their allocation to the risky asset by 17.63% on average, while they increase their allocation to the risk asset by only 3.20% on average when an equivalent shift in the risk-free rate occurs above the target return. The difference in these average variations in risk-taking (14.43%) is highly significant. The findings are similar for the high-target return condition; i.e., a shift in the risk-free rate near the target return leads to higher variation in the share of money allocated to the risky asset when that shift occurs below the target return than when it happens above the target return (in the latter case, the average variation is even negative, meaning that participants decreased their risk-taking) [23]. We also find significant differences in the average variation in the allocation to the risky asset between when the risk-free rate drops 4% below the target return and when it rises 4% above the target return (see Panel B) [24]. Our second hypothesis is therefore validated.

Our last hypothesis assumes that the prevailing reference point is the target return rather than the zero-threshold. To test this conjecture, we need to compare the variation in the share of money invested in the risky asset when the risk-free rate drops from 0% to −2% in the low-target return condition with the variation in the share of money invested in the risky asset

	High-target return condition	Low-target return condition
Panel A: Shift near the target return (± 2%)		
Δ2% below	10.30	17.63
Δ2% above	−4.40	3.20
Difference	14.70*** (<0.0001)	14.43*** (0.0003)
N	100	97
Panel B: Shift far from the target return (± 4%)		
Δ4% below	12.60	21.39
Δ4% above	−4.75	−2.40
Difference	17.35*** (<0.0001)	23.79*** (<0.0001)
N	100	97

Note(s): This table reports the average variations in the allocation to the risky asset (expressed in %) when the risk-rate moves to a point either near (± 2%) or far from (± 4%) the target return, the differences between these average variations, and the corresponding level of significance from two-sided paired t-tests. Panel A presents the results for situations in which the risk-free rate shifts by 2% (near the target return), while Panel B presents the results for situations in which the risk-free rate shifts by 4% (far from the target return). *$p < 0.05$; **$p < 0.01$; ***$p < 0.001$. N provides the sample size, i.e. the number of participants, and p-values are reported in brackets
Source(s): Authors' own creation/work

Table 6.
Variation in risk-taking demonstrating loss aversion

when the risk-free rate drops from 4% to 2% in the high-target return condition. Since the risk-free rate is below the target return and the distance between the risk-free rate and the target return is the same in both conditions, the participants should exhibit similar risk-seeking behavior if the target return still prevails as the reference point when the risk-free rate drops below zero. This means that the amount invested in the risky asset should increase by the same proportion in both conditions. Table 7 reports the results of a two-sample *t*-test addressing the difference in the average variations in risk-taking between the high- and low-target return conditions. This difference in means is positive (1.46%) but insignificant at any conventional level. This indicates that the average marginal increase in risk-taking is similar in both conditions, which supports our last hypothesis. The target return still acts as the prevailing reference point for the participants who face a negative risk-free rate. Having the risk-free rate cross the zero lower bound does not particularly affect their risk-taking; they continue to adjust their allocation to the risky asset based on the distance to their target return. We conclude that the movement of the risk-free rate into negative territory does not activate any additional (i.e., extra) risk-taking.

5.3 Multivariate analysis

To further investigate the impact of the target return on risk-taking behavior, we estimate a fractional logit model in which the dependent variable, $Risk\ taking_{i,d}$, is the share of money invested in the stock index fund by participant *i* for decision *d* [25]. The set of explanatory variables includes both individual-level variables and decision-level variables.

The individual-level variables include some sociodemographic characteristics as typical control variables (age, gender and student status) and the additional individual characteristics collected at the end of the experiment. For gender, we use a binary variable ($Male_i$) set to one for males. We also use a binary variable for student status ($Student_i$) that is set to one for participants who are students (and zero otherwise). Risk tolerance ($Risk\ tol_i$) is the participant's average score on the answers to the six questions taken from the DOSPERT scale, which ranges from 0 (extremely unlikely to take a risk) to 7 (extremely likely to take a risk). We use binary variables to characterize participants who own an actual deposit account ($Dep\ acc_i$ is set to one) and an actual portfolio of financial assets ($Stocks_i$ is set to one). To control for the condition to which the participant is assigned, we add another binary variable ($Low\ cond_i$) set to one for participants in the low-target return condition.

The decision-level variables are meant to capture the possible levels of the risk-free rate. We consider the base case to be when the risk-free rate matches the target return, i.e., 6% (2%) in the high- (low-) target return condition. Hence, $Below\ target_{i,d}$ is a binary variable set to one when the risk-free rate is below the target return. Similarly, $Above\ target_{i,d}$ is another binary variable set to one when the risk-free rate is above the target return. This leads to the following baseline model:

Δ when R_F moves from 0% to −2% (N = 97)	3.76
Δ when R_F moves from 4% to 2% (N = 100)	2.30
Difference	1.46
	(0.7604)

Note(s): This table reports the average variation in the allocation to the risky asset (expressed in %) when the risk-free rate moves from 0% to −2% in the low-target return condition and from 4% to 2% in the high-target return condition, the difference between these average variations, and the corresponding level of significance from a two-sample *t*-test. *p < 0.05; **p < 0.01;
***p < 0.001. N provides the sample size, i.e. the number of participants, and p-values are reported in brackets
Source(s): Authors' own creation/work

Table 7. Variation in risk-taking and NIRs

$$Risk\ taking_{i,d} = \beta_0 + \beta_1 Low\ cond_i + \beta_2 Age_i + \beta_3 Male_i + \beta_4 Student_i + \beta_5 Risk\ tol_i + \beta_6 Dep\ acc_i + \beta_7 Stocks_i + \beta_8 Below\ target_{i,d} + \beta_9 Above\ target_{i,d} + \varepsilon_{i,d} \quad (1)$$

We also estimate an alternative to the baseline model in which we split the two decision-level variables into the four following dummies: $Below\ 4\%_{i,d}$, $Below\ 2\%_{i,d}$, $Above\ 2\%_{i,d}$ and $Above\ 4\%_{i,d}$, which are set to one when the risk-free rate is 4% below, 2% below, 2% above and 4% above the target return, respectively. The resulting model is as follows:

$$Risk\ taking_{i,d} = \beta_0 + \beta_1 Low\ cond_i + \beta_2 Age_i + \beta_3 Male_i + \beta_4 Student_i + \beta_5 Risk\ tol_i + \beta_6 Dep\ acc_i + \beta_7 Stocks_i + \beta_8 Below\ 4\%_{i,d} + \beta_9 Below\ 2\%_{i,d} + \beta_{10} Above\ 2\%_{i,d} + \beta_{11} Above\ 4\%_{i,d} + \varepsilon_{i,d} \quad (2)$$

Since both fractional logit models involve panel data (i.e., each participant makes five independent investment decisions), we cluster the standard errors at the participant level (Petersen, 2009). We present the results in Table 8; Model 1 corresponds to our baseline model (Eq. 1), Model 2 corresponds to the alternative (Eq. 2) and Model 3 is an extension of Model 2 with an interaction variable ($Low\ cond_i$*$Below\ 4\%_{i,d}$) that indicates situations in which the participants in the low-target return condition face an NIR.

Looking at the decision-level variables in our baseline model (Model 1), the expected risk-seeking behaviors emerge. When the risk-free rate is below the target return, participants' risk-taking significantly increases compared to that in situations in which the risk-free rate just matches the target return. This increase is also economically significant since the allocation to the risky asset is higher by a factor of 1.883 when the risk-free rate is below the target return, as indicated by the odds ratio [26]. By contrast, when the risk-free rate is above the target return, the coefficient estimate is negative but not significant, which does not provide evidence of a real change in risk-taking. Next, the coefficient estimate for the condition variable is positive and strongly significant. This means that participants do not exhibit similar risk-taking behavior in both conditions. Specifically, the low-target return condition induces significantly higher risk-taking *per se*, i.e., the allocation to the risky asset is higher by a factor of 1.413 in the low-target return condition.

Most of the individual-level variables in our baseline model (Model 1) exhibit coefficient estimates that are not statistically significant. Only two of them display a significant coefficient estimate ($p < 0.05$). The first variable is gender, for which the coefficient estimate is positive, meaning that allocations to the risky asset are higher among men. All else equal, when the participant is a male, the allocation to the stock index fund is multiplied by a factor of 1.222. In the literature, gender is recognized as one of the major drivers of financial decision-making and empirical evidence point to men taking more risk than women, notably because of overconfidence (e.g., Barber and Odean, 2001). The second variable with a negative coefficient estimate ($p < 0.05$) is the dummy capturing whether participants are students. The latter appear to actually take on less risk than other participants, i.e., the allocation to the stock index fund is multiplied by a factor of 0.776 when participants are students. All the other individual-level variables (age, risk tolerance, deposit account ownership and financial asset ownership) do not help explain the heterogeneity in risk-taking across participants [27].

