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ESSAYS ON INDIVIDUAL REACTIONS TO ULTRA-LOW NEGATIVE AND INTEREST RATES

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DOCTORAL THESIS

ESSAYS ON INDIVIDUAL REACTIONS TO NEGATIVE AND ULTRA-LOW INTEREST RATES

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Contents

Abstract

Negative interest rates (NIRs) is unprecedented monetary policy that turns standard finance on its head. Since it turns standard finance at its head, the borrowers receive a reward for taking credits, and depositors have to pay for being patient and delaying their consumption. The main goal of this monetary policy is to stimulate economic growth and consumption by promoting both risk-taking and spending. Since its implementation, there is a growing body of literature studying its effectiveness. While examining its effectiveness, this literature focuses on various stakeholders touched by this monetary policy, including banks, institutional investors, and retail investors. In this thesis, we provide four experimental papers on how NIRs impact individuals' behavior.

We provide a general introduction in Chapter 1. Next, Chapter 2 investigates people's willingness to accept NIRs by analyzing their intertemporal preferences using an online experiment. We show that people are willing to tolerate negative interest rates on their savings. We find that this tolerance strongly depends on the amount of money and time horizon. Finally, we show that it also depends on whether an individual is a regular saver or not and whether he is anchored with NIRs or positive interest rates (PIRs) first.

Chapter 3 focuses on the impact of PIRs, NIRs, and procedures and costs on status quo bias in the context of savings. This status quo bias refers to the increased probability of one option being chosen when framed as status quo than when it is not framed as status quo. Using an online experiment, we find that the status quo bias is lower with NIRs than with PIRs. Next, we obtain that this status quo bias increases when one must go through procedures and pay costs to shift from the status quo to another alternative. Finally, we find that highly financially literate individuals show lower bias towards the status quo than their less financially literate counterparts.

In Chapter 4, we study the impact of positive and negative nominal interest rates on money illusion for an individual's savings and investment decisions. This money illusion occurs when individuals think in nominal rather than real terms while making decisions. We find that individuals facing negative nominal interest rates show a lower money illusion than

individuals facing positive nominal interest rates. Financial literacy is linked negatively with the money illusion, i.e., individuals who are more financially literate show a lower money illusion than their less financially literate counterparts.

Chapter's 5 goal is to test whether it is the zero interest rate level or the target return that impacts the risk-taking behavior of individuals in investment decisions. We set either a low or a high target return in our experiment and demand participants to make several independent investment decisions when the risk-free rate fluctuates around the target return. For some participants, it turns out negative. We find that the prevailing reference point is the target return, whatever the risk-free rate level. Our results also suggest that the target return serves as the prevailing reference point when the risk-free rate turns out negative. Chapter 6 reports a general conclusion.

Research accomplishments

Research visit - Heidelberg University (May - July 2021, Heidelberg, Germany)

Published papers

- Corneille, O., D'Hondt, C., De Winne, R., Efendic, E., Todorovic, A. (2021). What leads people to tolerate negative interest rates on their savings?, Journal of Behavioral and Experimental Economics, Volume 93, August 2021, 101714

Working papers

- D'Hondt, C., De Winne, R., Todorovic, A. Target Returns and Negative Interest Rates, *working paper* available at DIAL: `https://dial.uclouvain.be/pr/boreal/en/object/boreal%3A253623/datastream/PDF_01/view`
- Todorovic, A. Negative Interest Rates and Status Quo Bias, *working paper*
- Todorovic, A. Negative Interest Rates and Money Illusion, *working paper*

Communications

- European Financial Management Association 2021 Annual Meeting (Online, 2021)
- 37th International Conference of the French Finance Association (AFFI) (Online, 2021)

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Chapter 1

General Introduction

Negative interest rates (NIRs hereafter) is a monetary policy that aims at stimulating economic growth and consumption by encouraging both risk-taking and spending (Agarwal and Kimball, 2015; Kimball, 2015). When introduced, this policy turns standard finance upside down since borrowers are rewarded for taking credits, and depositors are punished for being patient and delaying their consumption by saving money. The introduction of this policy follows the 2008 financial crisis since several central banks of industrialized countries have brought their key rates into the negative territory.[1] Since this monetary policy is contemporary and unprecedented, a question of great importance is how banks have passed-through this policy to their clients and whether institutional and individual investors react in the expected direction, i.e., increase risk-taking and consumption. Banks run their businesses and earn profits by considering the difference in the interest rates on their loans and the interest rate on their household deposits. Before the 2008 financial crisis, depositors received rewards for their patience by earning interests. However, when NIRs on deposits are introduced, depositors are punished for holding their money with the commercial banks and could instead draw their money from the banks since cash has a zero-lower bound. Deposits are a crucial source of funding for commercial banks, and they could be afraid to implement NIRs to keep their customers (Basten and

[1]Seven central banks in Europe (Bulgaria, Denmark, Euro Area, Hungary, Norway, Sweden, and Switzerland) and the Bank of Japan have implemented this monetary policy (Boungou, 2019).

Mariathasan, 2018a). Evidence shows that banks are reluctant to implement NIRs on their deposits (Eggertsson et al., 2017).

With low and negative interest rates, institutional investors are motivated to increase their risk-taking by reaching for yield and increasing their investments in risky assets. This increase in risk-taking could be particularly pronounced among money market funds, which are obliged to invest in safe assets. More specifically, due to NIRs, these safe assets are no longer an option since they bring negative yields. Thus, money market funds increased their risk-taking by increasing the proportion of risky assets in their portfolios (Di Maggio and Kacperczyk, 2017a). Not only have money market funds reacted to this monetary policy, but also US corporate mutual funds. Particularly, Choi and Kronlund (2018) examine the reasoning behind increased risk-taking of these mutual funds and determine that the motive lies in the low and negative interest rates.

The most widely researched (although scarcely since this is a new monetary policy) area regarding NIRs is the one related to the reaction of individual investors to this unprecedented policy. Most of the authors focus on investment decisions and risk-taking, and their results show that low or negative interest rates in most cases lead to a higher appetite for risk (Bracha, 2016; Ganzach, Y., and Wohl, A., 2018; Lian et al., 2018; Baars et al., 2020). However, Efendic et al. (2019) show that individuals display large tolerance for NIRs when the only alternative is to take one's savings out of the bank. Besides investment behavior related to NIRs, David-Pur et al. (2020) analyze borrowing behavior in the positive interest rate (PIRs hereafter) and NIRs context. Participants increase their leverage mostly at the zero lower bound and keep a similar level in the NIR region considering the borrowing behavior. These authors obtain that the decreasing interest rate induces increased risk-taking by investing money in more risky assets, which provides investors an opportunity to achieve a higher expected return followed by a higher level of risk.

1.1 A four-essay doctoral research

NIRs should not be considered as a theoretical concept since several developed countries have implemented them. Thus, it is of crucial importance to understand the reactions of individuals to this unconventional monetary policy. Research regarding this Ph.D. thesis focuses on expanding existing knowledge related to individuals' reactions linked to NIRs. More specifically, we aim to examine individual and contextual factors that determine individuals' reactions when experiencing NIRs. In the first essay, the attention is focused on the context of savings related to NIRs. Besides concentrating on savings behavior, this study takes into account various time horizons and amounts. The second essay investigates the impact of NIRs on the status quo bias in the context of savings. This study aims to determine whether the status quo bias survives when the context involves losses (i.e., NIRs) compared to the situation when it involves gains (i.e., PIRs). Besides NIRs, we question whether transition costs and efforts amplify or weaken the status quo bias. The third essay focuses on the impact of money illusion on savings behavior in the NIRs context. More precisely, I compare money illusion in PIRs with NIRs savings contexts. The last but not least important essay questions whether the target return serves as a reference point and impacts individuals' risk-taking behavior when making decisions. More importantly, regarding NIRs, we determine what reference point prevails when the interest rate drops below zero - the target return or the zero interest rate level.

1.1.1 Essay I: What leads people to tolerate negative interest rates on their savings?

For a long time, interest rates are assumed to be positive since they represent a premium (i.e., a reward to delay consumption). However, monetary policy evolves and demands innovations in order to follow the desired direction of economic growth and development. Hence, several central banks of industrialized countries brought their policy rates into the negative territory following the 2008 financial crisis (Altavilla et al., 2019; Brown, 2018).

A question of great importance is the reaction of decision-makers to this unprecedented monetary policy.

In order to start investigating individuals' reactions to NIRs, our first study questions whether people would tolerate NIRs at all. Namely, since this economic policy should boost economic growth and consumption due to increased spending, and decreased savings, will individuals take their money from the savings account? Rationally, people should not accept to lose their money when they delay their consumption and exchange it for savings. This study does not only question whether people are ready to bear NIRs on their savings but also to what extent this tolerance depends on the amount of savings and time horizon.

We use an online experiment to answer whether and to which extent people are ready to bear NIRs on their savings.[2] More specifically, participants make intertemporal choices between the present and future values of savings. These future savings values could be either smaller, equal, or higher than the present values. The variation in future values is introduced to have a low or a high amount of savings. Besides, the time horizon for savings also fluctuates so that we have time horizons starting from short, medium, and long time horizons. The objective is to determine the switching point, i.e., the position when a participant switches from spending to saving or reverse. Subsequently, we can identify the indifference point and finally find the implicit interest rate, i.e., the rate at which a given participant would start saving his/her money instead of spending it.

The results of our study show that participants are indeed willing to accept lower future values on savings, i.e., NIRs on savings. However, this willingness to tolerate NIRs depends on several factors. First, they are willing to accept it for lower but not for higher savings amounts. Second, tolerance to NIRs decreases with longer time horizons, i.e., the longer the time horizon, the lower is the willingness to accept NIRs. Third, regular savers are more likely to tolerate NIRs, supporting the status quo bias.

[2]This paper is a joint work with Catherine D'Hondt, Rudy De Winne, Emir Efendic, and Olivier Corneille, wherein I am the corresponding author.

1.1.2 Essay 2: Do Negative Interest Rates Decrease the Status Quo Bias on Savings?

NIRs reverse the standard theory on its head since banks, instead of rewarding their depositors for borrowing their money, are now punishing them by giving them back a lesser amount than the initial savings. Since these deposits are a crucial source of funding for banks, banks are hesitant to introduce NIRs on savings (Eggertsson et al., 2017; Basten and Mariathasan, 2018b; Lopez et al., 2020). This situation occurs because cash has no lower bound, i.e., depositors could withdraw their money from their deposit accounts once NIRs are introduced and invest it elsewhere.

As long as interest rates are positive, depositors are rewarded for keeping their money at the banks. Another essential point to make is that depositors in the EU during the period from 2012 to 2019 kept similar levels of savings rates while at the same time deposit rates exhibited a downward trend. An explanation for such depositors' behavior is status quo bias, which is the enhanced probability of one option being chosen when framed as status quo as compared to the circumstance when it is not framed as status quo (Samuelson and Zeckhauser, 1988). In plain words, depositors kept their levels of savings due to a habit.

This essay's central research question is to go further beyond PIRs and test the status quo bias when NIRs on deposits are introduced. Furthermore, this essay examines whether depositors would still keep deposit accounts with NIRs or search for other alternatives to reduce these sure losses. The difference between the status quo in the PIRs savings context and the NIRs savings context is also of vital interest. Finally, we study whether status quo bias is more or less robust when transition costs and efforts are necessitated when one desires to leave his/her status quo deposit account.

To address the research question, an experiment design built on Samuelson and Zeckhauser (1988) is employed. This experiment is 2 (Status Quo vs. Neutral condition) * 2 (No transition costs/No effort vs. Transition Costs/Effort) mixed design. One alternative (a

fixed-term deposit in the "Bank B") occupies the status quo in the Status Quo conditions.[3] Individuals in these conditions are informed they have already invested in the "Bank B" fixed-term deposit and decide to retain it or invest in another option. Unlike that, the Neutral conditions involve choices in which individuals have not previously invested and must make a new decision. Individuals in both status quo and neutral conditions choose deposit accounts in PIRs and NIRs regions. Deposit accounts in the PIRs region offer positive interest rates. The "Bank B" interest rate is 0.25%, which is 1.25% lower than the "Bank A," which offers a 1.50% interest rate. Deposit accounts in the NIRs region offer negative interest rates. The "Bank B" interest rate is -1.50%, whereas the "Bank A" offers a -0.25% interest rate. Hence, the difference in the interest rate of 1.25% favors the "Bank A" in both PIRs and NIRs conditions.

This study results indicate that individuals in status quo conditions exhibit stronger status quo bias than individuals in neutral conditions. However, this finding occurs only in conditions with procedures and transition costs. Next, we show that individuals offered with NIRs show lower bias towards the status quo than individuals offered with PIRs. Hence, NIRs reduce the status quo bias, which is a significant finding of this study. Furthermore, we find a positive interaction between status quo conditions and procedures and transition costs. In particular, we find a more robust status quo bias among savers who must pay transitions costs and fill in the documents if desiring to switch from the status quo bank to another bank. Lastly, individuals with the highest level of financial literacy exhibit lower bias towards the status quo than their less financially literate counterparts.

1.1.3 Essay 3: Negative Interest Rates and Money Illusion

Although negative nominal interest rates have been recently implemented, negative real interest rates have already appeared in the past. For instance, in the European Union, inflation exceeded positive nominal deposit rates from 2017 to 2021, which constituted negative real interest rates. Although nominally they were positive, savers lost purchasing

[3]This working paper is my single-author paper.

power over time when placing their money on savings.

Since what is important for individuals is the real interest rates, individuals should behave similarly irrespective of nominal interest rates if the real interest rates are identical. Standard economics predicts this type of individual behavior. However, the concept of money illusion indicates that this is not always the case. More precisely, individuals do not always think in real but rather nominal terms, which is coined as money illusion (Shafir et al., 1997). Going back to the example of identical real, but in one case, positive nominal, and in another case, negative nominal interest rates, individuals who are money illusioned might behave differently. This situation occurs because those individuals consider positive nominal interest rates as gains and negative nominal interest rates as losses.

This essay's central research question is whether there is any difference in money illusion for positive versus negative interest rates in both the context of saving and the context of investments.[4] This central research question is then branched into two research questions. The first research question studies whether individuals are less or more able to determine who benefits more in economic terms when savers are presented with negative versus positive interest rates. The second research question examines whether individuals would invest similarly irrespective of the sign of nominal interest rates while keeping constant real returns of the stock index fund and real interest rates of the deposit account.

To answer both research questions, I employ an experimental research design. I adopt a survey with three conditions for the first research question wherein participants have to make one decision. Participants in Positive condition are asked to imagine two individuals living in two different US states. The first individual lives in a state wherein the bank offers a positive interest rate of 2% on the fixed deposit (inflation in this state is 0%), whereas the bank of the second individual offers a positive interest rate of 5% (inflation in this statue is 4%). In the Positive-Negative condition, I drop interest rates by 4% which means that the first individual faces a negative nominal interest rate of -2%, and

[4]This working paper is my single-author paper.

the second individual a positive interest rate of 1%. In the Negative condition, I drop further interest rates by 4% such that the first individual's nominal interest rate is -6%, whereas the second individual's rate is -3%. In all three conditions, the first individual benefits more in real terms.

The second research question involves one investment decision made by the participants in two conditions. The factor that varies between those two conditions is the inflation rate. The inflation rate in the first condition (Inflation condition) is 4%, and in the second (Deflation condition) it is -2%. Participants in both conditions make one investment decision: allocation of money between a deposit account and a stock index fund. A variable that is kept constant across conditions is the real return on the stock index fund (at 3% above the inflation rate) and the real interest rates on the deposit account (at -1% below the inflation rate). However, I present nominal expected returns and nominal interest rates as gains and losses for Inflation and Deflation conditions, respectively. "Rational" investors should make similar decisions in both conditions.

The results of this study can be summarized as follows. First, we show that individuals are more money illusioned when introduced with NIRs than when exclusively presented with PIRs. Next, we discover that the association between financial literacy and money illusion is negative, i.e., a higher financial literacy decreases money illusion. This improvement in financial literacy is particularly suitable in the NIRs region since NIRs increase money illusion in a manner not noted with PIRs. Finally, individuals proposed with negative nominal interest rates exhibit a higher risk appetite than individuals proposed with positive nominal interest rates.

1.1.4 Essay 4: Target Returns and Negative Interest Rates

Since the 2008 financial crisis, NIRs have been set as policy targets by several central banks of industrialized countries (Altavilla et al., 2019; Brown, 2018). This introduction of NIRs has been followed by several commercial banks in Europe, which required part of their depositors to pay to leave money in their savings accounts. NIRs deliver punishment

instead of a reward for consumption postponement and hence stimulate economic growth through increased risk-taking and/or spending (Agarwal and Kimball, 2015; Kimball, 2015).

Before NIRs, low interest rates were associated with increased risk-taking by institutional investors, coined as "reach for yield" (Choi and Kronlund, 2018). This "reach for yield" among regular people delivers different results. For instance, Leung and Zhu (2018) shows that when interest rates fall to extraordinarily low levels, retail investors allocate their funds towards mutual funds with a risky benchmark. When interest rates are assumed to be normal, retail investors allocate their funds according to the performance of the mutual fund managers. Further, while examining the impact of a decrease in the risk-free rate on individual allocations between a risk-free and a risky asset, Ganzach and Wohl (2018) find that decreasing interest rate leads to an increase in risk-taking. 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.

However, the impact of zero or negative interest rates on the risk appetite of individuals is ambiguous. Bracha (2020) finds no statistical difference in risk-taking behavior under both PIRs and NIRs. By contrast, Baars et al. (2020) finds that the risk-taking increases significantly only when the interest rate falls below zero. Finally, David-Pur et al. (2020) find that a zero interest rate has a more powerful impact on both investment and borrowing behavior than both PIRs and NIRs.

This paper introduces a new variable of interest into investment decisions, which is the target return.[5] 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." Since this target return represents the expected return an individual wants to achieve, it could have an impact on 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;

[5]This paper is a joint work with Catherine D'Hondt and Rudy De Winne, wherein Catherine D'Hondt is the corresponding author.

Bracha, 2016; David-Pur et al., 2020), an experiment wherein the explicit target return is set and randomly assigned to participants is employed. Our first objective is to test (by using prospect theory) whether the target return serves as a reference point and impacts individuals' risk-taking behavior while making investment decisions. The second objective is to test whether the target return is still the prevailing reference point when the risk-free drops below zero.

The experiment is a mixed design wherein we manipulate the target return to test its impact on risk-taking. Participants are randomly assigned to two conditions: a high (low) target return condition wherein the target return is set to 6% (2%). Subsequently, they are requested to make five independent investment decisions. For investment decisions, they are offered two assets: 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). The risk-free rate is manipulated in such a way that it is both above and below target returns. The variations in the risk-free rate are similar in both conditions. However, participants in the low-target return condition face both positive and negative risk-free rates, unlike participants in the high-target return condition, who always face positive risk-free rates.

Our results could be summarized as follows. The explicit target returns drive risk-taking in investment decisions to a significant extent. Participants invest significantly more in the risky asset when the risk-free rate is below their target return than above their target return. Participants' reactions to the risk-free rate below the target return exceed their corresponding reactions when the risk-free rate surpasses the target return (consistent with loss aversion). We obtain this finding in both high- and low-target return conditions.

The specific case when the risk-free rate drops below zero in the low-target return condition delivers compelling results. We find no significant difference 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). This result implies that the target return remains the prevailing refer-

ence point among participants who face a negative risk-free rate. Hence, the drop in the risk-free rate below zero does not notably impact the risk-taking when individuals have an explicit target return that differs from zero, and individuals adjust their allocations to the risky asset based on the distance between the risk-free rate and their target return.

Chapter 2

What leads people to tolerate negative interest rates on their savings?