The results of our alternative model (Model 2) are totally consistent with those of the baseline model (Model 1). Focusing on the four dummies related to the distance between the risk-free rate and the target return, we find that risk-seeking behaviors are observable when the risk-free rate is below the target return. Specifically, when the risk-free rate is 4% below the target return, participants invest more in the stock index fund by a factor of 2.010 than

Parameter	Model 1 Estimate	OR	Model 2 Estimate	OR	Model 3 Estimate	OR
Intercept	−0.170		−0.170		−0.150	
Low cond	0.346***	1.413	0.346***	1.413	0.306***	1.357
Age	−0.003	0.997	−0.003	0.997	−0.003	0.997
Male	0.201*	1.222	0.201*	1.222	0.201*	1.222
Student	−0.254*	0.776	−0.254*	0.776	−0.254*	0.776
Risk tol	−0.035	0.966	−0.035	0.966	−0.035	0.966
Dep acc	−0.021	0.979	−0.021	0.979	−0.021	0.980
Stocks	−0.020	0.981	−0.020	0.981	−0.020	0.981
Below target	0.633***	1.883				
Above target	−0.087	0.917				
Below 4%			0.698***	2.010	0.598***	1.819
Below 2%			0.569***	1.766	0.568***	1.765
Above 2%			−0.027	0.973	−0.027	0.974
Above 4%			−0.147	0.863	−0.147	0.863
Low cond.*Below 4%					0.213	1.237
N	985		985		985	

Note(s): This table reports the results of three fractional logit models in which the dependent variable, *Risk* $taking_{i,d}$, is the share of money invested in the stock index fund by participant *i* in decision *d*. The individual-level variables include sociodemographic characteristics as usual control variables and additional individual characteristics. *Male* is a binary variable set to one for males. *Student* is a binary variable set to one for participants who are students. *Risk tol* refers to the participant's average score on the answers to six questions taken from the DOSPERT scale, which ranges from 0 (extremely unlikely to take a risk) to 7 (extremely likely to take a risk). *Dep_acc* and *Stocks* are binary variables set to one for participants who own an actual deposit account and an actual portfolio of financial assets, respectively. *Low cond* is another binary variable set to one for participants in the low-target return condition. Among the decision-level variables in Model 1, *Below target* is a binary variable set to one when the risk-free rate falls short of the target return, while *Above target* is another binary variable set to one when the risk-free rate is above the target return. As alternatives in Model 2, the four following dummies are used: *Below* 4%, *Below* 2%, *Above* 2% and *Above* 4%, which are set to one when the risk-free rate is 4% below, 2% below, 2% above and 4% above the target return, respectively. In Model 3, *Low cond.***Below* 4% is an interaction term that refers to situations in which the participants in the low-target return condition face an NIR. OR refers to odds ratios. N is the number of observations (i.e. decisions). Standard errors are clustered at the participant level. $*p < 0.05$; $**p < 0.01$; $***p < 0.001$
Source(s): Authors' own creation/work

Table 8. Fractional logit regressions for risk-taking behavior

when the risk-free rate just matches the target return. Similarly, when the risk-free rate is 2% below the target return, allocations to the risky asset increase by a factor of 1.766. These results are both statistically and economically significant. All the other variables in Model 2 display coefficient estimates that are similar to those in Model 1.

The main point of interest in the third model (Model 3) in Table 8 is the inclusion of an interaction term (*Low cond***Below* 4%) that indicates situations in which participants in the low-target return condition face an NIR. The coefficient estimate for this interaction term is positive but not statistically significant. This confirms that the zero-threshold does not take over the role of reference point when the risk-free rate becomes negative. It is the target return that still plays this crucial role and drives risk-taking behaviors.

6. Follow-up study

One shortcoming of our approach is related to how we manipulate the between-subjects factor; i.e., we assign specific target returns to participants. In other words, the target return is exogenously determined. In reality, people are not assigned an explicit target return; they are rather asked to declare their target return, either to their financial intermediary or in any risk-return profile survey like investment policy statements (IPSs) [28]. To further investigate the role of target returns in risk-taking, an examination of how individuals make investment decisions while setting their own target returns is relevant. A follow-up study is therefore conducted to check whether an endogenous target return is as important as an exogenous one in driving risk-taking.

Theoretically, our hypotheses (see Section 4.2) are still fully valid. An endogenous target return is expected to be a better candidate for the reference point because of both increased commitment and decreased cognitive dissonance. On the one hand, when individuals determine their target return themselves, they decide and act. This mix of decision-action is likely to increase their commitment to the task, which, in turn, might exacerbate the goal-setting effects (i.e., their intrinsic motivation might become higher). On the other hand, when choosing their target return, participants are less subject to cognitive dissonance [29] that can arise when the exogenous target return is (very) different from the target return they have in mind (i.e., their own target return).

6.1 Experimental setting

The experimental setting of the follow-up study is similar to the one described in Section 3, except for the following aspects. First, before starting to make their investment decisions, participants are asked to select their target return within a list of five available rates: 0%, 2%, 4%, 6% and 8%. Using this predefined set of possible target returns allows us to apply the same methodology as in the previous experiment and provide comparable results across experiments, which is crucial to control for identical shifts of $\pm$ 2% and $\pm$ 4% of the risk-free rate from the target return. This implies that (1) the risk-free asset can range from -4% to 12% and (2) the corresponding distributions of returns for the stock index fund are adjusted keeping constant both the risk premium at 3% and the standard deviation at 6.67%. Put differently, the follow-up study makes participants select their target return among the predefined set of five available rates. Figure A6 in Appendix 6 provides a screenshot of the introductory instructions given to participants. They explicitly mention that the target return is unique and applies to each investment decision. Once selected, the target return is reminded in the following instructions (see Figure A7 in Appendix 6) as well as before each investment decision, as in the previous experiment.

Second, the initial endowment for each investment decision is equal to 40 ECU, regardless of the selected target return. Beyond simplification, using an identical amount of money for every participant to allocate between the risk-free asset and the stock index fund rules out any potential house money effects (e.g., Ackert *et al.*, 2006) that might have impacted risk-taking in the previous experiment, especially among participants in the high-target return condition.

Third, the incentive mechanism is slightly modified. In the previous experiment, the reward system includes a premium based on the average performance across the five decisions made by participants. Since the participant's payoff is related to all his/her decisions, these decisions are not strictly independent. This indirect dependence might induce potential portfolio or diversification effects (e.g., Cox *et al.*, 2015; Ackert *et al.*, 2016). To rule out these effects in the follow-up study, the incentive mechanism relies on a fixed payout of $1.50 plus a premium that only depends on the performance achieved at one investment decision randomly selected across the five decisions. Specifically, the premium is equal to the realized return earned at the randomly selected investment decision multiplied by 16 ECU (40 ECU $\times$ 0.4) [30]. In case the realized return is negative, the premium is set to zero.

6.2 Results

We recruited 209 participants on Prolific Academic, [31] applying the same prescreening options as the ones used in the previous experiment (see Section 5.1). Table 9 provides

Variable	Mean	Full sample N = 209 Median	Q1	Q3
Age	36.52	35	27	43
Male (in %)	51.20			
Student (in %)	13.88			
Target return in reality (%)	8.40	6.00	5.00	8.00
Risk tolerance (0–7 scale)	2.71	2.67	2.17	3.17
Deposit account owner (in %)	91.87			
Owner of financial assets (in %)	71.29			

Note(s): This table reports cross-sectional descriptive statistics (mean, median, and lower and upper quartiles) for the participants who took part in the follow-up study. "Target return in reality" refers to the target return that participants would set if they had an actual portfolio of financial assets. "Risk tolerance" refers to subjective risk-taking preferences as measured by the six questions about gambling and investing from the DOSPERT scale. This measure of risk tolerance is calculated as the average of the scores on these questions on a scale ranging from 0 (extremely unlikely to take a risk) to 7 (extremely likely to take a risk). "Deposit account owner" is a binary variable set to one for participants who currently have or have had in the past money in a savings account. "Owner of financial assets" is another binary variable set to one for participants who currently hold or have held in the past an actual portfolio of financial assets. "N" provides the sample size, i.e. the number of participants. Note that Age is missing for four participants
Source(s): Authors' own creation/work

Table 9. Descriptive statistics for the sample of participants

descriptive statistics for the full sample. The average age of the participants is 36.52 (with a median of 35). The sample is well-balanced, with 51.20% male. About 13.88% of the participants are students. On average, the participants report that they would set their target return at approximately 8% in reality. The median is somewhat lower at 6%. The average risk tolerance across participants is approximately 2.71 on the DOSPERT scale, indicating that the typical participant is rather risk-averse. Almost 92% of the participants own an actual deposit account and 71% of them also own an actual portfolio of financial assets. Compared to the sample of the previous experiment, only minor differences are noticeable.

Only a minority of participants (21 out of 209) selected the lowest target returns (i.e., 0% or 2%), 75 participants opted for 4% and 113 participants chose the highest returns (i.e., 6% or 8%). Table 10 reports the average share of money allocated to the risky asset depending on both the risk-free rate and the target return. As expected, the average allocation to the risky asset increases as the risk-free rate decreases, regardless of the target return. This upward trend is also noticeable in the corresponding median allocations. The only exception is the participant who set his/her target return to 0% and kept his/her allocation to the risky asset constant at 50%. In line with the previous experiment, the average risky allocations in Table 10 do not exactly correspond to the optimal allocations based on CPT values (see Table 2), but they obviously display consistent patterns.