Chapter Abstract

Using an online experiment, we investigate intertemporal preferences to infer people's willingness to accept negative interest rates (NIRs) on their savings. We find some tolerance of NIRs, i.e., of people being willing to hold money in the bank rather than spend it, thereby accepting less savings at some future time. This tolerance strongly depends on the amount of savings, time horizon, actual savings behavior, and anchoring. Specifically, the higher the amount, the lower is the tolerance of NIRs, consistent with a *reverse* magnitude effect. Moreover, as the time horizon increases, the tolerance of NIRs decreases. Regular savers are more likely to tolerate NIRs than nonregular savers, which is consistent with status quo bias, higher familiarity with savings deposits, or a future-oriented mindset. We also find a higher tolerance of NIRs on savings when participants are anchored towards NIRs, i.e., when participants are first presented with NIRs and then with positive interest rates (PIRs).

Keywords: negative interest rates, savings accounts

JEL Classification: G11, G21, G40, G41, G51, G53

2.1 Introduction

Interest rates refer to a percentage premium of money paid on a specified date for delaying consumption and risk-taking (Fisher, 1930). Any interest rate is composed of two parts: the risk-free rate and the risk premium. The higher the risk (i.e., uncertainty about outcomes), the higher is the risk premium. The risk-free rate captures the time value of money, which allows for comparison of different risk-free amounts of money at various points in time. Because interest rates were initially thought of as a premium, for a long time, it has been assumed that they could only be positive. However, since the 2008 financial crisis, several central banks in industrialized countries have brought their risk-free rates into negative territory (Altavilla et al., 2019; Brown, 2018). NIRs represent a historical precedent as well as a paradigm shift. Instead of rewarding delayed consumption, NIRs punish it. In practice, NIRs imply that banks will require depositors to pay to hold money on savings accounts (which some banks have already started to do).[1]

NIRs are essentially viewed as a monetary policy tool aimed at boosting economic growth by stimulating risk-taking and/or spending (Agarwal and Kimball, 2015; Kimball, 2015). The rationale behind their implementation is that people are not likely to tolerate NIRs because they are associated with certain losses. Because individuals are indeed punished for saving money when NIRs are applied, they should instead prefer to spend it, invest it, or lend it. Hence, people are not expected to tolerate NIRs on their savings (Lilley and Rogoff, 2019; Block, 1978). The reality, however, is more puzzling. On the one hand, there is some empirical evidence that NIRs may effectively promote risk-taking and spending, but mainly among institutional investors (Di Maggio and Kacperczyk, 2017a; Hong, G.H., and Kandrac, J., 2018). On the other hand, in several countries that are experiencing all-time low or negative rates, aggregate household savings seems rather demonstrate the opposite since savings are still increasing (Europe, 2019).

[1] Alternative Bank Schweiz AG in Switzerland is one of the first banks to require depositors to pay to hold money in savings accounts (with a deposit rate of -0.75%). The Danish Yyske Bank already applies a deposit rate of -0.6%. In Belgium, the private bank Puilaetco Dewaay has recently announced that it will apply NIRs for wealthy depositors, while the Dutch online broker DeGiro plans to apply NIRs on deposits exceeding €2,500.

Because the existence of NIRs on regular savings accounts flips standard practices on their head, it is of utmost importance to better understand to what extent people will accept a situation in which they have to pay banks some interest (in addition to traditional bank fees)[2] to hold money on their savings accounts. A growing body of research investigates the decision-making process of individuals in the face of low or negative interest rates. Most authors focus on investment decisions and risk-taking, and their results relate low or negative rates to a higher appetite for risk (Bracha, 2016; Ganzach, Y., and Wohl, A., 2018; Lian et al., 2018; Baars et al., 2020; David-Pur et al., 2020).[3] Our research question differs in this paper since we focus on savings (instead of investing) and aim at determining what leads people to tolerate NIRs on their savings. For that purpose, we build on Efendic et al. (2019), who are the first, to the best of our knowledge, to provide preliminary insights into the factors that may modulate people's tolerance for NIRs on savings. Using two experiments, these authors rely on direct questions to assess participants' tolerance towards penalties or NIR that apply to savings deposits.[4] Their results indicate that individuals show a surprisingly large tolerance for NIRs when the only alternative is to take one's savings out of the bank. Moreover, Efendic et al. (2019) find that this tolerance fluctuates as a function of the size of savings, the size of the NIR, and some individual characteristics such as age, gender and risk-taking inclinations.

In this paper, we determine people's intertemporal preferences to infer their willingness to

[2]Interest rates differ from bank fees. For regular savings accounts, bank fees refer to nominal fees for account setup and maintenance as well as transactional services. Such fees can be one-time, recurrent, or related to specific operations. Interest rates relative to regular savings accounts are risk-free rates; i.e., they do not include any risk premium (since there is no risk-taking by the saver). Such interest rates aim at capturing the time value of money, which allows for comparisons of different risk-free amounts of money at various points in time.

[3]Bracha (2016) reports no difference in investment decisions made by individuals faced with positive and negative interest rates. While not directly dealing with NIRs, Ganzach, Y., and Wohl, A. (2018) provides evidence that the lower the risk-free rate, the higher is the demand for risky assets. Baars et al. (2020) find significantly increased risk-taking only when interest rates turn negative. Lian et al. (2018) find that lower interest rates are associated with higher allocations to stocks and lower allocations to cash. David-Pur et al. (2020) conduct a series of lab experiments to analyze both borrowing and investment behavior in the PIR and NIR context. They find that the zero-interest rate has the strongest impact on individuals' investment decisions.

[4]Specifically, Efendic et al. (2019) ask all participants to imagine that all banks have introduced a new policy where one is required to pay to keep savings in the bank. In the first experiment, participants are asked questions in the following format: "You saved X on your account. To have access to it on your bank account for the next 1 year, would you be willing to pay X% of that amount?". In the second experiment, the questions are adjusted to explicitly mention that the payment will occur at the end of the year. For more details, see Efendic et al. (2019).

accept NIRs on their savings. Compared to Efendic et al. (2019) who use direct questions, our approach is indirect, but particularly well-suited to include different time horizons. Specifically, we use an online experiment on Prolific to evaluate intertemporal preferences based on a set of binary choices between spending money today or saving it for the future.[5] Crucially, what is innovative in our setting is that we present participants with future values of savings that may be higher than, equal to or *lower* than the present value of savings at their disposal. As explained before, lower future values of savings would imply that NIRs have been applied to a deposit. Based on participants' intertemporal preferences over two amounts ($500 and $20,000) and five time horizons (from 6 months to 10 years), we first estimate the indifference points, i.e., future amounts of savings that participants require to continue to save money. Subsequently, using the indifference points and the corresponding present values of savings, we are able to infer annual implicit discount rates, which allows for meaningful comparisons across amounts and horizons. In our setting, the discount rate refers to the annualized interest rate at which the decision-maker is willing to continue to save money (instead of spending it immediately on goods or services).

To control for the sequence of binary choices, we define two anchoring conditions in our setting. In the Ascending condition (from NIRs to PIRs), the sequence of choices provides increasing future amounts of savings, which are preset to annual interest rates of -4%, -2%, 0%, 2%, and 4%. By contrast, in the Descending condition (from PIRs to NIRs), the sequence of future amounts is reversed, i.e., future amounts are preset to an annual interest rate of 4%, 2%, 0%, -2%, and -4%. Because preferences can be affected by previous choices, we hypothesize that the decisions made in the Ascending condition should lead to a higher acceptance of NIRs than those made in the Descending condition.

[5]In the literature, two methods are used to measure intertemporal preferences: the matching-based method and the choice-based method. In the former, participants are provided with a given amount of money at a specific point in time (e.g., $20 today) and are asked to express the monetary equivalent at another point in time that makes them indifferent (e.g., $X in one year). This approach is cognitively demanding and can lead to extreme answers (Urminsky and Zauberman, 2015). The choice-based method relies on a set of binary choices that are presented to participants (e.g., $20 today or $25 in one year; $20 today or $30 in one year, etc.). Since participants have to select just one option to express their preferences, this approach is easy to understand. However, how the sequence of choices is presented can potentially bias the decisions. Therefore, one needs to control for the sequence of choices when applying this choice-based method.

This piece of experimental research is innovative in several ways. First, we determine annual implicit interest rates on savings for different amounts and time horizons, allowing people to express negative discounting. As mentioned above, our approach is more indirect that the one applied in Efendic et al. (2019). Its key advantage is to allow for meaningful comparisons across both amounts and time horizons. Although Efendic et al. (2019) only use one single time horizon (one year) in their two experiments, they point out that how people's time preferences would relate to NIRs is another important aspect to probe into. In this paper, we fill the gap and provide insights into how the tolerance to NIRs is related to the time horizon. Second, our two anchoring conditions allow us to compare decisions made by individuals depending on whether they face NIRs or PIRs first. By contrast, Efendic et al. (2019) focus exclusively on NIRs and do not consider PIRs (which is consistent with their approach). Third, we should stress that the range of interest rates in our experiment varies from -4% to 4%, while previous research only considers slightly negative rates. The lowest risk-free rate is equal to -1% in Lian et al. (2018) and Baars et al. (2020), -2% in David-Pur et al. (2020), or -3% in Bracha (2016). In Efendic et al. (2019) who focus on savings as we do, only three values are considered for NIRs, namely, -0.3%, -0.6%, and -1%. Fourth, we relate discount rates to decision-makers' actual savings behavior and financial literacy, which is really innovative in the scarce literature devoted to NIRs.[6] Past research reports that financially literate individuals are more likely to save money (Lusardi, 2008) and can better observe the benefits of saving and investing (Anantanasuwong, 2019). We posit that since financially literate people have a higher propensity to plan for retirement (Lusardi and Mitchell, 2007; van Rooij et al., 2012), they are more likely to tolerate NIRs on their savings than their counterparts. In addition, a higher familiarity with the low level of interest rates paid on savings deposits over the last decade and/or a more future-oriented mindset should make them more tolerant to NIRs than individuals with low financial literacy.

The main results of the paper can be summarized as follows. Participants show intertem-

[6]Efendic et al. (2019) do not include actual savings behavior and financial literacy in their study. They focus on the following individual differences: age, gender, education, income, risk-propensity, numeracy, and ability to delay gratification. They obtain significant differences in NIR tolerance with regards to age, gender, and risk-propensity. For more details, see Efendic et al. (2019).

poral preferences revealing that they are willing to accept lower future values (i.e., accept NIRs) on savings, and these preferences depend on several factors. First, participants are more likely to tolerate NIRs for the low amount of savings ($500) than for the high amount ($20,000). This result is consistent with a *reverse* magnitude effect. One possible reason for this effect is that the interest to be paid appears lower in absolute terms for the small amount of savings than for the corresponding interest on the large amount of savings. Second, annual implicit interest rates are positively associated with the time horizon—the longer the horizon, the lower is the tolerance of NIRs. This result is consistent with people's reluctance to accept recurrent losses or to commit to losses for longer time horizons. Third, participants who save money regularly are more likely to tolerate NIRs than those who are not regular savers. We relate this finding to the status quo bias, a higher familiarity with savings deposits, and/or a future-oriented mindset (i.e., regular savers have put savings aside for the future and NIRs cannot compromise that future). Next, participants who face future values implying NIRs first (in the Ascending condition) are more likely to tolerate NIRs than participants who face future values implying PIRs first (in the Descending condition). This result is consistent with anchoring and/or satisficing behavior. We however find no significant difference related to financial literacy. Since the level of financial literacy is pretty high among our participants, we cannot exclude that this finding is (at least partially) due to a lack of heterogeneity in the sample.

The remainder of the paper is organized as follows. Section 2.2 reviews the relevant literature and presents our hypotheses. Section 2.3 describes our experimental setting. Section 2.4 reports the results. Section 2.5 concludes.

2.2 Literature and Hypotheses

2.2.1 Why do people discount future monetary outcomes?

Why people tend to discount future monetary outcomes has been extensively addressed in the decision-making literature. Given our research question, we focus on the main economic reasons. The first driver is the opportunity cost, which represents the benefits of the second-best alternative. Let us take a simple example wherein a decision-maker is offered \$100 today or \$110 in one year. His/her choice depends on the opportunity cost. If he/she can put the available money in a bank account and receive \$120 in return after one year, the gain from this alternative is higher than the gain from choosing the future amount (\$120 > \$110). The difference between these two alternatives is \$10 (\$120 - \$110), and the best choice for him/her is to take the money now and deposit it in the bank for one year. If the bank offers only \$105 after one year, he/she is more likely to take the future amount (\$110) because it delivers a higher gain (\$110 - \$105= \$5).[7] The opportunity cost is then an important determinant of discounting that matters for both gains and losses. The higher the benefits of the alternative, the higher is the discount rate.

The second reason for discounting future monetary outcomes is uncertainty. The present is always certain, whereas the future is consistently related to some uncertainty. The uncertainty of human life can decrease the value of future monetary outcomes (i.e., "A bird in the hand is worth two in the bush"). People may worry that an accident might happen before they can receive their future reward. This could make immediate monetary options more favorable than future ones. Morbidity and mortality are additional reasons for worries regarding future payments. For instance, lower discount rates are observed among college students and teenagers than among soldiers who live in a risky and violent

[7] In the cases of losses, the decision-maker is offered the choice to pay a debt of \$100 today or \$110 in one year. If the bank offers \$120 in a year, a better option for him/her is to postpone the payment and deposit the money in the bank. If he/she does that, he/she can take \$120 from the bank after one year, pay the debt (\$110), and keep \$10 as gain. If the bank offers only \$105 in one year, it is better to pay the debt immediately because the money available in one year is not enough to pay the debt entirely (\$105 < \$110).

atmosphere wherein the risk of mortality is higher (Lahav et al., 2011). Individuals with bad health conditions also have higher discount rates than their healthier counterparts (Chao et al., 2009).

In the same vein, expectations about available resources in the future[8] are another driver of discounting. When expecting to receive additional money in the future and facing options related to gains, decision-makers are more likely to choose the immediate option ("I will have more money in the future, and I can spend the money now"). In contrast, decision-makers can postpone payments (losses) if they expect that their financial capacity will be better in the future ("I will have more money in the future, and I can pay that bill later even though it will cost me more").

2.2.2 Why do we observe differences in discount rates?

In the literature devoted to intertemporal preferences, several factors affecting discount rates for monetary outcomes have been proposed. First, discount rates for gains and losses differ significantly, meaning that the sign of the possible outcome plays a role. Because failing to wait for a reward creates an opportunity cost whereas postponing a loss creates an additional cost (Thaler, 1980), discount rates for losses are expected to be smaller than those for gains. Thaler (1981) finds that gains are typically related to higher discount rates than losses. Hardisty et al. (2013) also find lower discount rates for losses than for gains; for small losses, discount rates are slightly negative, while for large losses, discount rates are slightly positive.

The amount of money at stake is the second reason for the differences in discount rates. This is the so-called magnitude effect. Thaler (1981) finds a negative relationship between the size of gains and discount rates. For larger gains, discount rates are lower than those for smaller gains. For example, people prefer \$5 today over \$6 in a year but are willing to wait one year to get \$6,000 over \$5,000 today. Read et al. (2013) explain that this

[8]In the psychological literature, the concept of resource slack refers to the future availability of a certain resource (such as time or money). Zauberman and Lynch Jr (2005) find that time is discounted more steeply than money.

magnitude effect occurs because decision-makers pay attention to the absolute difference between the amount available today and its future value. In the above example, the case of \$5 implies a difference of only \$1 (\$6 - \$5), while the difference is much higher in the second case (\$1,000 (\$6,000-\$5,000)). The gain of \$1,000 appears much more attractive than the gain of \$1, although the discount rate is the same (20%) in both cases. Breuer et al. (2018) explore the differences in discount rates for gains and losses by drawing a distinction between an interest-rate frame and a money frame.[9] For gains, these authors find a negative relationship between the outcome size and discount rates regardless of the prevailing frame, consistent with a *conventional* magnitude effect. However, they document a *reverse* magnitude effect for losses in the interest-rate frame. This means that as the amount of money at stake increases, the interest rate also increases (i.e., interest rates are higher for larger losses than for smaller losses). Accordingly, people would prefer to receive \$4.2 after one year instead of \$5 today more than they would prefer to receive \$4,200 after one year instead of \$5,000 today. In this example, the loss of \$800 seems much higher than the loss of \$0.8, although the discount rate is the same in both cases (-20%). Efendic et al. (2019) find that the tolerance for NIRs is higher for small than for large amounts, which supports this *reverse* magnitude effect.

Mental accounting, whereby decision-makers have different mental accounts for small and large amounts, could also explain the magnitude effect. Small amounts are more easily associated with current expenditures (e.g., buying clothes, going on vacation, etc.), whereas large amounts are more easily seen as savings or outstanding spending (e.g., buying a car, a house, etc.). However, mental accounting does not help explain the discount rates for small and large losses (Hardisty et al., 2013).

Another driver of differences in discount rates is hyperbolic discounting, i.e., decision-makers typically have a declining discount rate as the time horizon increases (Ainslie and Haslam, 1992). The longer the horizon, the lower is the discount rate. Thaler (1981)

[9] In a money frame, participants have to choose between two monetary outcomes, and the corresponding implicit interest rate between the present amount and its future value is not revealed. By contrast, in an interest-rate frame, the implicit interest rates of return from alternative outcomes (instead of the monetary values) are directly presented to participants.

reports that when people are asked how much money they would require in one month/one year/ten years to make them indifferent towards the option of receiving $15 now, their responses are $20, $50 and $100, respectively, which implies an annual interest rate[10] of 345% for the one-month horizon, 120% for the one-year horizon and 19% for the ten-year horizon. Such differences in discount rates are potentially due to the compounding effect, which is hard to consider because of the accumulation of interest on interest. Decision-makers who do not consider the compounding effect might think that it is enough to multiply the initial rate per period by the number of periods. Therefore, as the number of periods increases, their future values also increase but at a decreasing rate.[11] Since the compounding effect is more prominent as the time horizon increases, this phenomenon is more likely to appear for longer than for shorter horizons. However, in the case of losses, neither a positive nor a negative correlation between the time horizon and discount rates has been observed.

Discount rates also depend on financial literacy. Lusardi and Mitchell (2011) defines financial literacy as basic knowledge regarding compounding, inflation, and diversification. These authors show that low financial literacy may lead decision-makers to make mistakes that are very often irreversible. Furthermore, financially literate people are more likely to save money (Lusardi, 2008) and to plan for retirement (Lusardi and Mitchell, 2007; van Rooij et al., 2012; Anantanasuwong, 2019). Focusing on the impact of financial literacy on time preferences, Lahav et al. (2015) find that higher financial literacy decreases subjective discount rates. These authors define the subjective discount rate as the rate at which individuals trade current and future values, which is assumed to be higher for individuals who are more focused on the present and lower for those who are more future-oriented.

The order of immediate outcomes in the experimental setting also drives some differences in discount rates. When presented to decision-makers, immediate outcomes can be as-

[10] Using a continuous compounding formula.

[11] Let us consider an example for gains. Decision-makers are faced with the choice of receiving $1,000 today or $1,100 in a year. After that first decision, they are faced with the choice of receiving $1,000 today and $1,610.51 in 5 years. The interest for one year is $100 and for 5 years is $610.51. In both cases, the annual interest rate is 10%. Decision-makers unfamiliar with compounding might think that the second option (with 5 years) yields a higher interest rate and may be more likely to accept the second option than the first one.

cending, descending or random. Immediate outcomes in ascending order are displayed from lowest to highest. For example, decision-makers are first presented with $100 today against $110 in one year and then with $1,000 today against $1,100 in one year, etc. The descending order is just the opposite—immediate outcomes are presented from the highest to the lowest (i.e., we first show $1,000 today as opposed to $1,100 in one year and subsequently $100 today against $110 in one year). The random order includes some randomization in the selection of immediate outcomes. The order of immediate outcomes is not trivial. Robles and Vargas (2007) determine the highest discount rates in descending order, slightly lower discount rates in ascending order, and the lowest discount rates in random order. They explain these results through the influence of past responses on future ones.

2.2.3 Why might people accept NIRs on their savings?

Although NIRs are often viewed as a monetary policy tool aimed at boosting risk-taking and/or spending (Lilley and Rogoff, 2019), aggregate household savings are still increasing in countries experiencing all-time low rates[12] or NIRs (Europe, 2019). Such an observation is puzzling and raises the critical question: why might people accept NIRs on their savings?

At the root of the implementation of NIRs is the belief that NIRs can boost economic growth, as individuals (just as financial institutions and firms) are penalized for hoarding money when they could spend it, lend it, or invest it instead. Because individuals tend to be loss averse (i.e., weight losses higher than gains)[13] and may regard NIRs as a certain loss, they should not tolerate them. Nevertheless, in reality, the observed facts may turn out to be different. There are at least three reasons why people might show some tolerance for NIRs.

The first reason is the *precautionary motive*, which explains why people save money. They save money to match future needs, i.e., expected and/or unplanned expenditures.

[12]Even when nominal rates are still positive, real rates may be negative because of the inflation rate.

[13]This finding is a cornerstone of prospect theory (Kahneman and Tversky, 1979) and is widely documented in the decision-making literature.

By doing so, people aim to ensure the security of future payments. This precautionary motive is especially related to uncertainty regarding future incomes. When uncertainty is high, people will start to save or will save more to mitigate this uncertainty (Aizenman et al., 2015). This is known as precautionary savings, i.e., extra savings (Lugilde et al., 2019). As uncertainty increases, current savings also increase (Merrigan and Normandin, 1996). Over the last decade, uncertainty has increased in many countries because of economic, political, and/or financial disturbances. In particular, most people are aware that monetary policy rates set by central banks and risk-free rates in general have reached all-time low (or even negative) levels in the aftermath of the 2008 financial crisis. Beyond the descending pattern of risk-free rates, the implementation of NIRs itself has acted as a red flag, i.e., a warning signal about the highly uncertain economic situation in most of the industrialized countries. Hence, this increasing uncertainty could explain why aggregate household savings are still increasing, despite all-time low rates or NIRs.

The next reasons relate to how people prefer to save money. *Safekeeping* is one of the oldest functions of banking (Lord, 1984). In this respect, banks obviously add value since saving money in a bank is safer than holding cash at home, where the risk of robbery is higher (He et al., 2008). In addition, the *practicality* associated with bank accounts is attractive. Deposit accounts are often considered advantageous (or even necessary) for easy management of one's money (e.g., for online payments, access, transfer, etc.).[14] Such practicality is important in an increasingly cashless society. We could add that in many industrialized countries, money kept in bank deposits is insured by the government (up to certain amounts). Such insurance might work in favor of saving money in banks.

Finally, we should stress that people's trust in the banking system could also play a role. Using household survey data from Central, Eastern and Southeastern European countries, Stix (2012) documents that a lack of trust in banks and memories of past banking crises are important determinants of why individuals prefer to hold assets in cash rather than in banks. In addition, he reports that cash preferences are negatively related with wealth

[14]Bank safe-deposit boxes fulfill the safekeeping function but do not offer the same practicality as bank deposits.

and financial literacy but positively related to risk aversion.

2.2.4 Hypotheses

Building on the literature, we formulate five hypotheses to be tested in our experiment.

The first hypothesis is related to the aforementioned magnitude effect. Since NIRs are associated with losses, we expect a *reverse* magnitude effect,[15] i.e., participants are expected to require higher annual interest rates for the high amount of savings ($20,000) than for the low amount ($500). Accordingly, participants should be more likely to tolerate NIRs for lower levels of savings. However, in our setting, each participant makes a set of choices involving either a positive or a negative interest rate, regardless of the anchoring condition. In the Descending condition, participants first face future values implying PIRs (so that they start in the domain of gains). Therefore, we expect a lower *reverse* magnitude effect for the participants in the Descending condition.

The second hypothesis captures the impact of time on annual implicit interest rates. Based on hyperbolic discounting, annual implicit rates of interest are expected to decrease as the time horizon increases. Thaler (1981) finds this negative relationship for gains, but no clear evidence is reported for losses. For the latter, a misunderstanding of the compounding effect could have the opposite impact to that related to gains. Let us use a simple example to illustrate this effect. Imagine decision-makers have to choose between taking $1,000 today or holding that amount in savings to receive $900 in one year. After that first decision, they have to choose between taking $1,000 today or holding it in savings to receive $590.49 in 5 years. The interest is negative and amount to -$100 for one year and -$409.51 for 5 years. Although both future amounts are based on an annual interest rate of -10%, losing $409.51 in interest after 5 years might seem more acceptable than losing $100 in a single year. On the other hand, for NIRs, another aspect could come into play:

[15]Since our participants are not directly informed of interest rates, we are in a monetary frame. However, since they are requested to make decisions related to their savings, the context itself leads them to adopt a return-oriented view (instead of a money-oriented view). For more details on this aspect, please refer to Breuer et al. (2018).

people might simply be reluctant to accept recurrent losses. Put differently, it might be harder to commit to losses for a longer time horizon. Consequently, we hypothesize that annual implicit interest rates will be higher for longer time horizons. Participants should then be more likely to tolerate NIRs when saving for shorter horizons. Again, the strength of this relationship could differ depending on the anchoring condition. In the Descending condition, participants first face future amounts implying PIRs, which means they start in the domain of gains. By contrast, in the Ascending condition, participants first face future amounts implying NIRs, which put them directly in a frame of losses. Participants could face NIRs in both conditions, but the anchoring difference could generate a positive but weaker relationship between annual interest rates and the time horizon in the Descending condition.

The third hypothesis considers individual savings behavior. We hypothesize that participants who save money regularly are more likely to tolerate NIRs on savings than those who are not regular savers. This hypothesis builds on status quo bias, which refers to people's preference to keep things the same by doing nothing (Samuelson and Zeckhauser, 1988). The potential causes of this psychological phenomenon are regret avoidance and drive for consistency. Regret avoidance means that decision-makers feel worse when bad consequences result from action rather than inaction. In our setting, status quo bias could lead participants to continue to save money (inaction) rather than remove their money from the bank (action). The drive for consistency is the belief that past decisions are optimal. In our setting, this could make decision-makers disregard new information to maintain their original decisions (i.e., continue to save money in the bank regardless of the updated conditions). Alternatives to the status quo bias might also explain why a higher tolerance for NIRs is expected among participants who are regular savers in reality. On the one hand, their familiarity with savings might make them aware of the (all-time) low interest rates offered by commercial banks over the last decade. We may assume that individuals who are not used to save regularly are not so familiar with the interest rates paid on savings deposits. On the other hand, regular savers might have a specific mindset, i.e., they are more future-oriented than the ones who do not save money

on a regular basis. According to Efendic et al. (2019), people might tolerate NIRs to be consistent with their savings commitment, i.e., they put savings aside for the future and NIRs cannot compromise that future (Ariely and Norton, 2008; Cialdini, 2009). Furthermore, the implementation of NIRs might act as a red flag about high uncertainty in the economic system, which might push people towards safer assets and make them tolerate small losses to ensure their future.

The fourth hypothesis is linked to financial literacy, i.e., general knowledge regarding compounding, inflation and diversification (Lusardi and Mitchell, 2011). More financially literate participants are expected to be more tolerant of NIRs on savings than less financially literate participants. This hypothesis is consistent with a higher propensity to plan for retirement among financially literate people (Lusardi and Mitchell, 2007; van Rooij et al., 2012). A low level of financial literacy may stimulate immediate consumption instead of savings (regardless of the offered conditions). In addition, financially literate individuals are more likely to save and then to be more familiar with the low level of interest rates paid on savings deposits. They are also more future-oriented, as suggested in Lahav et al. (2015). Both higher familiarity and more future-oriented mindset are expected to increase the tolerance to NIRs.

The fifth hypothesis aims to control for the sequence of choices. Consistent with anchoring bias[16], we assume that the annual implicit interest rates in the Ascending condition are lower than those in the Descending condition. In the Ascending condition, anchors are the lowest future values that imply NIRs, which should make participants more tolerant of NIRs. In the Descending condition, anchors imply PIRs, which should make participants less tolerant of NIRs. Such expectations might also be related to satisficing behavior (Itzkowitz et al., 2016). Individuals are said to be satisficers because when facing a large number of options, they tend to choose the first acceptable option rather than the best possible one. In our setting, the first acceptable option in the Ascending condition is more likely to be an annual implicit rate that is lower than the one corresponding to the first

[16]Anchoring is a particular type of priming effect whereby initial exposure to a number serves as a reference point and influences subsequent judgments about value. The process usually occurs without our awareness (Tversky and Kahneman, 2013).

acceptable option in the Descending condition.

2.3 Experimental setting

The experiment is conducted using oTree (Chen et al., 2016). All participants are directed to imagine that the central bank of their country applies an active interest rate policy, which aims at stimulating economic growth and consumption. They are also asked to imagine that there is only one commercial bank in their country and that they have accumulated some savings in their account at that bank. Participants are informed that interest rates on savings can be either positive or negative. They are then asked to decide whether they prefer to remove their money from the bank to spend it immediately on goods and/or services or continue to save for a given horizon. There is no risk, regardless of whether they remove the money from the bank to spend it or save it in the bank for the future. The full instructions are presented in Figure 2.1.[17]

The experiment includes 10 web pages that present various savings amounts and different time horizons. The savings amount is either high ($20,000) or low ($500). The time horizon ranges from 6 months to 1, 2, 5 or 10 years. Each participant moves through the 10 pages with different amounts and horizons, but the order of the savings amounts ($20,000 versus $500) and horizons is randomized to avoid the order effect for immediate outcomes (Robles and Vargas, 2007).

Our experiment has a mixed design with one factor that is between-subject, the anchoring condition (Ascending vs. Descending), and two factors that are within-subject, the time horizon and amount of savings. In both anchoring conditions, each page includes from one to five binary choices. For each choice, the first option is to remove the money from the bank to spend it immediately on goods and/or services, while the second option is to

[17]These instructions contain an example of binary choice, which is based on the low amount of savings ($500) and a future value of $495 in 3 months. This might create some anchoring and lead to a greater acceptance of NIRs for the low amount of savings. If any, such an anchor should however be very weak since (1) the amount of savings is randomized, and (2) participants are presented first with binary choices implying PIRs in the Descending condition or NIRs in the Ascending condition.

hold it in savings for the future. For each page, the present amount of savings is constant (either $500 or $20,000). The sequence of future amounts depends on the anchoring condition. In the Ascending condition, the sequence increases from the first to the fifth binary choice, with future amounts preset to annual interest rates of -4%, -2%, 0%, 2%, and 4%. Once the participant decides to continue to save money for the future, he/she moves to another page. For example, if in the first binary choice the participant opts for the future amount that yields -4%, he/she moves to the next page. By contrast, if his/her first choice is to take the money and spend it immediately (instead of saving it for the future to receive -4%), he/she faces the second binary choice with a future value that yields -2%. Again, if the participant takes the future amount (with -2%), he/she moves to the next page. The decision-making process for the Ascending condition is presented in Figure 2.2. In the Descending condition, the sequence of future outcomes is reversed—future amounts are preset to annual interest rates of 4%, 2%, 0%, -2% and -4%. Figure 2.3 displays the decision-making process in the Descending condition.

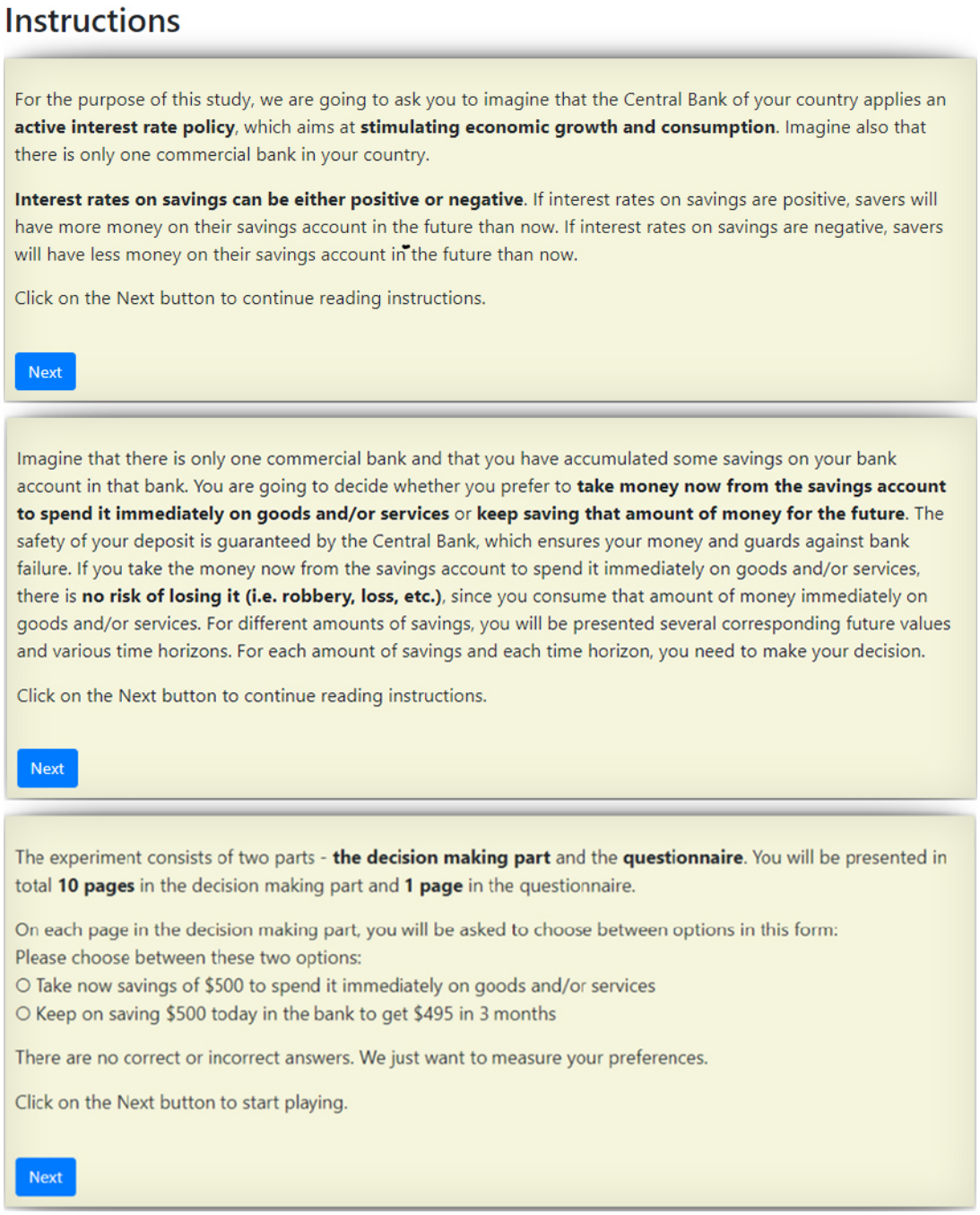


Figure 2.1: Computer screenshot of instructions

Our experiment includes a questionnaire presented after the decision-making section and including several items that relate to financial literacy, savings behavior, and the purpose of savings. The financial literacy item consists of three questions addressing compounding, inflation, and diversification (Meier and Sprenger, 2013). The question about savings behavior is dichotomous: does the participant save money regularly or not? The last question is related to the purpose of savings. Our goal is to investigate the relationship

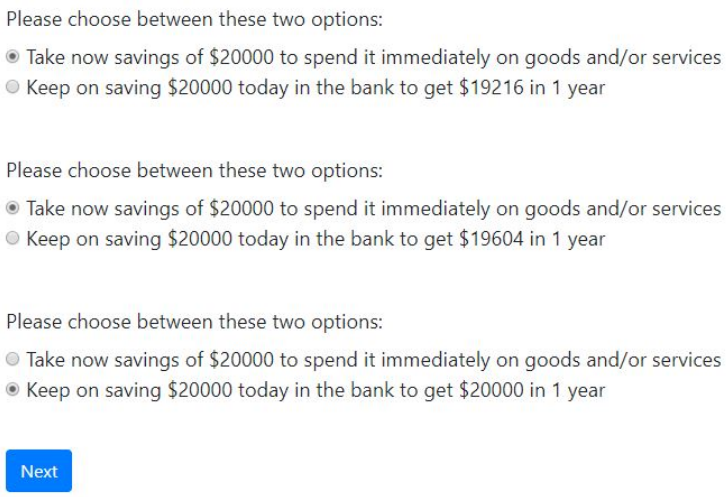


Figure 2.2: Computer screen—decision-making in the Ascending condition

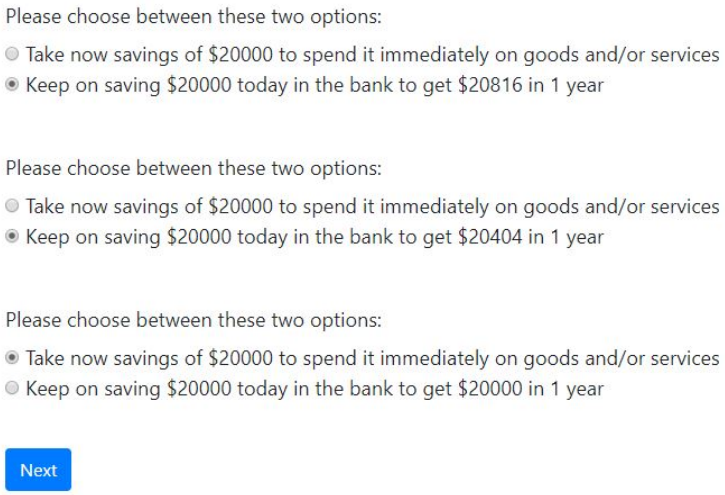


Figure 2.3: Computer screenshot—decision-making in the Descending condition

between these items and annual implicit interest rates. The specific questions are available in Appendix 7.4.2.

All participants in the experiment are paid a fixed reward of £1.50. This means that participants are not incentivized since their choices do not affect their rewards. This absence of incentives might be a limitation of our study because past research has shown that hypothetical questions do not always accurately predict real economic commitments (Neill et al., 1994). In particular, participants are more likely to overstate their preferences with hypothetical questions than with real economic commitments (List and Gallet, 2001). In our case, participants could reveal a higher or lower tolerance to NIRs than the one they

would show in reality. On the other hand, Camerer and Hogarth (1999) provide evidence that people's choices do not differ so much between incentivized and non-incentivized settings.[18] According to Read (2005), there is even no basis for requiring the use of real incentives in economic experimental settings. Facing this lack of consensus, we opt for a fixed reward given the difficulty to define any incentives depending on our set of binary choices that, for some of them, imply NIRs, i.e., losses.

2.4 Results

2.4.1 Participants

We use Prolific Academic[19] to recruit participants, with prescreening based on age, nationality, and first language. Participants are required to be between 18 and 65 years old and U.S. citizens[20] whose first language is English. Our average participant is 34 years old. We have more females (102) than males (84). The females in our sample are on average older than the males (35 versus 32 years). Most participants are full-time employed (54%), while 20% of them are students.

The score on financial literacy for each participant is built on three questions (addressing compounding, inflation, and diversification; see Appendix 7.4.2). Since the score is an equally weighted sum, its maximum is 3, when all three questions are answered correctly, and its minimum is 0, when none of the answers are correct. Hence, financial literacy is an ordinal variable, with four levels: 0 for the lowest level of financial literacy, 1 for a low level

[18] These authors review 74 experiments with no, low, or high performance-based financial incentives. They report that the modal result has no effect on mean performance, although higher payment is often associated with lower variance.

[19] Prolific Academic is an online crowdsourcing platform (https://www.prolific.co/). Crowdsourcing platforms have numerous advantages. They are as reliable as lab experiments (Peer et al., 2017). They allow for the recruitment of a large number of participants, which provides high statistical power. The speed of online experiments is also remarkable (Musch and Reips, 2000). In addition, online experiments are cost-effective since they are often less expensive than lab experiments.

[20] To the best of our knowledge, NIRs on standard savings accounts have not been introduced in the US. Participants are likely to be aware that the FED policy rates and risk-free rates in general have reached all-time low levels in the aftermath of the 2008 financial crisis, but none should have been confronted with NIRs on their actual bank savings account. This makes our sample homogeneous on that aspect. Our participants are free of any biases or misinformation on NIRs.

of financial literacy, 2 for a high level of financial literacy, and 3 for the highest level of financial literacy. The average level of financial literacy in our sample is relatively high at 2.33. More than half of the participants (103 out of 186) have the highest level of financial literacy (see Table 7.2 in Appendix 7.1.2). Participants are best at compounding: 86% answer the related question correctly (see Table 7.1 in Appendix 7.1.2). We also assess each participant's savings behavior with a binary variable (regular saver or not). The vast majority of our participants save money regularly (78%). Table 2.1 shows that the proportion of regular savers is lower among participants who have the lowest level of financial literacy. This is consistent with the findings of Lusardi and Mitchell (2011), who find that financially literate people are more likely to save money.