Table 11 provides the univariate results for our first hypothesis postulating that risk-seeking is higher when the risk-free rate drops below the target return than when the risk-free rate exceeds the target return. These findings confirm that participants invest significantly more in the risky asset when the risk-free rate is below their target return than when it is above. When the risk-free rate is 2% (4%) below the target return, participants invest on average 16.60% (25.59%) more in the risky asset than when the risk-free rate is 2% (4%) above the target return.

Regarding our second hypothesis, Table 12 reports univariate results showing significant evidence of loss aversion. When the risk-free rate drops 2% below the target return, participants increase their allocation to the risky asset by 14.38% on average, while they

Target return	−4%	−2%	0%	Risk-free rate 2%	4%	6%	8%	10%	12%
0% (N = 1)	50.00	50.00	50.00	50.00	50.00				
	(50.00)	(50.00)	(50.00)	(50.00)	(50.00)				
2% (N = 20)		64.38	60.00	40.50	30.25	37.50			
		(75.00)	(62.50)	(50.00)	(31.25)	(37.50)			
4% (N = 75)			60.13	51.27	38.10	36.40	33.63		
			(62.50)	(50.00)	(25.00)	(25.00)	(25.00)		
6% (N = 54)				63.70	57.78	41.39	40.56	39.26	
				(66.25)	(62.50)	(37.50)	(37.50)	(25.00)	
8% (N = 59)					65.51	61.31	48.73	47.25	40.04
					(75.00)	(65.00)	(50.00)	(50.00)	(25.00)

Note(s): This table presents the average share of money allocated to the risky asset (i.e. the stock index fund with a constant risk premium of 3%) for each risk-free rate depending on the target return selected by participants. The corresponding medians are provided in brackets. N refers to the number of participants who selected the corresponding target return
Source(s): Authors' own creation/work

Table 10.
Allocations to the risky asset (in %)

Full sample	
Panel A: 2% above and 2% below	
R_F is 2% below	56.61
R_F is 2% above	40.01
Difference	16.60*** (<0.0001)
N	209
Panel B: 4% above and 4% below	
R_F is 4% below	62.93
R_F is 4% above	37.34
Difference	25.59*** (<0.0001)
N	209

Note(s): This table reports the average share of money invested in the risky asset (expressed in %) when the risk-free rate (R_F) is above or below the target return, the differences between these average shares, and the corresponding level of significance from two-sided paired t-tests. Panel A presents the results for situations in which the risk-free rate is 2% above or below the target return, while Panel B presents the results for situations in which the risk-free rate is 4% above or below the target return. *$p < 0.05$; **$p < 0.01$; ***$p < 0.001$. N provides the sample size, i.e. the number of participants, and p-values are reported in brackets
Source(s): Authors' own creation/work

Table 11.
Risk-taking when the risk-free rate is above/below the target return

decrease their allocation to the risk asset by 2.22% on average when an equivalent shift in the risk-free rate occurs above the target return. The difference in these average variations in risk-taking (16.60%) is highly significant. The findings are similar when the risk-free rate drops 4% below the target return and when it rises 4% above the target return. In that case, the difference in the average variations in risk-taking is even bigger (25.59%). Consistent with the previous experiment, our second hypothesis is validated.

To test our third hypothesis assuming that the prevailing reference point is the target return rather than the zero-threshold, we need to compare the variation in the share of money invested in the risky asset when the risk-free rate drops from 0% to −2% for participants who selected a target return of 2% with the variation in the share of money invested in the risky asset when the risk-free rate drops similarly for participants who opted for a higher

Full sample	
Panel A: Shift near the target return (± 2%)	
Δ2% below	14.38
Δ2% above	−2.22
Difference	16.60*** (<0.0001)
N	209
Panel B: Shift far from the target return (± 4%)	
Δ4% below	20.69
Δ4% above	−4.89
Difference	25.59*** (<0.0001)
N	209

Note(s): This table reports the average variations in the allocation to the risky asset (expressed in %) when the risk-free rate moves to a point either near (± 2%) or far from (± 4%) the target return, the differences between these average variations, and the corresponding level of significance from two-sided paired t-tests. Panel A presents the results for situations in which the risk-free rate shifts by 2% (near the target return), while Panel B presents the results for situations in which the risk-free rate shifts by 4% (far from the target return). $*p < 0.05$; $**p < 0.01$; $***p < 0.001$. N provides the sample size, i.e. the number of participants, and p-values are reported in brackets
Source(s): Authors' own creation/work

Table 12. Variation in risk-taking demonstrating loss aversion

target return (i.e., 4%, 6% or 8%). Table 13 reports the results of a two-sample t-test addressing the aforementioned comparison. The mean difference is positive (2.18%) but insignificant at any conventional level. Since the sample size is small for participants who had the risk-free rate crossing the zero lower bound ($N = 20$), [32] this result should be taken with a pinch of salt.

To examine the impact of the endogenous target return on risk-taking behavior in a multivariate approach, we estimate the fractional logit models used in Section 5.3. The only change we made in the three models is removing the binary variable $Low\ cond_i$ since participants are not assigned a low- or high-target return condition in the follow-up study [33]. In addition, in Model 3, we replace the interaction variable ($Low\ cond_i{*}Below\ 4\%_{i,d}$) with a binary variable ($NIR_{i,d}$) that indicates situations in which participants face an NIR. The results, reported in Table 14, are fully consistent with the findings of the experiment using exogenous target returns for our variables of interest (i.e., the decision-level variables) [34]. When the risk-free rate is below the target return, participants' risk-taking significantly increases compared to that in situations in which the risk-free rate just matches the target return. This increase is again economically significant since the allocation to the risky asset is higher by a factor of 2.075 (see Model 1) when the risk-free rate is below the target return. This factor is even somewhat higher than the corresponding factor found for the exogenous target

Δ when R_F moves from 0% to −2% ($N = 20$)	4.37
Δ when R_F moves from 2% to 0% or 4% to 2% or 6% to 4% ($N = 188$)	6.56
Difference	2.18 (0.7780)

Note(s): This table reports the average variation in the allocation to the risky asset (expressed in %) when the risk-free rate moves from 0% to −2% for participants who selected 2% as target return and from 2% to 0% (4%–2% or 6%–4%) for participants who selected 4% (6% or 8%) as target return. The difference between these average variations and the corresponding level of significance from a two-sample t-test are also reported. $*p < 0.05$; $**p < 0.01$; $***p < 0.001$. N provides the sample size, i.e. the number of participants, and p-values are reported in brackets
Source(s): Authors' own creation/work

Table 13. Variation in risk-taking and NIRs

Parameter	Model 1 Estimate	Model 1 OR	Model 2 Estimate	Model 2 OR	Model 3 Estimate	Model 3 OR
Intercept	−0.496		−0.496		−0.504	
Age	−0.003	0.997	−0.003	0.997	−0.003	0.997
Male	0.167	1.182	0.168	1.183	0.171	1.186
Student	0.059	1.061	0.059	1.061	0.057	1.059
Risk tol	0.041	1.042	0.041	1.042	0.039	1.040
Dep acc	−0.015	0.985	−0.015	0.985	−0.012	0.988
Stocks	0.126	1.134	0.126	1.135	0.133	1.142
Below target	0.730***	2.075				
Above target	−0.149	0.862				
Below 4%			0.874***	2.396	0.855***	2.352
Below 2%			0.591***	1.805	0.590***	1.803
Above 2%			−0.099	0.906	−0.099	0.906
Above 4%			−0.199*	0.820	−0.199*	0.820
NIR (=1)					0.193	1.213
N	1,025		1,025		1,025	

Note(s): This table reports the results of three fractional logit models in which the dependent variable, *Risk* $taking_{i,d}$, is the share of money invested in the stock index fund by participant *i* in decision *d*. The individual-level variables include sociodemographic characteristics as usual control variables and additional individual characteristics. *Male* is a binary variable set to one for males. *Student* is a binary variable set to one for participants who are students. *Risk tol* refers to the participant's average score on the answers to six questions taken from the DOSPERT scale, which ranges from 0 (extremely unlikely to take a risk) to 7 (extremely likely to take a risk). *Dep_acc* and *Stocks* are binary variables set to one for participants who own an actual deposit account and an actual portfolio of financial assets, respectively. Among the decision-level variables in Model 1, *Below target* is a binary variable set to one when the risk-free rate falls short of the target return, while *Above target* is another binary variable set to one when the risk-free rate is above the target return. As alternatives in Model 2, the four following dummies are used: *Below* 4%, *Below* 2%, *Above* 2% and *Above* 4%, which are set to one when the risk-free rate is 4% below, 2% below, 2% above and 4% above the target return, respectively. In Model 3, *NIR* is a binary variable set to one when participants face an NIR. OR refers to odds ratios. N is the number of observations (i.e. decisions). Standard errors are clustered at the participant level. $*p < 0.05$; $**p < 0.01$; $***p < 0.001$. Note that four participants (i.e. 20 decisions) were disregarded because of missing data about age
Source(s): Authors' own creation/work

Table 14. Fractional logit regressions for risk-taking behavior

return in Table 8 (i.e., 1.883). By contrast, when the risk-free rate is above the target return, the coefficient estimate is negative but not significant.

In Model 2 of Table 14, risk-seeking behaviors are confirmed when the risk-free rate is below the target return. When the risk-free rate is 4% below the target return, participants invest more in the stock index fund by a factor of 2.396 than when the risk-free rate just matches the target return. Similarly, when the risk-free rate is 2% below the target return, allocations to the risky asset increase by a factor of 1.805. These results suggest again a stronger impact of the endogenous target return, compared to the corresponding results reported in Table 8 for the exogenous target return.

Despite the small number of participants who faced an NIR in the follow-up study, we estimate the third model using the aforementioned binary variable $NIR_{i,d}$. Its coefficient estimate is positive but not statistically significant (see Model 3 in Table 14). Such a result indicates that the endogenous target return still plays the crucial role of reference point and drives risk-taking behaviors.

6.3 Robustness check

Since participants are informed about their realized performance after each investment decision, the above results might show path dependency. Indeed, a string of low past returns for the stock index fund might incline participants to lower their return expectations for the risky asset in the next decision. Moreover, the participant's reference point itself might also be influenced by past outcomes (e.g., Baucells *et al.*, 2011; Riley *et al.*, 2020). Recalling participants their target return before each investment decision as we did (see Figure A7 in Appendix 6) could not be enough. Consequently, another experiment is conducted as a robustness check.

This third experiment relies on the experimental setting described in Section 6.1. The only difference is that participants are not informed about their realized performance after each investment decision. Instead, they receive the detailed information about their realized returns at each round and their overall performance after the fifth investment decision. This modification allows to rule out the potential path dependency issue.

We recruited 100 individuals from Prolific Academic to participate in this robustness study, using again identical prescreening options (see Section 5.1). Descriptive statistics for this sample and all the results are provided in Appendix 7. Since these findings are fully consistent with those reported for the follow-up study, we conclude that path dependency does not drive our results.

7. Conclusion

This paper adds to the literature on what stimulates the appetites of individuals for risk when making investment decisions. The novelty in our approach is the introduction of a variable of particular interest in such decisions, that is, the target return. Unlike past research that has, by default, considered the zero-threshold to be the reference point (e.g., Bracha, 2020; Ganzach and Wohl, 2018; Lian *et al.*, 2018; Baars *et al.*, 2020; David-Pur *et al.*, 2020), we run an experiment in which explicit target returns are randomly assigned to participants. Building on Heath *et al.* (1999) and Larrick *et al.* (2009), who postulate that goals incorporate the three main principles of prospect theory (i.e., the use of a reference point, loss aversion and diminishing sensitivity), we posit that target returns act as goals that alter the psychological value of outcomes and impact appetites for risk. Specifically, we first check whether the target return acts as a reference point and meaningfully impacts the risk-taking behavior of participants when they make investment decisions. Second, we determine whether it is the target return or the zero interest rate that acts as the prevailing reference point when the risk-free rate drops below zero. Our custom experiment incorporates a mixed design with one between factor – the target return condition (high versus low) – and two within factors – the interest rate on a deposit account (i.e., the risk-free rate) and a stock index fund return (i.e., the risky asset return with a constant risk premium of 3%).

Our original approach provides insightful results about the "reach for yield" among individuals. Overall, our findings confirm that participants use the target return as their reference point when making investment decisions. This holds regardless of the level of the target return, that is, in both the high- and low-target return conditions. First, participants invest more in the stock index fund when the risk-free interest rate is below their target return than when it is above their target return. Second, consistent with loss aversion, participant reactions to the risk-free rate falling below their target return (i.e., an increase in risk-taking) exceed the corresponding reactions to the risk-free rate rising above their target return.

Our results for the specific case in which the risk-free rate drops below zero in the low-target return condition provide new insights. Comparing the average increase in risk-taking for similar shifts in the risk-free rate in both conditions (i.e., from 0% to −2% in the low-target return condition and from 4% to 2% in the high-target-return condition), we find no significant difference. This indicates that the target return still acts as the prevailing reference point for our participants when they face a negative risk-free rate. Having the risk-free rate drop below zero does not particularly affect risk-taking behaviors when people have an explicit target return (that differs from zero); people continue to adjust their allocations to the risky asset based on the distance to their target return. Hence, a shift of the risk-free rate into negative territory does not activate any additional (i.e., extra) risk-taking.

Our additional findings from fractional logit models provide evidence for expected risk-seeking behaviors when the risk-free rate is below the target return. Controlling for the level of the target return, when the risk-free rate is 2% (4%) below the target return, participant allocations to the risky asset are multiplied by a factor of 1.766 (2.010). Such increases in risk-taking are both statistically and economically significant. Furthermore, for situations in which participants in the low-target return condition face a negative risk-free rate, our multivariate results confirm that the target return is still the prevailing reference point and, therefore, the main driver of risk-taking behavior.

Since in reality individual target returns are not exogenously determined as in our experimental design, we examine in a follow-up study how individuals make investment decisions while setting their own target returns. All the findings of this follow-up study confirm that the target return serves as a reference point and meaningfully impacts risk-taking behaviors.

Target returns, regardless of whether they are exogenously or endogenously determined, act as goals that alter the psychological value of outcomes and impact appetites for risk. This means that the zero-threshold does not act as the reference point when an explicit target return is set for investment decisions, which provides useful insights for both monetary policymakers and practitioners in the financial industry. Indeed, these results reveal that NIRs are limited as a tool to stimulate appetites for risk since the risk-taking behavior of individuals is mostly driven by their target returns when making investment decisions. Hence, if their target return differs from zero (which is highly plausible), these investors are expected to increase their risk-taking under NIRs, but only marginally. The higher the target return is, the smaller the marginal increase in risk-taking is likely to be when the risk-free rate is negative (since the shift in the risk-free rate happens far from the reference point). In other words, the investors who are expected to increase their risk-taking the most are those who have low target returns (i.e., target returns close to zero). The limitations of an NIR as an extra boost to risk-taking are particularly relevant among European Union member states where the Markets in Financial Instruments Directive (MiFID) [35] mandates a suitability assessment [36], which is a kind of regulated IPS in which each retail client is asked to declare his/her return objective (i.e., make his/her target return explicit) before investing.

Our experimental findings, as ecologically valid as they may be, do not fully reflect the dynamics and complexity of the investment decisions people make in reality. A first potential limitation of our experiments is that the standard deviation of the stock index fund returns (set at 6.67%) is well below that of the real market. It could be relevant to replicate our experiments using a larger variance for the risky asset returns. A second limitation is that we do not allow participants to update their target return at each round in the follow-up study. Replicating this experiment with that flexibility might provide insights into whether and how participants are influenced by past outcomes when selecting their target return. Such an approach could also contribute to the debate about the role of expectations in the formation of reference points (e.g., Hack and Von Bieberstein, 2015; Baillon *et al.*, 2020). Another limitation of our experiments is that leverage is not allowed, meaning that participants cannot borrow money at the risk-free rate to invest more than their initial endowment in the risky asset. This paper paves the way for future research that addresses these points.

Notes

1. Negative interest rates (NIRs) are no longer hypothetical. Since the 2008 global financial crisis, there have been NIRs in certain bond and monetary markets, and NIRs have even been set as policy

targets by the central banks of several industrialized countries (Altavilla *et al.*, 2019; Brown, 2018; Boungou, 2020). To a lesser extent, a few commercial banks in Europe have also implemented NIRs and have required some of their depositors to pay to leave money in their savings accounts. Some examples are the Alternative Bank Schweiz AG in Switzerland, which was one of the first banks to set a deposit rate of −0.75%, the Danish Yyske Bank, which has set a deposit rate of −0.6%, the private bank Puilaetco Dewaay in Belgium, which has set NIRs for wealthy depositors, and the Dutch online broker DeGiro, which has set NIRs for deposits exceeding €2,500. According to Altavilla *et al.* (2019), pioneers in the implementation of NIRs are investment-grade banks and healthier banks, which have started requiring their corporate depositors to pay for savings accounts.

2. Using a difference-in-difference approach to compare risk-taking of banks whose monetary authorities had implemented NIRs with that of banks whose monetary authorities did not, Boungou (2020) finds that the latter takes more risks. Moreover, among the banks whose monetary authorities have implemented NIRs, both smaller and better capitalized banks have taken fewer risks than larger and less well-capitalized banks.

3. Past research has found that mere goals have an impact on both performance and risk-taking (Locke and Latham, 1990). In particular, more-challenging goals have a larger positive impact on performance than less-challenging goals, even when goals are set at extremely high levels (Heath *et al.*, 1999). Specific and challenging goals also increase performance more than "do your best" goals.

4. These theories however differ in three aspects. The first difference refers to how the aspiration level (the reference point) exerts its impact. The second difference is that SP/A theory allows much more asymmetry between gains and losses than cumulative prospect theory does. The third difference is that, unlike cumulative prospect theory, SP/A theory predicts nonmonotonicities in preference patterns that depend on whether the aspiration level (the reference point) is guaranteed or not to be met. For more details, see Lopes and Oden (1999).

5. For comparison, the value function in expected utility theory is a function of final assets and a concave function of wealth.

6. For example, the negative subjective value given to a loss of 100 may be twice as high as the positive subjective value given to an equivalent gain.