Table 2.1: Savings behavior depending on financial literacy

	Financial literacy			
	0	1	2	3
Number of participants	9	25	49	103
Number of regular savers	6	21	41	78
Regular savers (%)	66.66	84.00	83.67	75.72

This table presents the number of participants and of savers by financial literacy level. Savings behavior is a binary variable: participants either save money regularly or do not. Financial literacy is an ordinal variable, with 0 and 3 as the lowest score and the highest score, respectively. The score is built on the number of correct answers provided to three questions addressing compounding, inflation, and diversification. These questions are available in Appendix 7.4.2.

2.4.2 Annual implicit interest rates

To make relevant comparisons across anchoring conditions, horizons, and amounts of savings, we need to determine annual implicit rates with a two-step process. In the first step, we determine the indifference points based on intertemporal preferences.[21] In the second step, we use the indifference points to calculate the corresponding annual implicit interest rates.[22]

[21]The indifference point is calculated as the point when a participant is indifferent between consumption today or saving money for the future. Accordingly, it is an average of the upper and the lower bounds of future amounts chosen by the participants. For individuals who make decisions at the boundaries, we use the future amount to derive the indifference point.

[22]We use the continuous compounding formula as in Thaler (1981)

In Panel A of Table 2.2, we report the average indifference points depending on both the anchoring condition and the amount of savings. In the Ascending condition, for both high and low amounts and across all horizons, the average indifference points are smaller than the corresponding ones in the Descending condition. For example, in the Ascending condition, for the shortest horizon (6 months) and when the amount is high, decision-makers are indifferent between taking $20,000 today and holding that amount in the bank to obtain $19,837.37 in 6 months. In the Descending condition, for the same horizon and amount, participants are indifferent between $20,000 today and $20,110.40 in 6 months. Panel B of Table 2.2 presents the average implicit interest rates based on the indifference points reported in Panel A. The average implicit interest rates are lower in the Ascending condition than the corresponding ones in the Descending condition.

Table 2.2: Average indifference points and average implicit interest rates

	Time Horizon				
Condition	6 months	1 year	2 years	5 years	10 years
Panel A: **Average indifference points**					
Ascending – High ($20,000)	$19,837.37	$19,622.78	$19,718.95	$19,547.62	$19,753.22
Ascending – Low ($500)	$497.10	$499.83	$509.44	$528.21	$599.92
Descending – High ($20,000)	$20,110.40	$20,128.33	$20,619.41	$21,234.53	$23,865.27
Descending – Low ($500)	$503.43	$510.57	$524.52	$561.99	$660.62
Panel B: **Average implicit interest rates**					
Ascending – High ($20,000)	-0.80%	-1.93%	-1.59%	-3.21%	-4.30%
Ascending – Low ($500)	-0.65%	-0.04%	1.63%	4.51%	14.82%
Descending – High ($20,000)	0.73%	0.61%	2.93%	5.42%	16.27%
Descending – Low ($500)	0.76%	2.11%	4.61%	10.95%	25.97%

In this table, Panel A presents the average indifference points across horizons, while Panel B provides the corresponding average implicit interest rates. There are two anchoring conditions (Ascending and Descending) and two amounts of savings ($500 and $20,000). Five time horizons are considered (6 months and 1, 2, 5, and 10 years).

Figure 2.4 presents the average annual implicit interest rates. The lowest average annual implicit interest rate is observed in the Ascending condition for the high amount ($20,000), while the highest average annual implicit interest rate is observed in the Descending condition when the amount is low ($500).

Our first hypothesis posits a *reverse* magnitude effect. We conduct a paired t-test of a

difference in the means of the annual implicit interest rates between the low and high amounts for each time horizon. Table 2.3 reports the results, with Panel A displaying those for the Ascending condition and Panel B those for the Descending condition. In both anchoring conditions, the difference between the annual implicit interest rates for the two amounts at the 6-month and 1-, 2-, 5- and 10-year horizons is negative and significant at the 1% level. These univariate findings reveal a *conventional* magnitude effect in both anchoring conditions: the average annual implicit interest rates are significantly lower for the high amount of savings. This evidence does not support our first hypothesis.

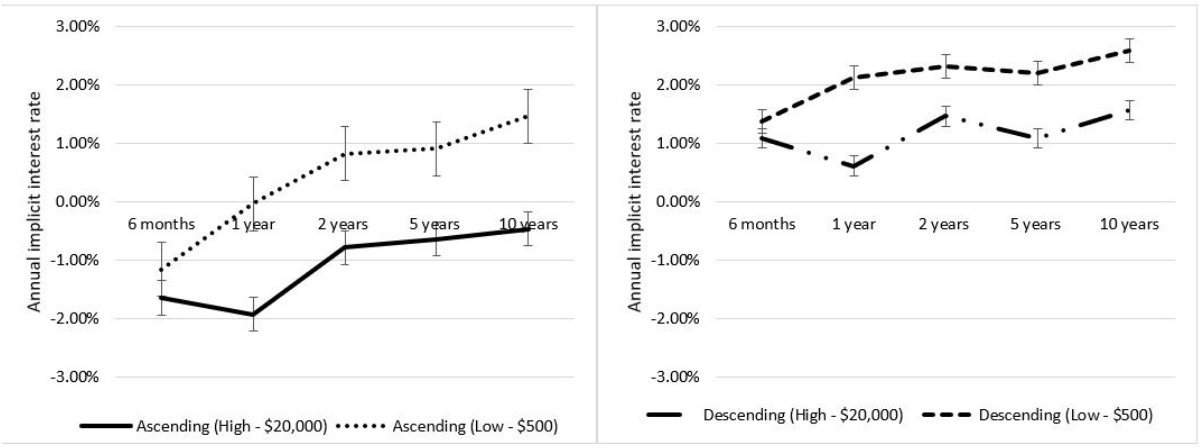


Figure 2.4: Average annual implicit interest rates

This figure presents the average annual implicit interest rates. The horizontal axis refers to the time horizon, while the vertical axis refers to the annual implicit interest rates.

Table 2.3: Differences in average annual implicit interest rates – magnitude effect

	Time Horizon				
Condition	6 months	1 year	2 years	5 years	10 years
Panel A: **Ascending condition**					
Ascending – High ($20,000)	-1.65%	-1.93%	-0.79%	-0.64%	-0.47%
Ascending – Low ($500)	-1.16%	-0.04%	0.82%	0.90%	1.46%
Differences (High - Low)	-0.49%	-1.89%	-1.61%	-1.54%	-1.92%
t-value	-11.95	-10.28	-9.18	-10.61	-9.28
p-value	<0.0001	<0.0001	<0.0001	<0.0001	<0.0001
Panel B: **Descending condition**					
Descending – High ($20,000)	1.08%	0.61%	1.46%	1.08%	1.56%
Descending – Low ($500)	1.37%	2.11%	2.31%	2.19%	2.58%
Differences (High - Low)	-0.29%	-1.50%	-0.85%	-1.11%	-1.02%
t-value	-15.07	-15.52	-13.69	-10.12	-14.22
p-value	<0.0001	<0.0001	<0.0001	<0.0001	<0.0001

This table presents the average annual implicit interest rates for both anchoring conditions across all time horizons, the differences between the average annual interest rates related to both the high and low amounts, and the corresponding t-values and p-values conducted with paired t-test. Panel A focuses on differences in the Ascending condition, while Panel B refers to the Descending condition.

Due to anchoring bias (and/or satisficing behavior), the average annual implicit interest rates are expected to be lower in the Ascending condition than in the Descending condition. Table 2.4 reports the results of a two-sample t-test assessing the differences in the average annual implicit interest rates between the two anchoring conditions. In the Ascending condition, for both the high and low amounts, the annual implicit interest rates are always significantly lower than those in the Descending condition. The largest differences are observed for the shortest horizon, i.e., 2.74% for $20,000 and 2.53% for $500. These univariate findings support our hypothesis. Consistent with Table 2.4, the proportion of decisions that tolerate NIRs is higher in the Ascending condition (54.89%) than in the Descending condition (20.95%). The details regarding acceptance of NIR, i.e., the number of decisions in which participants opt to hold their savings in the presence of NIRs, are provided in Appendix 7.1.3.

Table 2.4: Differences in average annual implicit interest rates – anchoring bias

Condition	Time Horizon				
	6 months	1 year	2 years	5 years	10 years
Panel A: **High amount**					
Descending – High ($20,000)	1.08%	0.61%	1.46%	1.08%	1.56%
Ascending – High ($20,000)	-1.65%	-1.93%	-0.79%	-0.64%	-0.47%
Differences (Descending - Ascending)	2.74%	2.54%	2.26%	1.73%	2.03%
t-value	7.25	7.33	5.91	5.16	6.26
p-value	<0.0001	<0.0001	<0.0001	<0.0001	<0.0001
Panel B: **Low amount**					
Descending – Low ($500)	1.37%	2.11%	2.31%	2.19%	2.58%
Ascending – Low ($500)	-1.16%	-0.04%	0.82%	0.90%	1.46%
Differences (Descending - Ascending)	2.53%	2.15%	1.49%	1.29%	1.12%
t-value	5.78	4.89	3.58	3.45	3.2
p-value	<0.0001	<0.0001	0.0002	0.0003	0.0008

This table presents the average annual implicit interest rates for both anchoring conditions across all time horizons, the differences between the average annual implicit interest rates for the high and low amounts separately, and the corresponding t-values and p-values. Panel A focuses on the differences in the annual implicit interest rates for the high amount of savings, while Panel B refers to those for the low amount of savings.

2.4.3 Tolerance of NIRs

To assess tolerance of NIRs, we estimate a binary logit model wherein the dependent variable, $TTNIR_{i,d}$, is set to one when the annual implicit interest rate associated with a given decision d made by participant i is negative and zero otherwise. Our set of explanatory variables includes both individual-varying and decision-varying variables. The individual-varying variables are age, gender, savings behavior, financial literacy, and the anchoring condition. Gender is defined as a binary variable ($Gender_i$) that is set to one for men. Savings behavior is captured by a binary variable ($Regular\_saver_i$) that equals one for participants who are regular savers. Financial literacy is also coded using three binary variables ($D\_Low\_literacy_i$, $D\_High\_literacy_i$, and $D\_Highest\_literacy_i$), which are set to one when financial literacy scores are at the low, high, and highest levels.[23] To control for the anchoring condition, we use an additional binary variable ($Ascending\_group_i$)

[23]We also estimate a logit model wherein we replace the binary variables for financial literacy with a dummy for compounding, which is set to one when participants provided a correct answer to the specific question about compounding and zero otherwise. We do not find any significant result for compounding and obtain similar findings overall (available upon request).

set to one for participants in the Ascending condition. The time horizon and amount of savings are the two decision-varying variables. The time horizon is included by using four binary variables ($D\_Year\_1_{i,d}$, $D\_Year\_2_{i,d}$, $D\_Year\_5_{i,d}$, and $D\_Year\_10_{i,d}$) set to one for time horizons of 1, 2, 5, and 10 years. The amount of savings is also coded as a binary variable ($High\_amount_{i,d}$) that is set to one when the amount is high ($20,000) and zero otherwise ($500).

All these explanatory variables are not highly correlated (see Table 7.4 in Appendix 7.1.4). Since we deal with panel data (with ten decisions per participant across 186 participants), we cluster standard errors by participant (Petersen, 2009) when estimating the resulting model:

$$\begin{aligned} TTNIR_{i,d} = \beta_0 + \beta_1 Age_i + \beta_2 Gender_i + \beta_3 D\_Year\_1_{i,d} + \beta_4 D\_Years\_2_{i,d} + \\ \beta_5 D\_Years\_5_{i,d} + \beta_6 D\_Years\_10_{i,d} + \beta_7 Ascending\_group_i + \\ \beta_8 High\_amount_{i,d} + \beta_9 Regular\_saver_i + \beta_{1_0} D\_Low\_literacy_i + \\ \beta_{1_1} D\_High\_literacy_i + \beta_{1_2} D\_Highest\_literacy_i + \epsilon_{i,d} \end{aligned} \tag{2.1}$$

Table 2.5: Tolerance of NIRs

Parameter	Model 1		Model 2	
	Estimate	OR	Estimate	OR
Intercept	-0.6605		-0.7763	
Age	-0.0026	0.9974	-0.0026	0.9974
Gender	-0.1656	0.8474	-0.1663	0.8468
D_Year_1	-0.1417*	0.8679	-0.1416*	0.8679
D_Years_2	-0.6879***	0.5027	-0.6898***	0.5017
D_Years_5	-0.8295***	0.4363	-0.8325***	0.4350
D_Years_10	-1.0066***	0.3655	-1.0111***	0.3638
Ascending_group	1.6093***	4.9990	1.8222***	6.1850
High_amount	-0.5808***	0.5594	-0.3169**	0.7280
Regular_saver	0.5155*	1.6744	0.5190*	1.6803
D_Low_literacy	-0.1645	0.8483	-0.1659	0.8471
D_High_literacy	-0.3304	0.7186	-0.3325	0.7171
D_Highest_literacy	-0.0746	0.9281	-0.0756	0.9271
Ascending_group*High_amount			-0.4504**	0.6370
N	1870		1870	

This table reports the results of a binary logit model wherein the dependent variable is set to one when the annual implicit interest rate is negative and zero otherwise (see Equation 2.1). The set of explanatory variables includes both individual-varying and decision-varying variables. *Gender* is a binary variable set to one for men. *D_Year_*1, *D_Year_*2, *D_Year_*5, and *D_Year_*10 are binary variables set to one when the time horizon is equal to 1, 2, 5, and 10 years, respectively. *Ascending_group* is a binary variable set to one for participants in the Ascending condition. *High_amount* is a binary variable set to one when the amount is high ($20,000) and zero otherwise ($500). *Regular_saver* is a binary variable set to one for participants who are regular savers. *D_Low_literacy*, *D_High_literacy*, and *D_Highest_literacy* are binary variables set to one when financial literacy scores are at the low, high, and highest levels, respectively. ***, **, and * indicate significance at 1%, 5%, and 10%, respectively. N gives the number of observations. OR refers to odds ratios. Standard errors are clustered by participant.

Table 2.5 presents the results for two versions of the logit model above. Our baseline model (Model 1) includes the aforementioned independent variables. When we focus on decision-varying variables, tolerance of NIRs is negatively related to both the amount of savings and the time horizon at the 1% level (except for the 1-year horizon). Tolerance of NIRs is less likely when the amount of savings is high than when the amount of savings is low. All else being equal, the odds of a decision to accept an NIR decreases by approximately 44% when the amount of savings is high. In other words, the higher the amount at stake, the lower is the tolerance of NIRs. This finding is consistent with the *reverse* magnitude effect posited in our first hypothesis. One possible reason for this effect is that the interest to be paid appears lower in absolute terms for the small amount of savings than for the

corresponding interest on the large amount of savings.

For the four time horizons (1, 2, 5, and 10 years), the likelihood of tolerating NIRs is lower than for the 6-month horizon. The odds of a decision to accept an NIR decrease when the time horizon increases. More precisely, compared to the 6-month horizon, when the time horizon is 1 year, the odds of a decision to accept an NIR on savings are multiplied by a factor of 0.9974 (i.e., decrease by 0.26%). For a 10-year horizon, the odds of a decision to tolerate an NIR on savings are multiplied by a factor of 0.3655 (i.e., decrease by 63.45%). Shorter horizons are then associated with a higher tolerance of NIRs than that at longer horizons. This result supports our second hypothesis, i.e., people are reluctant to accept recurrent losses or to commit to losses for longer time horizons.

Looking at individual-varying variables, the results for both the anchoring condition and savings behavior are statistically significant. In regards to the anchoring condition, our hypothesis is confirmed. Participants in the Ascending condition are much more likely to tolerate NIRs than participants in the Descending condition. The odds of accepting NIRs on savings are higher by a factor of 4.9990 in the Ascending condition than those in the Descending condition. This strong result is consistent with the anchoring effect. Alternatively, it might also be consistent with satisficing behavior, i.e., participants are more likely to tolerate NIRs in the Ascending condition because NIRs are presented first. As for regular savers, they are more likely to tolerate NIRs than nonregular savers, which confirms our third hypothesis. The odds of a participant tolerating NIRs on savings increase by 67.44% when he/she is a regular saver. This higher tolerance to NIRs can be related to the status quo bias, a higher familiarity with savings deposits, and/or a future-oriented mindset (i.e., regular savers have put savings aside for the future and NIRs cannot compromise that future).

We find no significant results for financial literacy and thus no support for our fourth hypothesis. Since the level of financial literacy is pretty high among our participants, we cannot exclude that this finding is (at least partially) due to a lack of heterogeneity in the sample. Age and gender are the usual control variables. We know from the literature

that younger people are more likely to save than middle-aged individuals (Heckman and Hanna, 2015) and that the latter save little compared to older generations, who oversave (Furnham and Argyle, 1998). Regarding gender, previous evidence suggests that women save less than men (Ohlund, 2017). However, we find no significant relationship between either age or gender and tolerance of NIRs on savings.

Our hypothesis about the *reverse* magnitude effect yields expectations whose strength could depend on the anchoring condition. Hence, we add an interaction variable between the amount of savings and the anchoring condition in our baseline model. The results are provided in Model 2 of Table 2.5. The interaction variable exhibits a negative coefficient at the 5% level of significance. The relationship between the amount of savings and tolerance of NIRs depends on the anchoring condition. When the amount is high, the likelihood of accepting NIRs is lower in the Ascending condition than in the Descending condition. This is consistent with a stronger *reverse* magnitude effect in the Ascending condition. The odds of tolerating NIRs decrease by 36.30% for the high amount of savings if a participant is in the Ascending condition.

2.4.4 Heterogeneity in annual implicit interest rates

As a side analysis, we investigate heterogeneity in the annual implicit interest rates with an OLS regression for the Ascending and Descending conditions separately. For this purpose, we estimate two models wherein the dependent variable is the annual implicit interest rate associated with a given decision[24] and the set of independent variables is the same as in our baseline logit model (see Model 1 in Table 2.5), except for the anchoring condition. Table 2.6 provides the results with standard errors clustered by participant. When the amount of savings is high, the annual implicit interest rate increases by 1.49% in the Ascending condition and by 0.94% in the Descending condition. Regardless of the anchoring condition, the higher the amount, the higher is the annual implicit interest rate. This finding supports our first hypothesis. In addition, the marginal effect appears

[24]The annual implicit interest rate is a discrete variable that can be -4, -3, -1, 1, 3, or 4% (coded as -0.04, -0.03, -0.01, 0.01, 0.03, and 0.04).

stronger in the Ascending condition, as expected. As the time horizon increases, the annual implicit interest rate increases. For the 1-year horizon in the Ascending condition, the annual implicit interest rate increases by 0.42% compared to the rate for the 6-month horizon. The increase is approximately 1.42% for the 2-year horizon, 1.54% for the 5-year horizon, and 1.90% for the 10-year horizon. The annual implicit rates also increase with the time horizon in the Descending condition, but the corresponding coefficient estimates are weaker. These results support our second hypothesis. When participants are regular savers, the annual implicit interest rates decrease. However, only the decrease of 0.95% in the Descending condition is statistically significant. These findings partially support our third hypothesis. For financial literacy, the results are again not statistically significant. In line with our previous findings, we again find no significant results for age and gender.

Table 2.6: OLS regressions – annual implicit interest rates

Parameter	Ascending condition	Descending condition
Intercept	-0.0082	0.0005
Age	0.0001	0.0000
Gender	0.0022	0.0016
D_Year_1	0.0042***	0.0014
D_Years_2	0.0142***	0.0066***
D_Years_5	0.0154***	0.0041**
D_Year_10	0.0190***	0.0086***
High_amount	0.0149***	0.0094***
Regular_saver	-0.0074	-0.0095**
D_Low_literacy	-0.0108	0.0176
D_High_literacy	-0.0126	0.0153
D_Highest_literacy	-0.0107	0.0108
N	920	950

This table reports the results for two OLS regression models wherein the dependent variable is the annual implicit interest rate. The latter is a discrete numerical variable that can take -4, -3, -1, 1, 3, or 4%. The set of explanatory variables includes both individual-varying and decision-varying variables. *Gender* is a binary variable set to one for men. D_Year_1, D_Year_2, D_Year_5, and D_Year_10 are binary variables set to one when the time horizon is equal to 1, 2, 5, and 10 years, respectively. *High_amount* a binary variable set to one when the amount is high ($20,000) and zero otherwise ($500). *Regular_saver* is a binary variable set to one for participants who are regular savers. $D\_Low\_literacy$, $D\_High\_literacy$, and $D\_Highest\_literacy$ are binary variables set to one when financial literacy is at the low, high, and highest levels, respectively. ***, **, and * indicate significance at 1%, 5%, and 10%, respectively. N gives the number of observations. Standard errors are clustered by participant.

2.5 Conclusion

In this paper, we use an experimental setting that enables us to address intertemporal preferences in savings decisions and reveal what leads people to tolerate NIRs. Specifically, our experiment is a mixed design with one between-subject factor, the anchoring condition (Ascending, moving from NIRs to PIRs vs. Descending, moving from PIRs to NIRs), and two within-subject factors: time horizon (6 months and 1, 2, 5, and 10 years) and the amount of savings ($500 vs. $20,000).

We provide evidence that tolerance of NIRs is negatively related to both the time horizon and the amount of savings. The higher the amount, the lower is the tolerance of NIRs. This is consistent with a *reverse* magnitude effect, meaning that the interest to be paid appears lower in absolute terms for the small amount of savings than that for the large amount of savings. As the time horizon increases, tolerance of NIRs decreases. Shorter horizons are thus associated with a higher tolerance of NIRs. This suggests that it is harder for people to commit to losses for a long time horizon (and incur recurrent losses in our case).

We extend the previous literature by relating tolerance of NIRs to actual savings behavior, financial literacy, and anchoring bias. Regular savers are more likely to tolerate NIRs than nonregular savers. We relate this result to the status quo bias, a higher familiarity with savings deposits, and/or a future-oriented mindset (i.e., regular savers care about the future and NIRs will not prevent them from putting savings aside for that future). As for the anchoring effect, we find a higher tolerance of NIRs on savings when participants are anchored towards NIRs on savings (i.e., in the Ascending condition). We find however no significant results for financial literacy. Since the level of financial literacy is particularly high among our participants, we cannot rule out that this finding is (at least partially) due to a lack of heterogeneity in the sample.

We should point out that what we observe in our experiment seems consistent with the actual savings behavior of people in countries that are experiencing all-time low rates or

NIRs. Our findings indeed confirm that people may be willing to continue to save money (instead of spending it) even if this means they will certainly lose some money. This is an important finding for policymakers and banks considering the implementation of NIRs on bank deposits. Our results provide relevant insights about some important factors (amount of money at stake, time horizon), conditions (facing NIRs or PIRs first), or individual characteristics (savings behavior, financial literacy) that can affect this propensity. When interest rates are very low or already negative, tolerance of NIRs is more likely to increase. Large and small depositors should be treated differently, since small depositors appear more likely to tolerate NIRs on savings. Different treatments could also be applied to regular and nonregular savers, since the latter are less likely to tolerate NIRs.

Our experimental findings, as ecologically valid as they may be, cannot entirely reflect the dynamics and complexity of individual savings behaviors in reality. First, the absence of incentives for participants might be a limitation of our study. Since their choices do not affect their rewards, participants might have overstated their preferences in our hypothetical questions, i.e., have revealed a higher or lower tolerance to NIRs than the one they would have shown with real economic commitments. Second, another shortcoming might be that participants make binary choices in our setting, i.e., either continue to save money or spend it immediately (on goods and/or services). This setting forces participants to make "all or none" decisions that are infrequent in real-life. Although the binary choice-based method has been shown to lead to better predictions of real-world outcomes (Hardisty et al., 2013), we acknowledge that the tolerance for NIR might differ when people have the possibility to either save or invest *part* of their money. In the same vein, we do not propose other alternatives to participants, such as investing in the stock market or paying off existing debts. Providing participants with a larger set of alternatives would give them more freedom in designing their own choices. Third, we find that the tolerance for NIRs is related to the saved amount. Since the amount of money at stake is also the participant's wealth (which is experimentally manipulated), it is hard to distinguish between the effect of the amount saved and the wealth effect. Finally, our study relies on binary choices between present and future amounts, revealing direct dollar

gains/losses to participants. Presenting interest rates (with or instead of future amounts in dollars) to participants might provide insights into how much people's reactions differ when facing dollar amounts and/or interest rates. All these points of attention highlight potential moderators of the current effects that may be examined in future research.

Chapter 3

Do Negative Interest Rates Decrease the Status Quo Bias on Savings?

Chapter Abstract

Using an online experiment, I study the impact of negative interest rates (NIRs hereafter) and positive interest rates (PIRs hereafter) and procedures and costs on status quo bias on savings. Status quo bias refers to the enhanced probability of choosing one option when framed as the status quo, which is often suboptimal. The results of this experiment indicate that the status quo bias is lower when the status quo option delivers loss (i.e., NIRs) than when the same option delivers gain (i.e., PIRs). This status quo bias increases when one must go through procedures and pay costs to switch from the status quo alternative. The overall effect on status quo bias is strong if an individual is a saver and has to go through procedures and pay costs if he/she desires to switch from the current bank to another bank. Finally, I find that at least low levels of financial literacy decrease the status quo bias.

Keywords: negative interest rates, status quo bias, savings

JEL Classification: G21, G41, G51, G53

3.1 Introduction

Together with European Central Bank (ECB), several central banks decreased their rates below zero.[1] Commercial banks have to pay to keep the minimum reserve requirements at the central bank. The objective of this decrease of interest rates and the introduction of NIRs is to stimulate banks to increase their lending (since loans are now cheaper for borrowers) and risk-taking through investments in the stock market. Since then, the literature has dealt with the effectiveness of this unconventional monetary policy.

NIRs reverse the standard theory upside down since banks punish depositors who pay to delay their consumption. Hence, commercial banks hesitate to introduce NIRs on deposits of their clients. Deposits represent a crucial source of funding for banks, which might reduce with NIRs since cash has no lower bound, i.e., depositors could withdraw money from their deposit accounts and invest it elsewhere. There is a piece of empirical evidence supporting this limited introduction of NIRs on deposits (Eggertsson et al., 2017; Basten and Mariathasan, 2018a; Lopez et al., 2020; Heider et al., 2019). Since it is easier for households than for corporates to withdraw their deposits, banks that rely more on household deposits should be more likely to limit the introduction of NIRs than banks that rely more on corporate deposits (Heider et al., 2019).

In normal times (i.e., when interest rates are positive), depositors keep on saving their money with the banks. What is more intriguing is that depositors kept similar levels of saving rates with decreasing deposit rates. For instance, during the period from 2012 to 2019, the saving rates in the EU remain relatively stable at 12%, whereas deposit rates dropped from 3% to 0.37%. Instead of searching for other potentially more profitable alternatives, depositors kept their money at banks to obtain this relatively small reward.

An explanation for such depositors' behavior is status quo bias, which could be defined as the enhanced probability of an option being chosen when framed as status quo compared

[1]ECB dropped deposit facility from 0% to -0.10% in June 2014 (Heider et al., 2019). Further, the Swiss National Bank cut its deposit facility rate to -75 basis points (bps), which should be charged on banks exceeding twenty times the minimum reserve requirement (Basten and Mariathasan, 2018b).

to the circumstance when it is not framed as status quo (Samuelson and Zeckhauser, 1988). Depositors keep their money in the bank because they are used to doing it. Individuals should rather rank all options according to their preferences and choose the most preferred one. According to the article of Samuelson and Zeckhauser (1988), one alternative labeled as status quo – doing nothing or maintaining current or previous decision (as in the case of depositors) posits a possible choice. This type of individual's behavior leads to sub-optimal investment decisions. When framed in such a way, the probability of its being selected increases significantly. A vast stream of empirical and experimental literature confirms the existence of this bias. Empirical literature confirms status quo bias in the case of health plans (Samuelson and Zeckhauser, 1988), electrical services (Hartman et al., 1991), mutual funds (Kempf and Ruenzi, 2006), bond market analysts' prediction of future interest rates (Gubaydullina et al., 2011), and institutional investors' investment in private equity funds (Freiburg and Grichnik, 2013). Experimental literature finds evidence of status quo bias in the case of risky decision-making (Samuelson and Zeckhauser, 1988), when individuals face wide choice sets (Dean et al., 2008), and stock picking (Brown and Kagel, 2009).

Samuelson and Zeckhauser (1988) report a comprehensive list of potential reasons for the status quo bias. Among economic reasons are transition costs, which comprise the costs related to switching from the status quo alternative to another alternative. When these costs surpass the benefits of another alternative, it is rational to keep the status quo option. In contrast, when the benefits of another alternative surpass costs, it is rational to leave the status quo. Another reason could be the effort and time needed to switch from the status quo to another alternative. Efforts and time are needed when switching from the status quo option to another alternative. However, keeping the status quo excludes time and effort, which could be the potential reasons to keep the status quo. Hence, these two reasons can serve as an obstacle and increase the bias toward the status quo.

The previous literature concerning status quo bias tackled decisions wherein the status quo option delivers a gain. However, what is unknown in the literature regarding NIRs and status quo bias is how individuals' saving decisions would evolve when the status quo

option (i.e., a deposit account) delivers a sure loss (e.g., NIRs).

This paper tackles four research questions:

(1) Would individuals still keep their money on deposit accounts with NIRs or instead search for other options to reduce these losses?

(2) Does status quo bias differ when deposit accounts offer PIRs (i.e., gains) vs. NIRs (i.e., losses)?

(3) Does the status quo bias increase when transition costs and efforts are associated with options other than the status quo?

(4) Does the status quo bias exhibit a negative association with financial literacy?

Addressing the previous research questions will answer whether the fear of commercial banks in introducing NIRs on deposits is justified or not (Eggertsson et al., 2017; Basten and Mariathasan, 2018a; Lopez et al., 2020; Heider et al., 2019). More precisely, depending on whether individuals leave their status quo and search for other options or retain their status quo, I will answer whether this significant funding source for banks' financing is decreased or not. Since in my research, I test the behavior of individuals regarding savings related to deposits, banks that rely more on deposit funding should be particularly interested in these research questions. Further, since households could withdraw their deposits more easily than corporates, addressing these research questions is particularly interesting for banks that rely more on household deposits than corporate deposits.

An experimental research design built on Samuelson and Zeckhauser (1988) status quo experiments is employed to answer research questions. This experiment is 2 (Status Quo vs. Neutral condition) * 2 (No transition costs/No effort vs. Transition Costs/Effort) mixed design. Participants choose among two fixed-term deposits offered by "Bank A" and "Bank B." Individuals in status quo conditions are informed they have already invested in the "Bank B" fixed-term deposit and decide to retain it or invest in another option. Unlike that, the neutral conditions involve choices in which individuals have not previously invested and must make a new decision. Individuals in both status quo and neutral

conditions choose deposit accounts in PIRs and NIRs regions. Deposit accounts in the PIRs region offer positive interest rates. The "Bank B" interest rate is 0.25%, which is 1.25% lower than the "Bank A," which offers a 1.50% interest rate. Deposit accounts in the NIRs region offer negative interest rates. The "Bank B" interest rate is -1.50%, whereas the "Bank A" offers a -0.25% interest rate. Hence, the difference in the interest rate of 1.25% favors the "Bank A" in both PIRs and NIRs regions.

The main results could be summarized as follows. Individuals in status quo conditions are more likely to choose the fixed-term deposit of "Bank B" (i.e., the status quo option) than individuals in neutral conditions. However, this finding is supported only in conditions that involve procedures and transition costs. Hence, the results confirm the bias towards the status quo. Next, further analysis shows that the bias towards the status quo is higher for NIRs than for PIRs. Therefore, NIRs serve as a moderator of the status quo bias. Subsequently, a positive interaction of status quo and procedures and transition costs on status quo bias is identified. In particular, the status quo bias is more robust when one is a saver and must pay transition costs and go through procedures if he/she desires to leave the status quo bank and move to another bank. Lastly, financial literacy is a significant explanatory variable of the status quo bias. In particular, individuals with at least low levels of financial literacy exhibit lower bias towards the status quo than their financially illiterate counterparts.

This paper contributes to the behavioral finance literature in several aspects. This paper analyzes the status quo bias literature prediction that individuals would retain their money on the fixed-term deposit offering NIRs due to inertia or habit. Unlike prior studies wherein the current status quo option delivers either gain or non-loss compared to the previous status quo (Samuelson and Zeckhauser, 1988; Hartman et al., 1991; Kempf and Ruenzi, 2006; Gubaydullina et al., 2011; Freiburg and Grichnik, 2013), in this state, it produces a sure loss. If one retains money in option B, he/she has less money in a year than today. Hence, these results are linked to the status quo bias and differentiate from others. Besides, unlike other literature with no transition costs and procedures, I formulate a more realistic framework wherein transition costs and procedures are related

to shifting from the status quo to other alternatives. Particularly, if one aspires to invest in an option other than the status quo, he/she must pay fees and follow procedures by filling out the documents. Adding these fees and procedures restricts shifting from the current status quo to another option. Since these costs and procedures may direct individuals to retain the status quo (Samuelson and Zeckhauser, 1988), status quo bias is more robust under these circumstances than when these costs and procedures are excluded. Finally, the added value of this article is the association between status quo bias and financial literacy. In particular, the results indicate that the highest levels of financial literacy reduce the status quo bias. Therefore, individuals should increase their financial literacy to the highest levels in order to make decisions leading to better outcomes.

The remainder of the paper is organized as follows. Section 3.2 reviews the relevant literature. Section 3.3 describes the experimental setting. Section 3.4 reports hypotheses. Section 3.5 reports the results. Section 3.6 concludes.

3.2 Literature Review

3.2.1 Status Quo Bias in Empirical Studies and Experiments

Numerous decisions in the economic environment incorporate status quo alternatives - individuals can either do nothing or adhere to the prior decisions. This behavior of individuals does not posit an obstacle if it drives to optimal choices in decision-making. However, Samuelson and Zeckhauser (1988) identify circumstances wherein individuals often retain prior decisions, which are sub-optimal. These authors interpret this phenomenon as status quo bias. More formally, the status quo bias could be defined as the enhanced probability of one option being chosen when framed as status quo compared to the situation when it is not. Rationally speaking, individuals should make decisions with well-defined preferences and dismiss this labeling of specific options as status quo. Individuals should rank options from the most preferred to the least preferred one and

then make a choice.

Numerous empirical studies confirm the existence of the status quo bias. Hartman et al. (1991) in a survey investigate the status bias in the customers' valuation of an unpriced product - residential electrical service reliability. Each customer in this survey is assumed to have an initial service contract reflecting his/her status quo defined by monthly bill and number of outage hours. Customers are then divided into two groups - the first (the second) experiencing three outages of two hours per year (fifteen outages of four hours per year). Then they are asked to rank six rate options from the most to the least preferred one. In order to test for the status quo, one option was labeled as status quo - current bill and number of outage hours. If the status quo bias exists, individuals should be more likely to choose their initial contract defined by monthly bill and number of outage hours. Unsurprisingly and in line with the status quo bias, individuals in both groups ranked the current bill and number of outage hours more than 60% of the time as the most preferred one. Customers preferred the status quo to the other options that could eliminate the number of outage hours (although this option is more costly than the status quo).

When making saving decisions, individuals are biased towards the status quo also. Samuelson and Zeckhauser (1988) report that employees in the US are biased toward firstly picked retirement plans although they have the opportunity to change them every year at zero cost. In the sample of 850,000 participants, the choice is to divide the premium between the TIAA fund (a portfolio of bonds, commercial loans, mortgages, and real estate) and CREF (a broadly diversified common stock fund). Each year after the first division choice, a participant can modify his/her distribution among the funds at no cost. These authors then observe participants' decisions from 1981 to 1986. They find that yearly changes between funds are insignificant, although the changes of TIAA and CREF fund rates occurred. The findings indicate that only 28% of participants had ever modified their initial allocation choices. Employees are biased towards their status quo allocation plans, which is detrimental to their well-being once they are retired.

Researchers in finance observe and find strong evidence of status quo bias. Kempf and

Ruenzi (2006) test the status quo bias in the US equity mutual fund market by investigating whether the current inflows in the mutual fund depend on the previous inflows in the same fund (the status quo). The database used to tackle this research question covers eight years (1993 - 2001) of US mutual funds. As control variables, these authors include the prior performance of the fund, age of the fund, the standard deviation of funds return, size of the fund, fees, turnover rate, and the number of funds offered by the same family funds. If the status quo bias exists, the managers should be more likely to invest in the funds they have invested previously. These authors find significant and robust evidence of the positive impact of previous inflows on the current inflows of the same fund. The better the fund's performance in the previous year is, the more likely it is to have a positive net flow in the same fund. Hence, investors chase previous performances. There is a positive impact of the number of funds offered by the same family funds on the net inflows. Hence, the status quo bias is more robust the larger the number of alternatives one can choose from.

Institutional investors in private equity funds exhibit strong status quo bias. Freiburg and Grichnik (2013) tackle whether status quo bias exists among German institutional investors. These authors conducted a survey wherein they collected data related to investment decisions, reinvestment decisions, previous performance of the fund, reputation of the fund (expressed through years of existence), investment size, and investor experience. The status quo bias occurs if the previous investment decisions positively impact reinvestment decisions. The results of their study imply that a reinvestment decision is strongly and positively associated with a positive investment decision. Hence, institutional investors tend to choose the same fund (i.e., the status quo) as the previous year. In line with the findings of Kempf and Ruenzi (2006), these authors find that previous positive performance has a positive impact on investment decisions. They also obtain results that a positive decision is more likely for a fund that is large in scale.

Not only are the mutual fund investors and institutional investors subject to the status quo bias, but also the bond market analysts. The research question that Gubaydullina et al. (2011) study regards the impact of the status quo bias on bond market analysts'

forecast of future interest rates. These authors tackle this research question by employing data of forecasters' interest rate predictions and real interest rates on the bond market. While making forecasting judgments, forecasters start from a certain point characterized by a specific current interest rate level, framed as the status quo. In order to determine the status quo bias, the real interest rate changes are compared with the forecast changes. If status quo bias exists, the former changes should be higher than the latter. In line with the status quo bias, the mean values of the forecast interest rate changes are significantly lower than the mean values of the real interest rate changes. This finding implies that forecasters overestimate the importance of current interest rate levels (i.e., current status quo) when predicting future interest rates and thereby undervalue future events when making forecasts.

In order to determine the causality of the status quo bias, researchers conduct experiments. To the best of my knowledge, Samuelson and Zeckhauser (1988) are pioneers to examine the status quo bias experimentally. These authors use controlled experiments comprising a series of decision questions to test the status quo bias. An experiment of particular interest in finance considers investment decisions. Individuals are divided into two conditions - neutral and status quo conditions. In the neutral condition, individuals learn that they are serious readers of financial pages and have just inherited a large sum of money to invest. Individuals in the status quo condition receive the same information as well as that a significant portion of the inherited portfolio is invested in a moderate-risk company (i.e., this is a status quo). Then they consider making a binary choice among the following alternatives: moderate-risk stock (the expected return is 9%), high-risk stock (the expected return is 28%), treasury bills (the interest rate is 9%), and municipal bonds (the interest rate is 6%). The status quo bias exists when individuals in the status quo condition are more likely to invest in the status quo option (moderate-risk stock) than individuals in the neutral condition. These authors discovered that when a significant portion of a portfolio was previously invested in a moderate risk company (i.e., the status quo condition), individuals pick this option 63% of the time. However, individuals in the neutral condition invest only 47% of the time in the same option. Hence, when one alter-

native (i.e., a moderate-risk stock) occupies the status quo, the probability of its being chosen increases significantly. Although they could invest in better-performing options, they retained the status quo alternative.