7. According to Heath *et al.* (1999), risk-taking in situations in which people have goals tied to discrete and discontinuous external rewards (e.g. a promotion or bonus) can be easily explained through basic economic calculations. By contrast, increased risk-taking in response to mere goals is a fundamentally psychological phenomenon.

8. Larrick *et al.* (2009) present these conditions as the standard manipulation in the goal-setting literature.

9. The amounts to invest vary between the two conditions to keep the final payoffs of the participants similar in both conditions. Since the interest rates on the deposit account and the expected returns on the stock index fund are by default higher in the high-target return condition, we reduce the initial amount in this condition. In using this procedure, we are following Bracha (2020) and Ganzach and Wohl (2018), who also define the available funding so as to equalize the final payoffs in their experiments.

10. This means that the risk-free rate does not monotonically increase or decrease across the five investment decisions.

11. Using a positive risk premium is very frequent in the literature on the impact of (risk-free) interest rates on risk-taking when examining investment decisions (e.g. Lian *et al.*, 2018; Ganzach and Wohl, 2018; Baars *et al.*, 2020; David-Pur *et al.*, 2020). This choice is mostly motivated by standard portfolio theory. Assuming a constant risk premium, this theory predicts that the share invested in risky assets is unaffected by changes in the interest rate under constant relative risk aversion preferences. The existence of a positive risk premium for risky assets is also in line with reality in financial markets. To the best of our knowledge, one exception is Bracha (2020) who conducted several

experiments wherein people are asked to allocate money between one sure risk-free portfolio and another risky portfolio. In her baseline investment parameters, the expected return of the risky asset equals the sure return. However, this author also included cases where the risky portfolio yields higher expected return than the sure return.

12. The advantage of such graphical representations is a better understanding of the decision that participants are asked to make as well as a decrease in uncertainty regarding the available alternatives. However, we are aware that these graphical representations might induce some potential framing effects, probably in favor of the risk-free asset. Framing effects refer to choices being presented in a way that highlights the positive or negative aspects of the same decision, leading to changes in their relative attractiveness (The Behavioral Economics Guide). In our case, Figure A3 highlights the absence of variation for the risk-free rate, compared to Figure A4 that depicts the various outcomes associated with the stock index fund. These contrasting representations might lead participants to invest more in the risk-free asset than what they would do without these graphical representations.
13. This means that in case of losses, participants are only paid the fixed amount of $1.50. This fixed reward is defined using the minimum requirements in terms of payment on Prolific Academic. Actual losses being not possible for participants might prevent them from showing loss aversion in their decisions. The results reported in Section 5 are not consistent with that.
14. Risk-taking when people have goals tied to discrete and discontinuous rewards can be easily explained through basic economic calculations (Heath *et al.*, 1999).
15. All three value function curves are S-shaped: they are concave when the risk-free rate exceeds the reference point and convex when the risk-free rate falls short of it. In addition, when the risk-free rate is below the reference point, all three value functions are steeper than when the risk-free rate is above it. In absolute terms, the negative subjective values that hold when the risk-free rate is below the reference point exceed the positive subjective values that hold when the risk-free rate exceeds the reference point by the same magnitude. Next, these value functions are steep (flat) when the risk-free rate is close to (far from) the reference point, meaning that the impact of a change in the risk-free rate diminishes when moving farther from the reference point.
16. This pattern of the preference between negative prospects being the mirror image of the preference between positive prospects is coined as the reflection effect by Kahneman and Tversky (1979).
17. We invited 200 persons to participate in our experiment, but 3 participants dropped out after reading the instructions.
18. We calculate risk tolerance as the average of the scores on six questions taken from the DOSPERT scale (available in Appendix 2).
19. Given the average actual target return reported by participants in the low-target return condition, these people made on average decisions within a context where they were assigned a target return well below their actual one in reality. Such a difference might have generated discomfort. In the worst-case scenario, participants in the low-target return condition might not have accepted the assigned target return (and might not have behaved in accordance with it). The results reported in Sections 5.2 and 5.3 are not consistent with this worst-case scenario.
20. This difference is however not statistically significant.
21. We also checked the proportion of 50–50 allocation decisions (i.e. identical amount of money invested in the risk-free asset and in the risky asset). Overall, the 50–50 allocations represent 18.27% of all investment decisions. When considering the two conditions separately, we have 17.73% of 50–50 allocations in the low-target return condition and 18.80% of them in the high-target return condition. This proportion looks stable and is not likely to drive the results.
22. Since we perform multiple pairwise comparisons on each target return condition sample, Bonferroni corrections might be recommended to control for the family-wise error rate. This would imply to multiply each p-value by four, that is the number of pairwise comparisons used in Tables 5 and 6. Such corrections would only slightly change the level of significance in Panel A of Table 5 for the low-target return condition, with a corrected p-value equal to 0.0012.

23. In Table 2, when the risk-free rate exceeds the target return, the optimal allocation to the risky asset is positive and even increases as the risk-free rate shifts away from the target return. As mentioned in Section 4.1, this phenomenon is mainly due to the role of loss aversion when computing CPT values. As soon as the risk-free rate exceeds the target return by 2%, the loss associated with the risky asset in the worst possible outcome is compensated by the gain obtained on the risk-free asset. Such a phenomenon does not appear in our findings, revealing that participants on average did not identify this compensation between the biggest potential losses on the stock index fund and the positive difference between the risk-free rate and the target return. In Panel A of Table 6, a small but positive variation in risk-taking when the risk-free is above the target return is noticeable in the low-target return condition. However, the multivariate results in Section 5.3 do not provide significant evidence of a real change in risk-taking when the risk-free rate is above the target return.
24. Applying Bonferroni corrections to control for the family-wise error rate would only slightly change the level of significance in Panel A of Table 6 for the low-target return condition, with a corrected *p*-value equal to 0.0012.
25. Because our dependent variable is bounded between 0 and 1, the use of OLS models is questionable. Fractional logit models are indeed econometrically more appropriate for dependent variables taking on values ranging from zero to one. For comparability, the results obtained from an OLS regression are available in Appendix 5. They are qualitatively similar for our main variables of interest.
26. As suggested by an anonymous reviewer, we test whether the probability of loss (that is not kept constant in the experimental design) might better explain the results. When estimating Model 1 including the probability of loss as additional explanatory variable, we still find that participants significantly increase their allocation to the risky asset when the risk-free rate is below the target return. The coefficient estimate for the probability of loss is also positive and highly significant. This is consistent with an increasing probability of loss on the risky asset when the risk-free rate goes below the target return in our experimental setting. These unreported results are available upon request.
27. Regarding risk tolerance, we also estimate the model using an interaction term between risk tolerance and gender. The results (unreported here but available upon request) show that risk tolerance, even when combined with gender, does not explain the heterogeneity in risk-taking across participants.
28. An IPS is a written document that clearly sets out a client's return objectives and risk tolerance over that client's relevant time horizon, along with applicable constraints such as liquidity needs, tax considerations, regulatory requirements and unique circumstances (Maginn *et al.*, 2006). The following items are key components of an IPS: goals and objectives, fears and concerns, investment time frame, expected mortality, retirement time frame, short-term financial needs, risk tolerance attitudes and risk capacity (Boone and Lubitz, 2004).
29. Cognitive dissonance is an important concept in social psychology developed by Festinger (1957). In short, it refers to the uncomfortable tension that arises when people face simultaneous and conflicting ideas or feelings. Contradictions in one's beliefs also lead to cognitive dissonance, thereby making the person uncomfortable.
30. We multiply the amount invested (40 ECU) by a factor of 0.4 to ensure comparable average final payoffs between the two experiments. In the experiment using an exogenous target return, the average payoff across participants is equal to $4.03. In the experiment using an endogenous target return, the average payoff across participants is equal to $5.44.
31. We invited 210 persons to have little margin for dropout, but only 1 participant stopped after reading the instructions.
32. Since participants were free to select their target return, the size of this group is determined by their choices.
33. When we replace this binary variable with the target return selected by the participants (to control for its level), our results remain similar. These unreported findings are available upon request.

34. The individual-level variables do not help explain the heterogeneity in risk-taking across participants since none is significant at the 5% level.
35. This piece of regulation came into force in November 2007 in European Union member states. MiFID I (2004/39/EC) is the first version of this piece of regulation and was updated to MiFID II in January 2018 (known as MiFID II (2014/65/UE)). The European Commission website provides a complete description of MiFID II. See https://finance.ec.europa.eu/capital-markets-union-and-financial-markets/financial-markets/securities-markets/investment-services-and-regulated-markets_en#legislation.
36. MiFID distinguishes among three types of services: the execution of orders, the provision of financial advice and portfolio management. Investors who require financial advice or portfolio management have to complete the suitability test, which aims to ensure that the instruments and services offered by the investment firm align with the investor's knowledge and experience, his/her investment objectives and his/her financial situation.

References

Ackert, L.F., Charupat, N., Church, B.K. and Deaves, R. (2006), "An experimental examination of the house money effect in a multi-period setting", *Experimental Economics*, Vol. 9 No. 1, pp. 5-16.