Brown and Kagel (2009) investigate the impact of status quo bias in a simplified stock market on individuals' investment behavior experimentally. Their experiment comprised twenty rounds wherein individuals could invest their money in only one stock per round. At the end of each round, individuals learn about the performance of the stock they have in their portfolios. Then they could keep this stock or choose to observe the market, i.e., the performances of nineteen remaining stocks. If they opted to observe the market, they could invest in a new stock or continue holding the previously purchased stock. The status quo bias exists when individuals keep the same stock throughout the course of the experiment to the detriment of other better-performing stocks. When examining the investment behavior of individuals, these authors find that only 50% of all individuals bothered to observe the market. Once a chosen stock becomes the status quo, individuals do not bother to check the market and other potentially better-performing stocks. Individuals kept their initial choice (i.e., the status quo) more than 80% of the time.

Previous experimental studies involve a relatively simple scenario wherein individuals make a binary choice to invest in only one option. However, in reality, individuals can invest in several options simultaneously. Moreover, there are transaction costs related to switching from one option to another. For instance, in order to open a new bank account, individuals must pay opening fees, whereas keeping money in the current bank involves no entry fees since they have already paid for them. One can make the same analogy with stocks. Holding the same stocks in the portfolio does not involve any additional costs, whereas buying new stocks is costly (transaction costs). Hence, I want to approximate investment decisions towards reality in this experiment. In particular, switching from the status quo option towards a new option is not cost-free.

3.2.2 The Relation Between Saving Decisions and Status Quo Bias in European Union

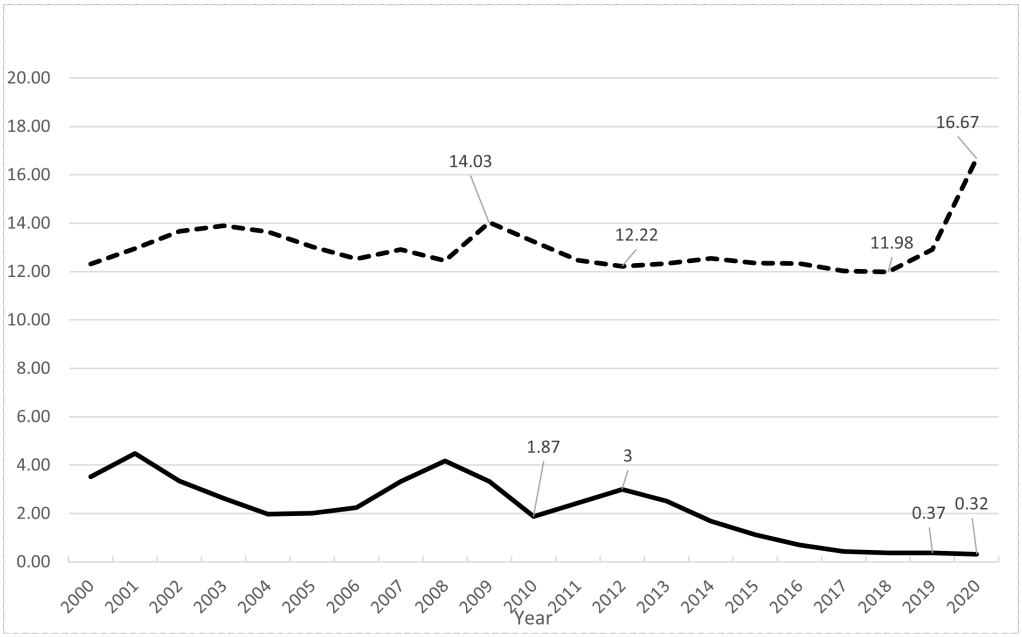
Depositors are subjects of the status quo bias. Rationally speaking, the relationship between saving rates and deposit rates should be positive. When deposit rates increase, depositors should increase their savings since the reward from delaying consumption increases. By contrast, when the deposit rate reduces, they should decrease their deposits in banks because their reward in terms of interest earned shrinks. They should rather spend or invest their money elsewhere.

However, the reality is more puzzling. Although deposit rates in the EU have indicated a downward trend from the years 2000 to 2020, households have either increased or kept their saving rates at similar levels instead of decreasing them (see Figure 3.1). Several reasons explain households' increase in saving rates after periods of deposit rates' reduction. More precisely, peaks of saving rates occur after the Financial Crisis 2007-2009 and the 2020 Covid-19 crisis (14.03% in 2009 and 16.67% in 2020, respectively). This increase in saving rates during and after the crisis occurs due to precautionary motives, i.e., people save money to match future needs. There is great uncertainty regarding households' future incomes (they can be either reduced or non-existing when people lose their jobs). Consequently, households allocate more money on savings to meet their future needs.

An intriguing association between saving and deposit rates occurred from 2012 to 2019. In particular, deposit rates have shown a downward trend (3% in 2012 to 0.37% in 2019), whereas saving rates remained relatively stable during the same period (around 12%). There was no crisis occurring during this period. Instead of searching for other higher-rewarding alternatives, households retain their money to receive this reducing reward. I propose an explanation for this empirical observation. Households kept their saving rates at similar levels due to the status quo bias. This status quo bias occurs since households who are used to savings are reluctant to change their decisions. Several essential questions arise: (1) what will happen with saving rates when deposit rates turn out negative? (2) Will individuals still keep their saving rates to receive a smaller amount in the future due

to the status quo bias, or will they search for other alternatives?

Figure 3.1: Deposit interest rates and household saving rates from 2000 to 2020 in EU



This figure presents the development of household saving rates (dashed line) and deposit rates (solid line) in the European Union countries from 2000 to 2020. Saving rates refer to gross saving divided by gross disposable income, whereas deposit rates cover those rates that resident monetary financial institutions apply to euro-denominated deposits by households (Source: Eurostat (2021).

3.2.3 What drives the status quo bias?

This subsection 3.2.1 reviews empirical and experimental studies wherein the literature confirms the existence of the status quo bias. The question that arises is: why does the status quo bias occur? What are determinants of status quo bias?

Samuelson and Zeckhauser (1988) provide a comprehensive list of potential reasons for the status quo bias. The first among them are economic reasons. A reason to keep the status quo is transition costs, which comprise costs of switching to another alternative. It is rational to keep the status quo option whenever the costs of switching from the status quo to another option exceed the benefits of another option. For instance, if fees from switching from one bank to another are higher than potential interest, keeping money in the current bank is rational.

Another reason is uncertainty in decision-making. Alternatives other than the status quo

are unknown and must be discovered. Individuals are unfamiliar and uncertain regarding these options, whereas they are familiar with the status quo. Hence, even when no transition costs are involved, individuals could keep the status quo due to uncertainty aversion. If the process of searching for better alternatives is slow, uncertain, and/or costly, the likelihood of keeping the status quo increases. For instance, when individuals are used to saving in the bank, they might be unfamiliar as well as uncertain regarding other banks' conditions and thus keep money in their current bank. They might also think of the procedures regarding opening an account in another bank to be slow. Costs of other banks' search analysis and conditions could also be the grounds to remain in the current bank.

These authors then mention that cognitive misperceptions might be the reason for the status quo bias. They start with Prospect Theory, which is a model of decision-making under risk entailing a value function derived from the changes in wealth rather than ultimate wealth (Kahneman and Tversky, 1979; Tversky and Kahneman, 1992). Prospect Theory is often summarized in its three core principles: reference point, loss aversion, and diminishing sensitivity. They imply loss aversion to be the candidate for the status quo bias. Individuals take the status quo as a reference point and weigh potential losses related to switching options higher than potential gains. Due to this loss aversion, individuals are biased toward the status quo. Loss aversion could positively affect the status quo bias, i.e., the higher it is, the more likely it is to keep the status quo option. Hence, for a client to switch from one bank to another, the bank's interest should be significantly higher than transition costs. If this is not the case, individuals stick to the current bank.

Last but not least group of reasons are related to psychological commitments. These authors start with sunk cost fallacy, which occurs when individuals commit to the same behavior due to previously invested resources (effort, time, or money) (Arkes and Blumer, 1985). These authors explain that individuals might be reluctant to "cut their losses" or desire to justify previous commitments to (failing) course of action by keeping the previous status quo in the following decisions. The higher the sunk cost, the greater is the inclination to keep the previous status quo. Hence, this sunk cost fallacy could positively

impact the status quo bias, i.e., the higher it is, the more likely for an individual it is to keep the status quo. For instance, before choosing their current bank, individuals have invested time and effort to find a bank that provides the best services, the lowest fees, and offers the highest interest rate. These costs (although not monetary measurable) are irreversible, and individuals could consider them crucial before analyzing other banks. Finally, these costs could restrain switching from the current bank to banks offering better conditions.

Another justification for the status quo bias is the drive for consistency, which results from cognitive dissonance theory. Cognitive dissonance exists if an individual feels tension when considering two contrasting ideas (Festinger, 1962; Akerlof and Dickens, 1982). An individual, in this case, distorts new information and tension by believing that a choice previously made is optimal, thereby strengthening the status quo bias. Hence, he/she decreases cognitive dissonance by increasing his/her drive for consistency. This drive for consistency directs individuals to justify previous decisions by adhering to them, irrespective of their effectiveness. The more robust this drive for consistency is, the stronger is the status quo bias. An individual with low cognitive dissonance (i.e., high drive for consistency) might remain a client of his/her bank by neglecting other banks offering better conditions compared to his/her current bank. This situation occurs because he/she does not want to acknowledge that the selection of the current bank was sub-optimal, i.e., he/she desires to view himself/herself as a good decision-maker.

Another candidate for bias towards the status quo is coined in self-perception theory. According to this theory, an individual builds his/her attitudes and preferences for current and future decisions based on past decisions. While making these decisions, individuals act as if they were outsiders observing their choices (Bem, 1972). Therefore, their prior behavior affects their attitudes and future decisions, leading to status quo choices. When making decisions, whether they desire to pursue the same course of action as before or alter them, individuals may prefer to disregard information that can drive their loss of confidence or doubt their ability in their past decisions (Bénabou and Tirole, 2002). For instance, individuals who are confident and do not desire to question their abilities in

choosing their bank in the past (because they have done the research prior to making their previous decision) might disregard information regarding other banks and their terms and conditions. The more confident someone is in his/her past decisions, the more likely the choice towards the status quo is.

The bias towards the status quo could also depend on financial literacy. Lusardi and Mitchell (2011) defines financial literacy as basic knowledge regarding compounding, inflation, and diversification. The more knowledge regarding the previous three items an individual posits, the more financially literate he/she is. These authors show that low financial literacy may lead decision-makers to make frequently sub-optimal choices. Turning now to the example of banks, individuals who can calculate the interest based on the interest rate can determine which bank provides the best conditions and are less likely to be biased towards the status quo (i.e., staying with the current bank offering more unfavorable conditions compared to other banks). On the contrary, individuals who have less able to determine the interest based on the interest rate could be more biased towards the status quo. Hence, the association between financial literacy and the status quo bias is negative, i.e., the more financially literate an individual is, the less status quo biased he/she is.

For the research question raised in this article, uncertainty aversion and financial literacy serve as candidates to explain the inclination towards the status quo. Individuals who dislike uncertainty might be more likely to retain the status quo option than individuals who dislike uncertainty to a lesser degree. Since individuals are already familiar with the terms of the bank in which they saved money and not with other banks, they are more likely to remain in the former than to divert towards the latter banks. Financial literacy might also be a significant variable since individuals who are more financially literate might be more capable of determining which option is optimal and hence be less biased towards the status quo than less financially literate individuals.

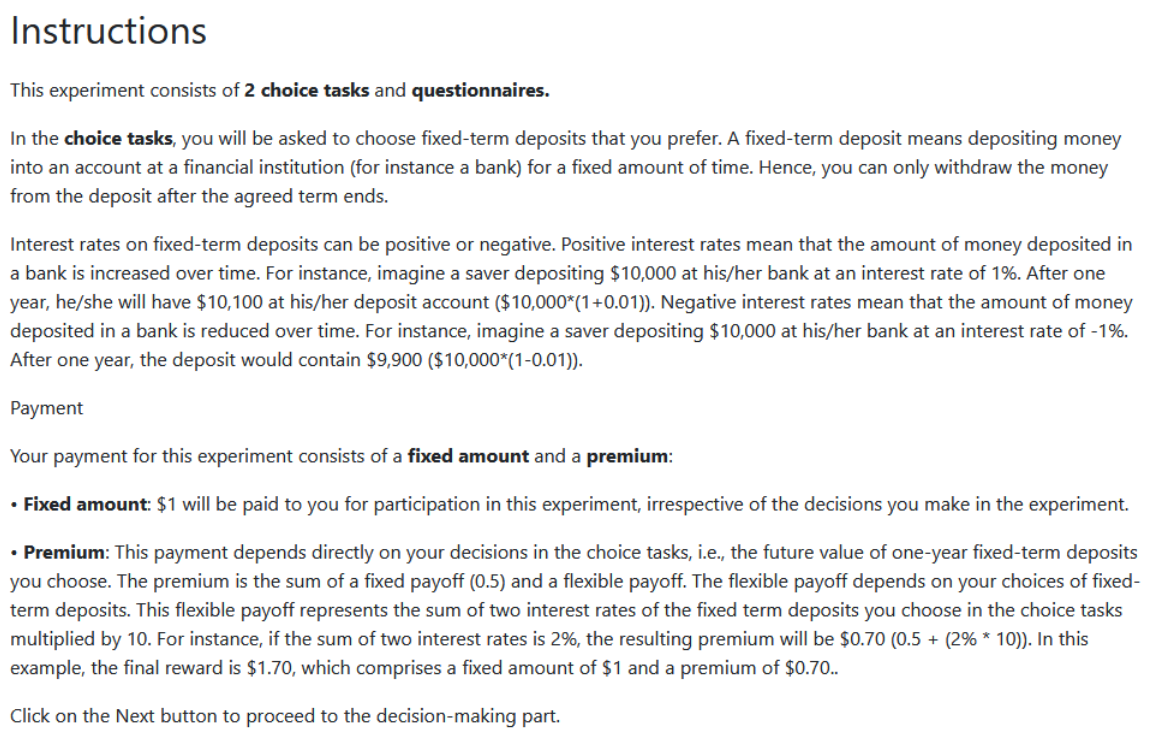
3.3 Experimental setting

A 2 (Status Quo vs. Neutral condition) * 2 (No transition costs/No effort vs. Transition costs/Effort) * 2 (PIRs vs. NIRs) mixed design is adopted to examine the status quo bias. Between factors are condition (Status Quo. vs. Neutral) and transition costs and efforts (No transition costs/No effort vs. Transition costs/Effort). Within factor is the interest rate (PIRs. vs. NIRs). Hence, there are, in total, four independent conditions (details regarding conditions are provided in Table 3.1). Participants are randomly assigned to four conditions and face both PIRs and NIRs in random order. Participants are first familiarized with the experiment by receiving instructions (for more details regarding instructions, please refer to Figure 3.2). Participants are then asked to make two binary choices among two banks offering different conditions for savings. They can choose "Bank A" or "Bank B" to open a one-year fixed-term deposit. They choose their fixed-term deposits with both PIRs and NIRs. To avoid any framing effect, whether a participant chooses a fixed-term deposit first with PIRs or NIRs is random. Hence, there are, in total, two investment decisions - one decision with PIRs and another with NIRs. After each of these two investment decisions, participants are informed about the amount they saved over the term period. Participants are then asked to answer questions about financial literacy, risk tolerance, and loss aversion. For that purpose, I used three questionnaires: the financial literacy questionnaire (for more details regarding questions, please refer to Appendix 7.3.4), DOSPERT scale to measure risk tolerance (for more details regarding questions, please refer to Appendix 7.3.3), and Loss Aversion Questionnaire (for more details regarding questions, please refer to Appendix 7.2.3).

In The first condition (Status Quo/Transition Costs/Effort) reflects the ones of Samuelson and Zeckhauser (1988). To begin with, individuals in this condition are familiarized that one alternative (a fixed-term deposit in the "Bank B") occupies the status quo position and decide whether they desire to retain the status quo or invest in another alternative. They are told they opened a fixed-term deposit with "Bank B" last year at a 0% annual interest rate. Subsequently, they decide between two investment alternatives: retain a

fixed-term deposit in "Bank B" or open a fixed-term deposit in "Bank A." They are also informed that if they want to switch from "Bank B" to "Bank A," they must pay transition costs ($10) and fill in the documents. The second condition (Status Quo/No transition costs/No effort) is similar to the first one, except that individuals do not have to pay transition costs and fill in the documents to switch from "Bank B" to "Bank A."

Figure 3.2: Computer Screenshot of Instructions



In the third condition (Neutral/Transition costs/Effort), individuals are instructed to imagine facing a new investment decision and pick from the same investment alternatives as individuals in the Status Quo condition. To open a fixed-term deposit in either of the two banks, they must pay transition costs ($3 and $10 for fixed-term deposits in "Bank A" and "Bank B," respectively) and fill in the documents. The fourth condition (Neutral/No transition costs/No effort) is similar to the third condition. However, individuals do not have to pay transition costs and fill in the documents to open a fixed-term deposit in either of the two banks.

The description of alternatives is as follows. All participants make choices in PIRs and NIRs regions. In the PIRs region, a fixed-term deposit in the "Bank B" delivers a positive interest rate of 0.25%. A fixed-term deposit in "Bank A" delivers a 1.50% interest rate

Table 3.1: Description of conditions

2x2 Design		Transition costs and effort	
		Yes	No
Condition	Status Quo	Status Quo/Yes	Status Quo/No
	Neutral	Neutral / Yes	Neutral / No

This table describes conditions in this experiment. The left-hand side explains whether individuals belong to Status Quo or Neutral condition, whereas the upper right side explains whether individuals must fill in the documents and pay transition costs or not.

(more details on the description of alternatives in the PIRs region are provided in Table 3.2). In the NIRs region, a fixed-term deposit in the "Bank B" offers a negative interest rate of -1.50%. In "Bank A," a fixed-term deposit delivers a -0.25% interest rate (more details on the description of alternatives in NIRs region are provided in Table 3.3). Hence, a higher interest rate is offered by "Bank A," whereas a lower interest rate is offered by "Bank B" (status quo option in status quo conditions) irrespective of the region. Individuals can invest in the manner they desire, i.e., choose either of those two banks. Rationally speaking, individuals should invest the total amount in "Bank A" since it offers a higher nominal interest rate of 1.25% in both PIRs and NIRs regions.

This experiment is incentivized, with a reward system containing a fixed amount of $1 and a premium. The former obtain all individuals irrespective of the results of their decisions. By contrast, the premium is an additional amount of money that directly depends on their choices of fixed-term deposits. This premium is the sum of a fixed payoff of $0.50 and the flexible payoff (sum of two interest rates in the choice tasks multiplied by 10). The premium involves fixed payoff since the sum of two interest rates in choices tasks could be negative. Without this fixed payoff, the fixed amount could reduce and be below $1 if the sum of two interest rates is negative. Let us take an example of the final reward. If the sum of two interest rates is 1.25%, the premium is $0.63 (0.50 + (1.25% * 10)). In this example, the final reward is $1.63, which comprises a fixed amount of $1 and a premium of $0.63. However, we do not deduct them from the premium in conditions involving transition costs and procedures, potentially impacting our results. This variable part of the premium is relatively small compared to the fixed part and fixed payoff, impacting the results. However, there is evidence showing that high financial incentives do not improve

Table 3.2: Description of alternatives in PIRs region

Panel A: Description of alternatives in Status Quo conditions

	SQ/TC/E		SQ/NTC/NE	
Type	**Bank A Fixed-term deposit**	**Bank B Fixed-term deposit**	**Bank A Fixed-term deposit**	**Bank B Fixed-term deposit**
Duration	**1 year**	**1 year**	**1 year**	**1 year**
Interest (per year)	**1.50%**	**0.25%**	**1.50%**	**0.25%**
Bank Fees	**$10**	**$0**	**$0**	**$0**
Documents Filling Out	**Yes**	**No**	**No**	**No**
Withdrawal before the end of the year	**No**	**No**	**No**	**No**

Panel B: Description of alternatives in Neutral conditions

	N/TC/E		N/NTC/NE	
Type	**Bank A Fixed-term deposit**	**Bank B Fixed-term deposit**	**Bank A Fixed-term deposit**	**Bank B Fixed-term deposit**
Duration	**1 year**	**1 year**	**1 year**	**1 year**
Interest (per year)	**1.50%**	**0.25%**	**1.50%**	**0.25%**
Bank Fees	**$10**	**$3**	**$0**	**$0**
Documents Filling Out	**Yes**	**Yes**	**No**	**No**
Withdrawal before the end of the year	**No**	**No**	**No**	**No**

This table reports descriptions of deposit accounts with PIRs. Panel A refers to status quo conditions, whereas Panel B refers to Neutral conditions. Abbreviations SQ/TC/E and SQ/NTC/NE refer to Status Quo/Transition Costs/Effort and Status Quo/No Transition Costs/No effort conditions, respectively. Abbreviations N/TC/E and N/NTC/NE refer to Neutral/Transition Costs/Effort and Neutral/No Transitions Costs/No effort conditions, respectively.

performance in choice tasks that are rather simple (Lee, 2007). Since participants make only two independent binary choices, these rather small financial incentives might be sufficient.

To examine the factors determining the bias towards the status quo, I include questionnaires after the decision-making part. In the first and the third condition, I ask individuals to fill in documents, i.e., provide their demographic information (age, gender, nationality, employment status, and the highest level of education). I include three questions from Lusardi (2008) to determine the financial literacy of each individual in this experiment (details are available in Appendix 7.3.4). Besides, to explain risk-aversion, I elicit participants' subjective risk-taking inclination with the DOSPERT scale (Blais and Weber,

Table 3.3: Description of alternatives in NIRs region

Panel A: Description of alternatives in Status Quo conditions

	SQ/TC/E		SQ/NTC/NE	
Type	**Bank A Fixed-term deposit**	**Bank B Fixed-term deposit**	**Bank A Fixed-term deposit**	**Bank B Fixed-term deposit**
Duration	**1 year**	**1 year**	**1 year**	**1 year**
Interest (per year)	**-0.25%**	**-1.50%**	**-0.25%**	**-1.50%**
Bank Fees	**$10**	**$0**	**$0**	**$0**
Documents Filling Out	**Yes**	**No**	**No**	**No**
Withdrawal before the end of the year	**No**	**No**	**No**	**No**

Panel B: Description of alternatives in Neutral conditions

	N/TC/E		N/NTC/NE	
Type	**Bank A Fixed-term deposit**	**Bank B Fixed-term deposit**	**Bank A Fixed-term deposit**	**Bank B Fixed-term deposit**
Duration	**1 year**	**1 year**	**1 year**	**1 year**
Interest (per year)	**-0.25%**	**-1.50%**	**-0.25%**	**-1.50%**
Bank Fees	**$10**	**$3**	**$0**	**$0**
Documents Filling Out	**Yes**	**Yes**	**No**	**No**
Withdrawal before the end of the year	**No**	**No**	**No**	**No**

This table reports descriptions of deposit accounts with NIRs. Panel A refers to status quo conditions, whereas Panel B refers to Neutral conditions. Abbreviations SQ/TC/E and SQ/NTC/NE refer to Status Quo/Transition Costs/Effort and Status Quo/No Transition Costs/No effort conditions, respectively. Abbreviations N/TC/E and N/NTC/NE refer to Neutral/Transition Costs/Effort and Neutral/No Transition Costs/No effort conditions, respectively.

2006), restricted to the six questions about gambling and investing (details are available in Appendix 7.3.3). Finally, I use 20 questions from Loss Aversion Questionnaire developed by De Baets and Buelens (2012) to study participants' loss aversion (details are available in Appendix 7.2.3).

3.4 Hypotheses

I derive the following hypotheses to tackle the research questions:

Hypothesis 1: Individuals in the status quo conditions are more likely to choose "Bank B" (i.e., the status quo) for a fixed-term deposit than individuals in the neutral con-

ditions. This situation occurs because individuals in the former conditions are used to saving in "Bank B," whereas individuals in the latter form a new decision (Samuelson and Zeckhauser, 1988). This effect should be more significant for individuals who must pay transition costs and fill in the documents to switch from "Bank B" to "Bank A."

Hypothesis 2: Individuals in the NIRs region are less likely to maintain the status quo than individuals in the PIRs region. This situation emerges due to a loss aversion linked to NIRs. Notably, in the NIRs region, holding the status quo leads to a loss since the interest rate is negative. Due to a loss aversion (Tversky and Kahneman, 1992), a negative subjective value associated with a loss is approximately two times higher than a positive subjective value associated with an equivalent gain (as in the PIRs region). Hence, due to this loss aversion, individuals in the NIRs region are less likely to keep the status quo option than individuals in the PIRs region.

Hypothesis 3: More financially literate individuals are less likely to select "Bank B" for a fixed term deposit than less financially literate individuals. This situation occurs because "Bank A" (i.e., non-status quo bank) offers a 1.25% higher interest rate than "Bank B," and more financially literate individuals should be better able to perceive it than less financially literate individuals. In particular, better financially literate individuals are better able to determine the interest of both banks and pick the one offering a higher interest rate.

3.5 Results

3.5.1 Descriptive statistics

For this experiment, I recruited 200 participants via Prolific, which is an online crowd-sourcing platform.[2] To better define the sample in accordance with my setting, the prescreening options in Prolific are used. I requested from Prolific the US citizens who

[2]In total, 210 participants took part, but 10 participants dropped off from the experiment.

are between 18 and 65 years of age and whose first language is English.

Table 3.4 involves the descriptive statistics for the full sample of participants, as well as for the SQ/TC/E, SQ/NTC/NE, N/TC/E, and N/NTC/NE conditions, respectively. The average age of the full sample is 37. The sample is slightly unbalanced, with 35% male and 65% female participants. However, this should not posit an issue since both female and male participants do not differ significantly in their choice towards the status quo (for more details on the difference in status quo choice depending on participant's gender, refer to Appendix 7.2.4). The average financial literacy is 2.40, which means that, on average, participants answer more than two financial literacy questions correctly out of in total of three financial literacy questions.[3] Only one financial literacy question is answered correctly by 11% of all participants. Almost one-third of all participants answer the two financial literacy questions correctly, whereas more than half of the full sample (56%) correctly answer all three financial literacy questions. The mean risk tolerance across all participants is 2.43 on a scale ranging from 1 (extremely unlikely to take a risk) to 7 (extremely likely to take a risk).[4] Finally, average loss aversion across the full sample is 3.44 on a scale ranging from 1 (strongly disagree) to 5 (strongly agree).[5]

I randomly allocate participants to SQ/TC/E, SQ/NTC/NE, N/TC/E, and N/NTC/NE conditions. Participants across all four conditions are similar in age (between 36 in SQ/TC/E and 38 in both N/TC/E and N/NTC/NE). Next, in terms of gender, there are between 26% and 45% males across conditions. The highest proportion of male participants is in the SQ/NTC/NE condition, whereas the lowest is in the N/TC/E condition. Participants in all four conditions respond on average to two financial literacy questions correctly. I record that 13% of participants in SQ/TC/E respond to one financial literacy question correctly, whereas this number drops to 8% in N/NTC/NE. Two financial literacy questions are answered correctly by more than one-third of participants in N/TC/E,

[3]Based on the answers to the three questions taken from the Financial Literacy Questionnaire (available in Appendix 7.3.4), I calculate financial literacy as the average of the scores on these three questions.

[4]Based on the answers to the six questions taken from the DOSPERT scale (available in Appendix 7.3.3), I calculate risk tolerance as the average of the scores on these questions.

[5]Based on the answers to the twenty questions taken from the Loss Aversion Questionnaire (available in Appendix 7.2.3), I calculate loss aversion as the average of the scores on these questions.

whereas this proportion is one-fourth in the SQ/TC/E condition. On all three financial literacy questions, 60% of participants in SQ/TC/E condition correctly, whereas 53% of participants in N/NTC/NE answered correctly to these questions. The average risk tolerance is lowest in SQ/TC/E condition (2.07), whereas it is the highest in SQ/NTC/NE condition. The lowest average loss aversion is 3.35 in N/NTC/NE condition, whereas this average is the highest in SQ/TC/E condition (3.54).

Table 3.4: Descriptive statistics about the sample of participants

Variable	**Full sample**	**SQ/TC/E**	**SQ/NTC/NE**	**N/TC/E**	**N/NTC/NE**
Age	37	36	37	38	38
Male (in %)	35	38	45	31	26
Financial literacy (0 - 3 score)	2.40	2.44	2.43	2.37	2.37
Low financial literacy (in %)	11	13	12	10	8
High financial literacy (in %)	32	25	27	38	35
Highest financial literacy (in %)	56	60	59	50	53
Risk tolerance (1 - 7 score)	2.43	2.07	2.76	2.49	2.39
Loss aversion (1 - 5 score)	3.44	3.54	3.46	3.40	3.35
N	200	48	49	52	51

Table 5.3 shows descriptive statistics for the full sample as well as for the SQ/TC/E, SQ/NTC/NE, N/TC/E, and N/NTC/NE conditions, respectively. 'Financial Literacy' refers to the individual financial literacy of each participant. It takes values 0, 1, 2, 3 if the participant correctly answered zero, one, two, and all three financial literacy questions, respectively. 'Low financial literacy,' 'High financial literacy,' and 'Highest financial literacy' refer to the proportion of individuals that answered one, two, and three financial literacy questions correctly, respectively. 'Risk tolerance' refers to the subjective risk-taking inclination elicited using the six questions about gambling and investing in the DOSPERT scale. This measure of risk tolerance is calculated as the mean of the scores on these questions, on a scale ranging from 1 (extremely unlikely to take a risk) to 7 (extremely likely to take a risk). 'Loss aversion refers to the subjective loss aversion inclination measured through the 20 questions about loss aversion in the Loss Aversion Questionnaire on a scale ranging from 1 (strongly disagree) to 5 (strongly agree). N refers to the number of observations., i.e., participants who are involved in this experiment.

I conduct additional analysis regarding the variable of interest - status quo choice. Figure 3.3 displays the proportion of status quo (i.e., suboptimal) choices by age group. This figure might indicate that younger individuals (particularly those between 18 and 30) are more biased towards the status quo than middle-aged individuals (those between 41 and 50 years of age). In particular, almost one-fourth (i.e., around 25%) of individuals who are younger than 31 choose the status quo option. This proportion drops to almost 13% for individuals who are between 41 and 50 years of age.

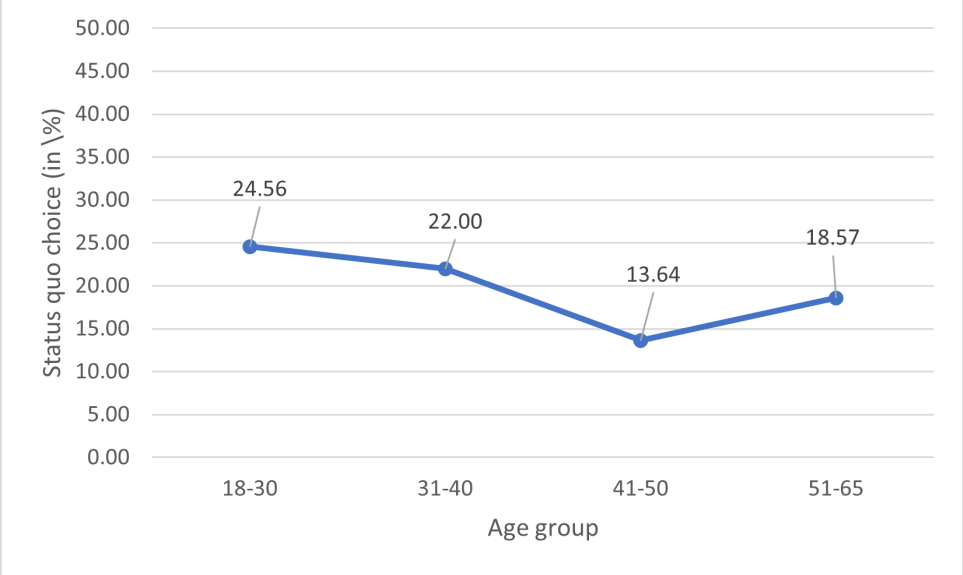


Figure 3.3: Status quo choice by age group

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This figure presents the proportion of status quo choices by age group. There are four age groups: 18-30 years old, 31-40 years old, 41-50 years old, and participants aged more than 51.

In the final analysis of this subsection, I decompose participants by gender and observe the proportion of status quo choices. Table 3.5 exhibits outcomes of this analysis. The results might suggest that females are more biased towards the status quo option than their male counterparts. On average, around 4% more females select the status quo option than males. However, after conducting t-tests, the difference in status quo choices depending on gender is statistically insignificant (for more details, refer to Appendix 7.2.4).

Table 3.5: Status quo choice by gender

Gender	Status quo (in %)
Male	18.12
Female	22.31

This table presents the proportion of status quo choice by gender.

3.5.2 Univariate analysis

To test Hypothesis 1, Hypothesis 2, and Hypothesis 3, I adopt a one-sided two-sample t-test.

Hypothesis 1 assumes that the proportion of individuals preferring the "Bank B" (i.e., the status quo option) is higher in the status quo conditions than in the neutral conditions. This proportion is larger in conditions involving transition costs and documents fulfillment than those without transition costs and documents fulfillment. Table 3.6 reports the results. Panel A displays the differences in proportions of individuals choosing the status quo between status quo and neutral conditions involving transitions costs and documents fulfillment if one aspires to switch from the status quo to another option. Panel B shows the differences in proportions if transition costs and documents fulfillment are omitted if one aspires to shift from the status quo to another option.

When transition costs and documents fulfillment are involved (Panel A of Table 3.6), the proportion of individuals picking the status quo option in status quo condition (SQ/TC/E) is around 38%. The proportion of individuals picking the same option in neutral conditions (N/TC/E) is only around 22%. The difference of around 16% favors the status quo condition, which is highly statistically significant. This evidence provides strong support for the first hypothesis. If transitions costs and documents fulfillment are excluded (Panel B of Table 3.6), the proportion of individuals choosing the status quo in status quo condition (SQ/NTC/NE) is only around 10%. The proportion of individuals choosing the same option in the neutral condition (N/NTC/NE) is 13%. This result does not support the first hypothesis. To summarize, the results of t-tests partially support the

first hypothesis. In particular, the status quo bias is discovered in conditions involving transitions costs and documents fulfillment but not in the conditions excluding them. From these tests, it turns out that the driving force of the status quo maintenance is more related to the effort and costs associated with the options other than the status quo and less with the status quo option solely. However, as Subsection 3.5.3 shows, the multivariate analysis exhibit that the status quo option solely leads to the status quo bias, without the mandatory inclusion of these efforts and costs.

Table 3.6: Differences in status quo choices between status quo and neutral conditions

Panel A : **Difference in SQ choices between SQ/TC/E and N/TC/E**	
SQ/TC/E	38.54%
N/TC/E	22.12%
Difference	16.42%
t-value	2.55
p-value	0.0059
Panel B : **Difference in SQ choices between SQ/NTC/NE and N/NTC/NE**	
SQ/NTC/NE	10.20%
N/NTC/NE	12.75%
Difference	-2.55%
t-value	-0.56
p-value	0.7126

This table reports the proportion of individuals choosing the "Bank B" (i.e., the status quo option) in SQ/TC/E, N/TC/E, SQ/NTC/NE, and N/NTC/NE conditions. Subsequently, the differences between these proportions are presented, and the corresponding t-values and p-values from one-sided two-sample t-tests. Panel A refers to the differences in these proportions between SQ/TC/E and N/TC/E conditions, while Panel B refers to the differences in proportions between SQ/NTC/NE and N/NTC/NE.

Hypothesis 2 assumes that the proportion of individuals selecting the "Bank B" is lower in the NIRs than in the PIRs region due to the loss aversion. Table 3.7 reports results of this analysis. Overall, the proportion of individuals selecting the status quo option in the NIRs region is 17.50%, whereas it grows to 24% in the PIRs region. The difference in proportions of 6.50% favors the PIRs region, which is significant at the 10% level. Hence, individuals facing PIRs are more likely to retain the status quo than individuals facing NIRs. This result supports the second hypothesis.

Table 3.7: Differences in status quo choices between NIRs and PIRs

NIRs	17.50%
PIRs	24.00%
Difference	-6.50%
t-value	1.6
p-value	0.0548

This table reports the proportion of individuals selecting the "Bank B" (i.e., the status quo option) in NIRs and PIRs regions, the differences between these proportions, and the corresponding t-values and p-values from one-sided one-sample t-tests.

Last but not least, Hypothesis 3 assumes that more financially individuals are less likely to select the status quo option than less financially literate individuals. Table 3.8 reports results for this hypothesis, in Panel A for the differences in proportions of status quo choices for individuals with the highest financial literacy and low financial literacy, and in Panel B for the differences in proportions for individuals with the highest and high financial literacy.

Focusing on Panel A of Table 3.8, the proportion of individuals preferring the status quo option who respond accurately to all three financial literacy questions (i.e., the highest financially literate individuals) is only around 16%. The proportion of individuals taking the same option but who responded to only one financial literacy question accurately (low financially literate individuals) grows to almost 36%. This difference in proportions favors the low financially literate individuals and provides sound evidence that less financially literate individuals are more biased towards the status quo. Panel B of the corresponding table summarizes the differences in proportions between the highest and high financially literate individuals. The difference in proportions of 6% favors high literacy individuals and delivers weakly (at the 10% level of significance) statistically significant evidence that more financially literate individuals are less prone to the status quo bias. This result shows robust evidence of the third hypothesis that more financially literate individuals are less biased towards the status quo and take more optimal decisions than their less financially literate counterparts.

Table 3.8: Differences in status quo choices depending on individual's financial literacy

Panel A : **Difference in SQ choices for the highest and low financial literacy**	
Highest literacy	16.22%
Low literacy	35.71%
Difference	19.49%
t-value	2.47
p-value	0.0084
Panel B : **Difference in SQ choices for the highest and high financial literacy**	
Highest literacy	16.22%
High literacy	22.22%
Difference	-6.00%
t-value	1.34
p-value	0.0902

This table reports the proportion of individuals choosing the "Bank B" (i.e., the status quo option) with the highest, high, and low financial literacy. Subsequently, the differences between these proportions are presented, and the corresponding t-values and p-values from one-sided two-sample t-tests. Panel A refers to the differences between the highest and low financial literate individuals, while Panel B refers to the differences in proportions between the highest and high financial literate individuals.