Ackert, L.F., Church, B.K. and Qi, L. (2016), "An experimental examination of portfolio choice", *Review of Finance*, Vol. 20 No. 4, pp. 1427-1447.

Altavilla, C., Burlon, L., Giannetti, M. and Holton, S. (2019), "Is there a zero lower bound? The effects of negative policy rates on banks and firms", ECB Working Paper No. 2289.

Baars, M., Cordes, H. and Mohrschladt, H. (2020), "How negative interest rates affect the risk-taking of individual investors: experimental evidence", *Finance Research Letters*, Vol. 32, 101179.

Baillon, A., Bleichrodt, H. and Spinu, V. (2020), "Searching for the reference point", *Management Science*, Vol. 66, pp. 93-112.

Barber, B.M. and Odean, T. (2001), "Boys will be boys: gender, overconfidence, and common stock investment", *The Quarterly Journal of Economics*, Vol. 116 No. 1, pp. 261-292.

Barberis, N. and Huang, M. (2008), "Stocks as lotteries: the implications of probability weighting for security prices", *American Economic Review*, Vol. 99, pp. 2066-2100.

Barberis, N., Mukherjee, A. and Wang, B. (2016), "Prospect theory and stock returns: an empirical test", *Review of Financial Studies*, Vol. 29 No. 11, pp. 3068-3107.

Baucells, M., Weber, M. and Welfens, F. (2011), "Reference-point formation and updating", *Management Science*, Vol. 57, pp. 506-519.

Benartzi, S. and Thaler, R. (1995), "Myopic loss aversion and the equity premium puzzle", *The Quaterly Journal of Economics*, Vol. 110, pp. 73-92.

Blais, A.-R. and Weber, E. (2006), "A Domain-Specific Risk-Taking (DOSPERT) scale for adult populations", *Judgment and Decision Making*, Vol. 1 No. 1, pp. 33-47.

Boone, N.M. and Lubitz, L.S. (2004), *Creating an Investment Policy Statement: Guidelines and Templates*, AdvisorPress, San Francisco.

Boungou, W. (2020), "Negative interest rates policy and banks' risk-taking: empirical evidence", *Economics Letters*, Vol. 186, 108760.

Bracha, A. (2020), "Investment decisions and negative interest rates", *Management Science*, Vol. 66 No. 11, pp. 5316-5340.

Brown, B. (2018), "Negative interest rates and the war against cash", in *The Case against 2 Per Cent Inflation*, Springer, pp. 149-163.

Chen, D.L., Schonger, M. and Wickens, C. (2016), "oTree—an open-source platform for laboratory, online, and field experiments", *Journal of Behavioral and Experimental Finance*, Vol. 9, pp. 88-97.

Choi, J. and Kronlund, M. (2018), "Reaching for yield in corporate bond mutual funds", *Review of Financial Studies*, Vol. 31 No. 5, pp. 1930-1965.

Cox, J.C., Sadiraj, V. and Schmidt, U. (2015), "Paradoxes and mechanisms for choice under risk", *Experimental Economics*, Vol. 18 No. 2, pp. 215-250.

David-Pur, L., Galil, K. and Rosenboim, M. (2020), "To decrease or not to decrease: the impact of zero and negative interest rates on investment decisions", *Journal of Behavioral and Experimental Economics*, Vol. 87, 101571.

Festinger, L. (1957), *A Theory of Cognitive Dissonance*, Stanford University Press, Stanford, California.

Ganzach, Y. and Wohl, A. (2018), "A behavioral theory of the effect of the risk-free rate on the demand for risky assets", *Journal of Behavioral and Experimental Economics*, Vol. 76, pp. 23-27.

Hack, A. and Von Bieberstein, F. (2015), "How expectations affect reference point formation: an experimental investigation", *Review of Managerial Science*, Vol. 9 No. 1, pp. 33-59.

Heath, C., Larrick, R.P. and Wu, G. (1999), "Goals as reference points", *Cognitive Psychology*, Vol. 38 No. 1, pp. 79-109.

Kahneman, D. and Tversky, A. (1979), "Prospect theory: an analysis of decision under risk", *Econometrica*, Vol. 47 No. 2, pp. 263-291.

Larrick, R.P., Heath, C. and Wu, G. (2009), "Goal-induced risk taking in negotiation and decision making", *Social Cognition*, Vol. 27 No. 3, pp. 342-364.

Leung, W.S. and Zhu, Z. (2018), "Zero lower bound and investors' risk taking on fixed income mutual funds". doi: 10.2139/ssrn.3103496, SSRN available at: https://ssrn.com/abstract=3103496

Lian, C., Ma, Y. and Wang, C. (2018), "Low interest rates and risk-taking: evidence from individual investment decisions", *Review of Financial Studies*, Vol. 32 No. 6, pp. 2107-2148.

Locke, E.A. and Latham, G.P. (1990), *A Theory of Goal Setting and Task Performance*, Prentice-Hall, Englewood Cliffs, New Jersey.

Lopes, L.L. (1987), "Between hope and fear: the psychology of risk", *Advances in Experimental Social Psychology*, Vol. 20 No. 3, pp. 255-295.

Lopes, L.L. and Oden, G. (1999), "The role of aspiration level in risky choice: a comparison of cumulative prospect theory and SP/A theory", *Journal of Mathematical Psychology*, Vol. 43 No. 2, pp. 286-313.

Maggio, M.D. and Kacperczyk, M. (2017), "The unintended consequences of the zero lower bound policy", *Journal of Financial Economics*, Vol. 123 No. 1, pp. 59-80.

Maginn, J., Tuttle, D., Pinto, J. and McLeavey, D.W. (2006), *Managing Investment Potfolios: A Dynamic Process*, CFA Institute.

Payne, J.W., Laughhunn, D.J. and Crum, R. (1980), "Translation of gambles and aspiration level effects in risky choice behavior", *Management Science*, Vol. 26 No. 10, pp. 1039-1060.

Petersen, M.A. (2009), "Estimating standard errors in finance panel data sets: comparing approaches", *Review of Financial Studies*, Vol. 22 No. 1, pp. 435-480.

Rechenberg, T., Gutt, D. and Kundisch, D. (2016), "Goals as reference points: empirical evidence from a virtual reward system", *Decision Analysis*, Vol. 13, pp. 127-151.

Riley, C., Summers, B. and Duxbury, D. (2020), "Capital gains overhang with a dynamic reference point", *Management Science*, Vol. 66, pp. 4726-4745.

Shefrin, H. and Statman, M. (2000), "Behavioral portfolio theory", *The Journal of Financial and Quantitative Analysis*, Vol. 35 No. 2, pp. 127-151.

Tversky, A. and Kahneman, D. (1992), "Advances in prospect theory: cumulative representation of uncertainty", *Journal of Risk and Uncertainty*, Vol. 5 No. 4, pp. 297-323.

Appendices

Appendix 1. Screenshots of the instructions in the main study (exogenous target return)

Instructions

In this experiment, you are going to make several independent investment decisions. For that purpose, you will have a monetary amount that can be used for the following investment alternatives: a deposit account and a stock index fund.

The riskiness of these two options differs. The deposit account is a risk-free asset, i.e. the interest rate is known for sure and there is no risk at all since deposit accounts are guaranteed by the Central Bank. The stock index fund is a risky asset that offers on average higher reward than the deposit account.

Interest rates on the deposit account can be either positive or negative, depending on the monetary policy set by the Central Bank. The returns of the stock index fund can be either positive or negative, depending on the stock market conditions.

The currency used in this experiment is the ECU (Experimental Currency Unit). The exchange rate between the ECU and the US dollar ($) is 1:1, which means that 1 ECU is worth $1.

Click on the Next button to continue reading instructions.

Next

Source(s): Authors’ own creation/work

Figure A1. Screenshot of the introductory instructions (page 1)

Instructions

Your target return is 2%. Reaching this target return means that you earn 0.8 ECU on an investment amount of 40 ECU.

You are going to make five independent investment decisions. For each of them, you will indicate how much of the available money you want to invest in the deposit account and the stock index fund, respectively. You can invest all the available money in either the deposit account or the stock index fund, or you can choose any combination of these two assets.

The total amount invested in the deposit account and the stock index fund must add up to 100% for each investment decision, i.e. you need to invest all the available money.

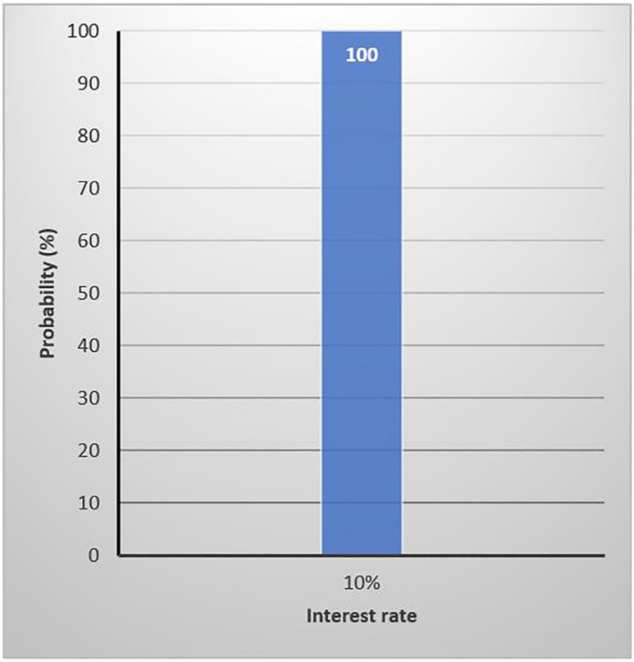
The reward system in this experiment is made of both a fixed payment of 1.5 ECU and a premium. The premium is an additional amount of money that directly depends on your performance across the five investment decisions. Namely, the premium is simply equal to the average realized return multiplied by 40 ECU. For example, if your average return is 4%, your reward would be 3.1 ECU, which consists of a premium of 1.6 ECU (40 ECU x 4%) plus the fixed amount (1.5 ECU).

Click on the Next button to proceed to the first investment decision.

Next

Source(s): Authors’ own creation/work

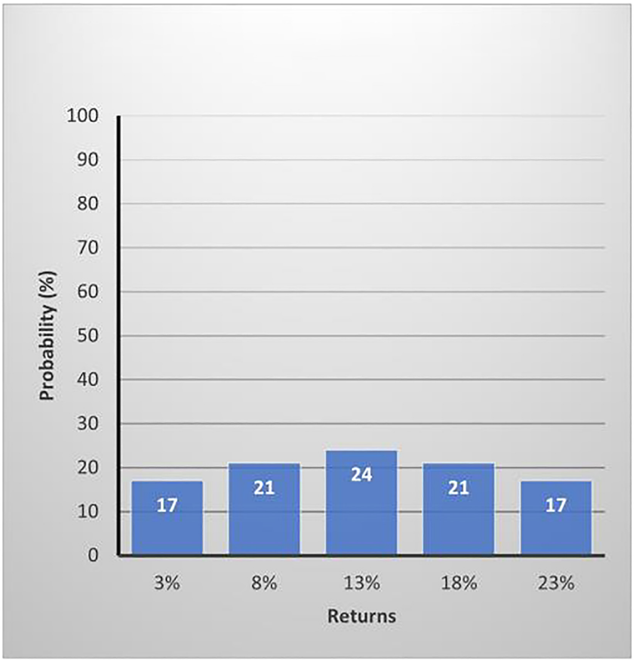
Figure A2. Screenshot of the introductory instructions (page 2)



Note(s): This figure shows the interest rate on the deposit account for a randomly chosen investment decision. The horizontal axis refers to the interest rate on the deposit account, while the vertical axis refers to the probability of earning this risk-free rate (which is 100% by definition). This example illustrates the case when the risk-free rate is set at 10%

Source(s): Authors' own creation/work

Figure A3.
Interest rate on the deposit account



Note(s): This figure presents the distribution of the stock index fund returns for a randomly chosen investment decision. The horizontal axis indicates the five possible outcomes for the stock index fund, while the vertical axis indicates their respective probabilities of occurrence. This example illustrates the case when the expected return is equal to 13%

Source(s): Authors' own creation/work

Figure A4. Distribution of the stock index fund returns

Appendix 2. Domain-specific risk-taking (DOSPERT) scale – Statements

For each of the following statements, please indicate the likelihood that you would engage in the described activity or behavior if you were to find yourself in that situation. Provide a rating from "Extremely Unlikely" to "Extremely Likely".

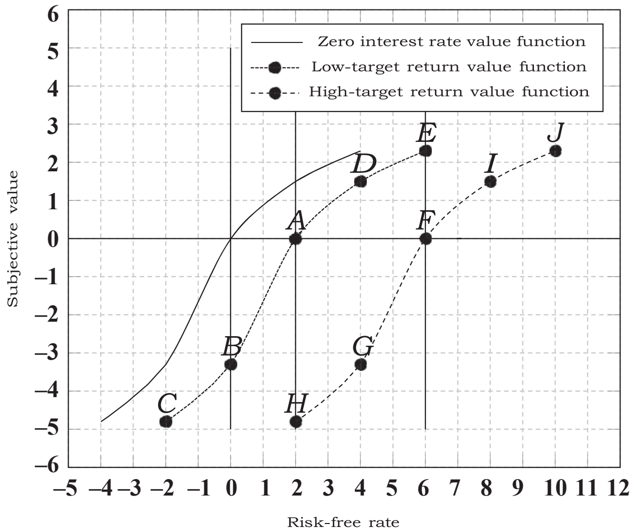
Statement 1: Betting a daily income at the horse races.
Statement 2: Investing 10% of your annual income in a moderate growth diversified fund.
Statement 3: Betting a daily income at a high-stake poker game.
Statement 4: Investing 5% of your annual income in a very speculative stock.
Statement 5: Betting a daily income on the outcome of a sporting event.
Statement 6: Investing 10% of your annual income in a new business venture.

Appendix 3. CPT function specifications (Tversky and Kahneman, 1992)

$$v(x) = \begin{cases} x^{\alpha} \text{ if } x \geq 0 \\ -\lambda(-x)^{\beta} \text{ if } x < 0 \end{cases}$$

$$w^{+}(p) = \frac{p^{\gamma}}{\left(p^{\gamma} + (1-p)^{\gamma}\right)^{1/\gamma}};\ w^{-}(p) = \frac{p^{\delta}}{\left(p^{\delta} + (1-p)^{\delta}\right)^{1/\delta}}$$

Appendix 4. Value function curves for risk-free rate outcomes based on prospect theory



Note(s): This figure depicts three value function curves for risk-free rate outcomes based on prospect theory. For each curve, the reference point is assumed to be the target return. For the first value function (solid line), the target return is set to 0% (i.e., a zero interest rate). For the second value function (dense dashed line), the target return is set to 2% (i.e., a low level), while for the third value function (less dense dashed line), the target return is set to 6% (i.e., a high level). The horizontal axis indicates the risk-free interest rate, while the vertical axis indicates the subjective value of the risk-free rate based on prospect theory

Source(s): Authors' own creation/work

Figure A5.
Value function curves for risk-free rate outcomes depending on the level of the reference point based on prospect theory

Appendix 5. OLS regression results

Parameter	Model 1	Model 2	Model 3
Intercept	0.458***	0.458***	0.462***
Low cond	0.083***	0.083***	0.074***
Age	−0.001	−0.001	−0.001
Male	0.048*	0.048*	0.048*
Student	−0.061*	−0.061*	−0.061*
Risk tol	−0.008	−0.008	−0.008
Dep acc	−0.005	−0.005	−0.005
Stocks	−0.005	−0.005	−0.005
Below target	0.154***		
Above target	−0.021		
Below 4%		0.169***	0.147***
Below 2%		0.139***	0.139***
Above 2%		−0.007	−0.007
Above 4%		−0.036	−0.036
Low cond*Below 4%			0.045
N	985	985	985

Note(s): This table reports the results for panel-data OLS regression models in which the dependent variable, *Risk taking*$_{i,d}$, is the share of money invested in the stock index fund by participant *i* in decision *d*. The individual-level variables include sociodemographic characteristics that are typical control variables and additional individual characteristics. *Male* is a binary variable set to one for males. *Student* is a binary variable set to one for participants who are students. *Risk tol* refers to the participant's average score on the answers to six questions taken from the DOSPERT scale, which ranges from 0 (extremely unlikely to take a risk) to 7 (extremely likely to take a risk). *Dep acc* and *Stocks* are binary variables set to one for participants who own an actual deposit account and an actual portfolio of financial assets, respectively. *Low cond* is another binary variable set to one for participants in the low-target return condition. Among the decision-level variables in Model 1, *Below target* is a binary variable set to one when the risk-free rate is below the target return, while *Above target* is another binary variable set to one when the risk-free rate is above the target return. As alternatives in Model 2, the four following dummies are used: *Below* 4%, *Below* 2%, *Above* 2% and *Above* 4%, which are set to one when the risk-free rate is 4% below, 2% below, 2% above and 4% above the target return, respectively. In Model 3, *Low cond*Below* 4% is an interaction term that indicates situations in which participants in the low-target return condition face an NIR. N is the number of observations (i.e. decisions). Standard errors are clustered at the participant level. *$p < 0.05$; **$p < 0.01$; ***$p < 0.001$
Source(s): Authors' own creation/work

Table A1.
OLS regression models for risk-taking behavior

Appendix 6. Screenshots of the instructions in the follow-up study (endogenous target return)

Instructions

In this experiment, you are going to make several independent investment decisions. For that purpose, you will have a monetary amount that can be used for the following investment alternatives: a deposit account and a stock index fund.

The riskiness of these two options differs. The deposit account is a risk-free asset, i.e. the interest rate is known for sure and there is no risk at all since deposit accounts are guaranteed by the Central Bank. The stock index fund is a risky asset that offers on average higher reward than the deposit account.

Interest rates on the deposit account can be either positive or negative, depending on the monetary policy set by the Central Bank. The returns of the stock index fund can be either positive or negative, depending on the stock market conditions.

The currency used in this experiment is the ECU (Experimental Currency Unit). The exchange rate between the ECU and the US dollar ($) is 1:1, which means that 1 ECU is worth $1.

Before reading the next page, you must select your target return. This target return is unique and applies to each investment decision.

Please select your target return among the following values:

Click on the Next button to continue reading instructions.

Next

Source(s): Authors' own creation/work

Figure A6. Screenshot of the introductory instructions in the follow-up study (page 1)

Instructions

Your target return is 6%. Reaching this target return means that you earn 2.40 ECU on an investment amount of 40 ECU.

You are going to make five independent investment decisions. For each of them, you will indicate how much of the available money you want to invest in the deposit account and the stock index fund, respectively. You can invest all the available money in either the deposit account or the stock index fund, or you can choose any combination of these two assets.

The total amount invested in the deposit account and the stock index fund must add up to 100% for each investment decision, i.e. you need to invest all the available money.

The reward system in this experiment is made of both a fixed payment of 1.50 ECU and a premium. The premium is an additional amount of money that directly depends on your performance achieved at one investment decision randomly selected across the five decisions. Namely, the premium is equal to the realized return earned at the randomly selected investment decision multiplied by (40 x 0.4) ECU. For example, if your realized return is 4%, your reward would be 2.14 ECU, which consists of a premium of 0.64 ECU (0.4 x 40 ECU x 4%) plus the fixed amount (1.50 ECU). In case the realized return at the randomly selected investment decision is negative, the premium is set to zero.

Click on the Next button to proceed to the first investment decision.

Next

Note(s): This figure illustrates the instructions used in the follow-up study, once the target return has been selected. This example refers to a participant who selected 6% as target return
Source(s): Authors' own creation/work

Figure A7. Screenshot of the instructions describing the reward system in the follow-up study (page 2)

Appendix 7. Robustness check: sample statistics and results

Variable	Full sample N = 100 Mean	Median	Q1	Q3
Age	36.84	35	29.50	45
Male (in %)	52.00			
Student (in %)	12.00			
Target return in reality (%)	8.77	6.00	4.17	8.00
Risk tolerance (0–7 scale)	2.76	2.58	2.08	3.25
Deposit account owner (in %)	89.00			
Owner of financial assets (in %)	63.00			

Note(s): This table reports cross-sectional descriptive statistics (mean, median, and lower and upper quartiles) for the participants who took part in the robustness check. "Target return in reality" refers to the target return that participants would set if they had an actual portfolio of financial assets. "Risk tolerance" refers to subjective risk-taking preferences as measured by the six questions about gambling and investing from the DOSPERT scale. This measure of risk tolerance is calculated as the average of the scores on these questions on a scale ranging from 0 (extremely unlikely to take a risk) to 7 (extremely likely to take a risk). "Deposit account owner" is a binary variable set to one for participants who currently have or have had in the past money in a savings account. "Owner of financial assets" is another binary variable set to one for participants who currently hold or have held in the past an actual portfolio of financial assets. "N" provides the sample size, i.e. the number of participants
Source(s): Authors' own creation/work

Table A2. Descriptive statistics for the sample of participants

	Risk-free rate								
Target return	−4%	−2%	0%	2%	4%	6%	8%	10%	12%
0% (N = 0)									
2% (N = 17)		63.53	43.68	42.94	40.15	39.26			
		(75.00)	(50.00)	(37.50)	(37.50)	(37.50)			
4% (N = 34)			63.97	54.12	30.44	36.03	28.53		
			(62.50)	(50.00)	(25.00)	(25.00)	(25.00)		
6% (N = 27)				72.96	51.30	26.57	24.72	25.28	
				(75.00)	(50.00)	(25.00)	(12.50)	(12.50)	
8% (N = 22)					71.59	65.34	38.86	39.32	35.23
					(86.25)	(75.00)	(25.00)	(25.00)	(25.00)

Note(s): This table presents the average share of money allocated to the risky asset (i.e. the stock index fund with a constant risk premium of 3%) for each risk-free rate depending on the target return selected by participants. The corresponding medians are provided in brackets. N refers to the number of participants who selected the corresponding target return
Source(s): Authors' own creation/work

Table A3. Allocations to the risky asset (in %)

Full sample	
Panel A: 2% above and 2% below	
R_F is 2% below	54.05
R_F is 2% above	34.40
Difference	19.65*** (<0.0001)
N	100
Panel B: 4% above and 4% below	
R_F is 4% below	68.00
R_F is 4% above	30.95
Difference	37.05*** (<0.0001)
N	100

Note(s): This table reports the average share of money invested in the risky asset (expressed in %) when the risk-free rate (R_F) is above or below the target return, the differences between these average shares, and the corresponding level of significance from two-sided paired *t*-tests. Panel A presents the results for situations in which the risk-free rate is 2% above or below the target return, while Panel B presents the results for situations in which the risk-free rate is 4% above or below the target return. *$p < 0.05$; **$p < 0.01$; ***$p < 0.001$. N provides the sample size, i.e. the number of participants, and *p*-values are reported in brackets
Source(s): Authors' own creation/work

Table A4.
Risk-taking when the risk-free rate is above/below the target return

Full sample	
Panel A: Shift near the target return (± 2%)	
Δ2% below	20.68
Δ2% above	1.03
Difference	19.65*** (<0.0001)
N	100
Panel B: Shift far from the target return (± 4%)	
Δ4% below	34.63
Δ4% above	−2.43
Difference	37.05*** (<0.0001)
N	100

Note(s): This table reports the average variations in the allocation to the risky asset (expressed in %) when the risk-rate moves to a point either near (± 2%) or far from (± 4%) the target return, the differences between these average variations, and the corresponding level of significance from two-sided paired *t*-tests. Panel A presents the results for situations in which the risk-free rate shifts by 2% (near the target return), while Panel B presents the results for situations in which the risk-free rate shifts by 4% (far from the target return). *$p < 0.05$; **$p < 0.01$; ***$p < 0.001$. N provides the sample size, i.e. the number of participants, and *p*-values are reported in brackets
Source(s): Authors' own creation/work

Table A5.
Variation in risk-taking demonstrating loss aversion

Δ when R_F moves from 0% to −2% (N = 17)	19.85
Δ when R_F moves from 2% to 0% or 4% to 2% or 6% to 4% (N = 83)	12.74
Difference	−7.11
	(0.5068)

Note(s): This table reports the average variation in the allocation to the risky asset (expressed in %) when the risk-free rate moves from 0% to −2% for participants who selected 2% as target return and from 2% to 0% (4%–2% or 6%–4%) for participants who selected 4% (6% or 8%) as target return. The difference between these average variations and the corresponding level of significance from a two-sample t-test are also reported. *p < 0.05; **p < 0.01; ***p < 0.001. N provides the sample size, i.e. the number of participants, and p-values are reported in brackets
Source(s): Authors' own creation/work

Table A6.
Variation in risk-taking and NIRs

Parameter	Model 1 Estimate	OR	Model 2 Estimate	OR	Model 3 Estimate	OR
Intercept	−1.329***		−1.335***		−1.315**	
Age	0.003	1.003	0.003	1.003	0.002	1.002
Male	0.415*	1.514	0.419*	1.520	0.426*	1.530
Student	0.403	1.497	0.407	1.502	0.413	1.511
Risk tol	0.077	1.080	0.077	1.080	0.074	1.077
Dep acc	0.207	1.230	0.209	1.232	0.203	1.225
Stocks	−0.207	0.813	−0.209	0.811	−0.213	0.808
Below target	1.159***	3.188				
Above target	−0.032	0.968				
Below 4%			1.470***	4.350	1.523***	4.587
Below 2%			0.869***	2.384	0.869***	2.385
Above 2%			0.047	1.048	0.047	1.048
Above 4%			−0.113	0.893	−0.113	0.893
NIR (=1)					−0.301	0.740
N	500		500		500	

Note(s): This table reports the results of three fractional logit models in which the dependent variable, *Risk* $taking_{i,d}$, is the share of money invested in the stock index fund by participant i in decision d. The individual-level variables include sociodemographic characteristics as usual control variables and additional individual characteristics. *Male* is a binary variable set to one for males. *Student* is a binary variable set to one for participants who are students. *Risk tol* refers to the participant's average score on the answers to six questions taken from the DOSPERT scale, which ranges from 0 (extremely unlikely to take a risk) to 7 (extremely likely to take a risk). *Dep acc* and *Stocks* are binary variables set to one for participants who own an actual deposit account and an actual portfolio of financial assets, respectively. Among the decision-level variables in Model 1, *Below target* is a binary variable set to one when the risk-free rate falls short of the target return, while *Above target* is another binary variable set to one when the risk-free rate is above the target return. As alternatives in Model 2, the four following dummies are used: *Below* 4%, *Below* 2%, *Above* 2% and *Above* 4%, which are set to one when the risk-free rate is 4% below, 2% below, 2% above and 4% above the target return, respectively. In Model 3, *NIR* is a dummy variable set to one when participants face an NIR. OR refers to odds ratios. N is the number of observations (i.e. decisions). Standard errors are clustered at the participant level. *p < 0.05; **p < 0.01; ***p < 0.001
Source(s): Authors' own creation/work

Table A7.
Fractional logit regressions for risk-taking behavior

Corresponding author
Rudy De Winne can be contacted at: rudy.dewinne@uclouvain.be