3.5.3 Multivariate analysis

To address the status quo bias and answer the research questions, I estimate three baseline binary logit models and cluster standard errors by financial literacy. I utilize three models in order to present marginal changes when variables of interest are used in the analysis. The dependent variable $Choice\_status\_quo_i$ is set to one when the individual chooses a fixed-term deposit of the "Bank B" (i.e., a status quo option) and zero otherwise. Independent variables used to explain the dependent variable are $Status\_quo\_cond_i$, $Procedures\_Costs_i$, interaction term $Status\_quo\_cond_i * Procedures\_Costs_i$, NIR, Age, $Male$, $Risk/Tol$, and $Loss/aver$. $Status\_quo\_cond_i$ is a binary variable set to one if an individual is assigned to Status Quo condition and zero otherwise. $Procedures\_Costs_i$ is a binary variable set to one if an individual must fill in the documents and pay transition costs, and zero otherwise. NIR_i is a binary variable that takes value one if the interest rate is negative and zero if the interest rate is positive. $Status\_quo\_cond_i * Procedures\_Costs_i$ is an interaction term. NIR is a binary variable that takes value one if the interest rate is negative and zero if the interest rate is positive. Age refers to the age of a participant. $Male$ is a dummy variable related to the gender of a participant,

and it takes value one if a participant is male and zero otherwise. $Risk\_Tol$ is a variable related to participant's risk tolerance, which represents the participant's average score on the answers to the six questions taken from the DOSPERT scale, which ranges from 1 (extremely unlikely to take a risk) to 7 (extremely likely to take a risk). $Loss\_aver$ is a variable related to participant's loss aversion, and it represents the participant's average score on the answers to the 20 questions obtained from the Los Aversion questionnaire, which ranges from 1 (strongly disagree) to 5 (strongly agree).

$$\begin{aligned} Choice\_status\_quo_i = \beta_0 + \beta_1 S\_Q\_cond_i + \beta_2 Proc\_Costs_i + \\ \beta_3 S\_Q\_cond_i * Proc\_Costs_i + \beta_4 NIR_i + \beta_5 Age_i + \beta_6 Male_i + \beta_7 Risk\_tol_i + \\ \beta_8 Loss\_aver_i + \epsilon_i \end{aligned} \tag{3.1}$$

Table 3.9 reports results for the models explained above. The first model (Model 1) includes S_Q_cond as the primary variable of interest. The coefficient sign is positive and statistically significant for this variable, supporting Hypothesis 1. In particular, the odds of choosing the status quo option increases by around 50% if a participant is in the Status Quo condition compared to the Neutral condition. For the variable NIR, the sign of a coefficient is negative and weakly statistically significant. If an individual is offered NIRs on his/her fixed-term deposit, the likelihood of choosing the status quo option decreases compared to the PIRs. All else being equal, the odds of choosing the status quo option decreases by 33.51% when an individual faces NIRs. This result brings support to Hypothesis 2. Variable Age exhibits a negative and highly statistically significant coefficient. Specifically, the odds of choosing the status quo option decrease by 1.93% if an individual is older compared to younger individuals. For the variable $Risk\_tol$, the sign of a coefficient is negative and significant at 5%. The odds of choosing the status quo option decrease by 20.82% if individuals exhibit a higher risk tolerance inclination. For variables $Male$ and $Loss\_aver$, the sign of a coefficient is statistically insignificant.

The second model (Model 2) includes $Proc\_Costs$ as the primary variable of interest

and excludes the *S_Q_cond* variable. The coefficient is positive and highly statistically significant for this variable (at the 1% level of significance). Hence, when procedures and transitions costs are involved in switching from the status quo to another option, the likelihood of choosing the status quo option increases compared to the case which includes no procedures and no costs. All else being equal, the odds of an individual choosing the status quo option increases by a factor of 2.13 when procedures and transition costs are involved when one wants to shift from the status quo to another option. For other variables, we obtain similar results as in Model 1. However, in this model, the significance of the variable *Risk_tol* drops to 10% compared to 5% in Model 1.

The final model (Model 3) incorporates both between-experimental variables and an interaction term between those two variables. Compared to Model 1, the variable *S_Q_cond* losses its significance. However, the second variable (*Proc_Costs*) maintains its significance and direction (positive sign), which confirm the findings of Model 2. The odds of choosing the status quo option increase by 93,03% if an individual has to go through procedures and pay transition costs when desiring to open a deposit account than when he/she does not have to do that. Hypothesis 1 postulates that the status quo choice depends simultaneously on status quo condition, procedures, and transition costs. In order to test this hypothesis, an interaction term is included. This interaction variable exhibits a positive relationship and a significance at 10%. If procedures and costs are involved when one wants to shift from the status quo to another option, the likelihood of choosing the status quo option increases in the status quo condition, compared to the neutral condition. The odds of choosing the status quo option increase by 171.64% if a participant is in the status quo condition and faces procedures and transition costs. We obtain similar results for all other independent variables as in both Model 1 and Model 2, except for the variable *Risk_tol*, which does not maintain any traditional level of significance.

Table 3.9: Choices of status quo

Parameter	Model 1		Model 2		Model 3	
	Estimate	OR	Estimate	OR	Estimate	OR
Intercept	-0.0987		-1.0441		-0.7657	
S_Q_cond	0.4070**	1.5023			-0.2237	0.7996
Proc_Costs			1.1408***	3.1293	0.6577***	1.9303
S_Q_cond * Proc_Costs					0.9993**	2.7164
NIR	-0.4081*	0.6649	-0.4255*	0.6534	-0.4341*	0.6478
Age	-0.0195***	0.9807	-0.0184***	0.9818	-0.0170***	0.9831
Male	-0.2591	0.7717	-0.2222	0.8008	-0.2910	0.7475
Risk_tol	-0.2334**	0.7918	-0.1235*	0.8838	-0.0569	0.9447
Loss_aver	0.0285	1.0289	0.0818	1.0852	-0.0265	0.9738
N	400		400		400	

This table reports the results of three binary logit models wherein the dependent variable *Choice_status_quo* is set to one if an individual chooses the status quo option and zero otherwise. Independent variables are *S_Q_cond*, *Proc_Costs*, and an interaction term $S\_Q\_cond * Proc\_Costs$. *S_Q_cond* is a binary variable set to one if an individual is in Status Quo condition and zero otherwise. *Proc_Costs* is a binary variable set to one if an individual must fill in the documents and pay transition costs, and zero otherwise. $S\_Q\_cond * Proc\_Costs$ is an interaction term. NIR_i is a binary variable that takes value one if the interest rate is negative and zero if the interest rate is positive. NIR is a dummy variable that takes value one if the interest rate is negative and zero if the interest rate is positive. *Age* refers to the age of a participant. $Male$ is a dummy variable related to the gender of a participant, and it takes value one if a participant is male and zero otherwise. $Risk\_Tol$ is a variable related to participant's risk tolerance, which represents the participant's average score on the answers to the six questions taken from the DOSPERT scale, which ranges from 1 (extremely unlikely to take a risk) to 7 (extremely likely to take a risk). $Loss\_aver$ is a variable related to participant's loss aversion, and it represents the participant's average score on the answers to the 20 questions obtained from the Los Aversion Questionnaire, which ranges from 1 (strongly disagree) to 5 (strongly agree). N gives the number of observations. Standard errors are clustered at the financial literacy level. OR refers to odds ratios. ***, **, and * indicate significance at 1%, 5%, and 10%, respectively.

The second set of models adds another independent variable compared to the baseline model - financial literacy (to test Hypothesis 3). Financial literacy is coded using three binary variables ($D\_Low\_literacy_i$, $D\_High\_literacy_i$, $D\_Highest\_literacy_i$), which are set to one when financial literacy is low, high, and the highest, respectively.

$$
\begin{aligned}
Choice\_status\_quo_i = \beta_0 + \beta_1 S\_Q\_cond_i + \beta_2 Proc\_Costs_i + \\
\beta_3 S\_Q\_cond_i * Proc\_Costs_i + \beta_4 NIR_i + \beta_5 Age_i + \beta_6 Male_i + \beta_7 Risk\_tol_i + \\
\beta_8 Loss\_aver_i + \beta_9 D\_Low\_l_i + \beta_{10} D\_High\_l_i + \\
\beta_{11} D\_Highest\_l_i + \epsilon_{i,d}
\end{aligned}
\tag{3.2}
$$

Table 3.10 summarizes the results of the models specified in the equation above. This model contains the abovementioned variables. Focusing on Model 1, the sign of coefficients and statistical significance are similar for the variables selected from Model 1 of Table 3.9 (S_Q_cond, $Proc\_Costs$, NIR, Age, $Male$, $Risk\_tol$, $Loss\_aver$). For the S_Q_cond variable, the sign of a coefficient is positive and significant at the 5% level, implying a higher likelihood of choosing the status quo option if an individual is in the status quo condition than if he/she is not. For three variables related to financial literacy, the coefficient sign is statistically significant for all three literacy levels (as conjectured in Hypotheses 3). As predicted, the coefficient sign is negative for all three financial literacy variables. The odds of choosing the status quo option decrease as the financial literacy levels increase. When an individual shows low levels of financial literacy (i.e., he/she answers one out of three financial literacy questions correctly), the odds of picking the unfavorable status quo option decrease by almost 13% compared to the individual who displays the lowest level of financial literacy (i.e., who answered all three financial literacy questions incorrectly). These odds of not picking the status quo option increase to 66,43% if the individual displays the highest level of financial literacy (i.e., he/she answers all three financial literacy questions correctly). To summarize the findings related to financial literacy, as financial literacy increases, the bias towards the status quo decreases substantially.[6]

[6]Our questionnaire related to financial literacy, which includes only three questions, might be insufficient to obtain the individual's financial literacy comprehensively. It might be that this measure of financial literacy (due to its simplicity in terms of a relatively limited number of questions) explains an individual's education level. Specifically, as shown in the empirical paper of Mandell and Klein (2009), education is a good predictor of financial literacy, i.e., individuals who are more educated show a higher financial literacy than their less-educated counterparts.

Model 2 resembles Model 2 of Table 3.9. The sign of coefficients and statistical significance is similar to Model 1 of this table, except for the variable *Risk_tol*, whose significance levels fall short of any traditional level. For the variable of interest (*Proc_Costs*), the sign of a coefficient is positive and highly statistically significant, which implies a higher likelihood of choosing the status quo option if the individual faces procedures and must pay costs to open a savings account than an individual who is exempted from these procedures and costs. In particular, the odds of picking the status quo option increases by 226.81% if an individual faces these procedures and costs than if he/she does not face these procedures and costs. We obtain similar coefficients and significance for all three variables related to financial literacy as in Model 1 of the same table. The coefficients related to financial literacy imply that odds of not picking the status quo option increase compared to Model 1.

Model 3 is similar to Model 3 of Table 3.9. Compared to Model 1, the variable *S_Q_Cond* loses significance and changes the sign. Variable *Proc_Costs* maintains its significance as in Model 2 of this table. However, the odds of picking the status quo option increase by 94,29% if one must go through procedures and costs, which is lower than in Model 2 (226.81%). As expected, the sign of a coefficient is positive and highly statistically significant for the interaction term. In particular, the odds of picking the status quo option increase by almost 197% when an individual is assigned to the status quo condition and must pay transition costs and go through procedures when desiring to open a savings account. Findings for all three variables related to financial literacy are similar to Model 2.

Table 3.10: Choices of status quo

Parameter	Model 1		Model 2		Model 3	
	Estimate	OR	Estimate	OR	Estimate	OR
Intercept	0.2336		-0.5768		-0.3040	
S_Q_cond	0.4116**	1.5092			-0.2584	0.7723
Proc_Costs			1.1842***	3.2681	0.6642***	1.9429
S_Q_cond * Proc_Costs					1.0884**	2.9695
NIR	-0.4165*	0.6594	-0.4357*	0.6468	-0.4453*	0.6406
Age	-0.0113*	0.9888	-0.0099**	0.9901	-0.0078	0.9922
Male	-0.0016	0.9984	0.0474	1.0485	-0.0132	0.9869
Risk_tol	-0.2352**	0.7904	-0.1169	0.8897	-0.0375	0.9632
Loss_aver	0.0512	1.0525	0.1129	1.1195	-0.0031	0.9969
D_Low_l	-0.1361**	0.8728	-0.2735**	0.7607	-0.2911***	0.7474
D_High_l	-0.6483***	0.5229	-0.9387***	0.3911	-0.8868***	0.4120
D_Highest_l	-1.0914***	0.3357	-1.3125***	0.2691	-1.3629***	0.2559
N	400		400		400	

This table reports the results of three binary logit models wherein the dependent variable $Choice\_status\_quo_i$ is set to one if an individual chooses the status quo option and zero otherwise. Independent variables are $S\_Q\_cond_i$, $Proc\_Costs_i$, and an interaction term $S\_Q\_cond_i * Proc\_Costs_i$. $S\_Q\_cond_i$ is a binary variable set to one if an individual is in Status Quo condition and zero otherwise. $Proc\_Costs_i$ is a binary variable set to one if an individual must fill in the documents and pay transition costs, and zero otherwise. NIR_i is a binary variable that takes value one if the interest rate is negative and zero if the interest rate is positive. $S\_Q\_cond_i * Proc\_Costs_i$ is an interaction term. Age refers to the age of a participant. $Male$ is a dummy variable related to the gender of a participant, and it takes value one if a participant is male and zero otherwise. $Risk/Tol$ is a variable related to participant's risk tolerance, and it represents the participant's average score on the answers to the six questions taken from the DOSPERT scale, which ranges from 1 (extremely unlikely to take a risk) to 7 (extremely likely to take a risk). $Loss/aver$ is a variable related to participant's loss aversion, and it represents the participant's average score on the answers to the 20 questions obtained from the Loss Aversion Questionnaire, which ranges from 1 (strongly disagree) to 5 (strongly agree). Financial literacy is coded using three binary variables ($D\_Low\_l_i$, $D\_High\_l_i$, $D\_Highest\_l_i$), which are set to one when financial literacy of a participant is low, high, and the highest, respectively. ***, **, and * indicate significance at 1%, 5%, and 10%, respectively. N gives the number of observations. Standard errors are clustered at the financial literacy level. OR refers to odds ratios.

3.6 Conclusion

This paper pioneers in investigating the impact of status quo bias on saving decisions when individuals are simultaneously presented with NIRs and PIRs. The added value of this research is investigating in an online experiment separately behavior of savers (i.e., individuals that have already opened a fixed-term deposit and choose whether to keep it or shift to another one) vs. non-savers (individuals who open the fixed-term deposit for the first time) when offered both NIRs and PIRs. This experiment is 2 (Status Quo

vs. Neutral condition) * 2 (No transition costs/No effort vs. Transition costs/Effort). Building on Samuelson and Zeckhauser (1988), who postulate that one alternative labeled as status quo posits a possible choice and often leads to suboptimal decisions, I posit that individuals who are in status quo conditions (i.e., savers) are more likely to keep the status quo option than individuals in the neutral conditions (i.e., non-savers). Besides, since transition costs and procedures could impede an individual's shifting from the status quo option to another alternative, I assume a more robust status quo bias when they are included than when they are not. Subsequently, due to loss aversion, I assume that individuals offered with fixed-term deposits proposing NIRs (i.e., losses) are less likely to keep the status quo option than individuals facing PIRs (i.e., gains). Finally, I assume that more financially literate individuals are less likely to shift from the status quo option than their less financially literate counterparts.

This innovative approach conveys compelling results on status quo bias in both PIRs and NIRs regions. Firstly, findings partially validate the difference in status quo bias between status quo and neutral conditions. I notice that individuals in status quo conditions select the status quo option more frequently than individuals in neutral conditions. Nevertheless, I find this evidence exclusively in conditions involving procedures and transitions costs, not in conditions excluding them. Hence, the status quo choice depends strongly on procedures and transition costs individuals encounter. Secondly, in line with loss aversion, I realize that individuals offered NIRs select less frequently the status quo option than individuals facing PIRs. Hence, NIRs serve as a moderator of status quo bias compared to PIRs. Thirdly, I notice that more financially literate individuals are less likely to be status quo biased than their less financially literate counterparts. This result shows that improving financial literacy leads to better decision-making and reduces the status quo bias.

The effect of the status quo bias, when confronting mean variations in proportions of taking the status quo option between SQ/TC/E and N/TC/E, produces new implications. The mean proportion of individuals selecting the status quo option in SQ/TC/E and N/TC/E is 38% and 22%, respectively. The difference of 16% favors the status quo

condition and soundly confirms the status quo bias. Next, analyzing mean differences in proportions selecting status quo option between fixed-term deposits with either NIRs or PIRs delivers new insights. The mean proportion of individuals taking the status quo option in NIRs and PIRs regions is 17.50% and 24%, respectively. The difference in mean proportions of 6.50% favors the PIRs region, which implies a higher (lower) bias towards the status quo in PIRs (NIRs) region. Finally, comparing mean differences in proportions of selecting the status quo option between the individuals with the highest financial literacy and those with the low financial literacy provides compelling indications for the status quo bias. In particular, the former (latter) individuals pick the status quo option 16% (36%)of the time, which implies that financial literacy matters for the status quo bias. This difference in mean proportions of around 20% favors the individuals with low financial literacy, which are more status quo biased than their counterparts displaying the highest level of financial literacy.

Two sets of binary logit models supply additional implications for the status quo bias. To begin with, these models confirm that NIRs reduce the likelihood of selecting the status quo option (i.e., the status quo bias) compared to PIRs. Next, procedures and transition costs when one wants to switch from the status quo to another option can be an obstacle in reducing the status quo bias. Subsequently, the results imply that the status quo bias depends not only on the status quo (i.e., when an individual is a regular saver) but also on the procedures and costs involved when one wants to shift from the status quo to another option (for instance, to change a bank). Hence, the likelihood of maintaining the status quo option increases when there is an interaction between the status quo (i.e., an individual being a saver) and procedures and costs if one wants to switch from the current to another bank. Finally, all levels of financial literacy decrease the status quo bias.

This paper provides implications for economic policy, banks, and individual investors. From an economic policy point of view, regular savers are more likely to leave their status quo option and opt for alternatives when NIRs are introduced, which occurs due to loss aversion. This situation implies that NIRs policy could effectively lead to an individual's behavioral change towards optimal decisions. This individuals' change in behavior could

mean that banks' important funding source (i.e., deposits) could be reduced, which can significantly harm the banks that depend heavily on deposits. On the contrary, procedures and costs impede this individual's behavioral change and lead to the retention of the existing deposits. This individuals' change in behavior towards optimal decisions is enhanced when individuals reach at least low levels of financial literacy. Hence, it is crucial to raise an individual's financial literacy in order to reduce the bias towards the status quo.

The results of this study cannot fully reflect the reality and dynamics of individuals' saving decisions. A potential limitation of this study is that there is only one time horizon - one year. However, when one desires to save money, a bank proposes both short and long time horizons. Hence, future studies can involve more than one time horizon and measure its impact on status quo bias in the NIRs region. Further, in this study, the savings amount is small - $1.000. It is also essential to test the impact of NIRs on status quo bias when this amount is high. Subsequently, this study involves only non-risky assets - fixed-term deposits. However, the reality is more complex, and individuals could also choose risky assets when desiring to switch from the status quo option. Hence, it is beneficial to scrutinize the influence of risky assets besides non-risky assets on status quo bias when NIRs are introduced.

Chapter 4

Negative Interest Rates and Money Illusion

Chapter Abstract

This paper researches the impact of negative and positive nominal interest rates on money illusion for individuals' saving and investment decisions involving risk-taking. Money illusion refers to an individual's nominal rather than real reasoning, driving towards sub-optimal decisions. Using an online experiment, I determine that individuals considering saving decisions with negative nominal interest rates display a higher money illusion than individuals facing positive nominal interest rates. Next, the findings reveal that financial literacy aids in reducing individuals' money illusion whatever the sign of nominal interest rates.

Keywords: negative interest rates, money illusion, savings, investments, financial literacy

JEL Classification: G11, G21, G40, G41, G51, G53

4.1 Introduction

The 2008 global financial crisis required monetary policy modifications to increase consumption and stimulate economic activity. Several central banks of industrialized countries have implemented an unconventional monetary policy - negative interest rates (NIRs) to reach these two targets. Commercial banks now must pay to keep the minimum reserve requirements at the central bank.[1] Instead of doing that, banks should increase their non-interest income activities (equity purchasing) and loan volumes.

NIRs reverse the standard theory upside down since depositors now must pay to delay their consumption. Hence, commercial banks are hesitant to introduce NIRs on deposits of their clients. Deposits are a critical source of funding for banks, which could be reduced because cash has no lower bound, i.e., depositors can take money from their deposit accounts and invest it elsewhere. Empirical evidence supports this limited introduction of NIRs on deposits (Eggertsson et al., 2017; Basten and Mariathasan, 2018a; Lopez et al., 2020; Corneille et al., 2020).

The aforementioned consequences of NIRs on deposits consider exclusively nominal interest rates and not the impact of inflation on real interest rates. Since inflation in the same period is none-negative and is higher than the nominal interest rates, the real interest rates (i.e., the difference between nominal interest rates and inflation) are also negative. However, there are other periods wherein we have negative real interest rates, although nominal interest rates were positive. For instance, inflation exceeded positive nominal deposit rates in the European Union from 2017-2021, which constituted negative real interest rates. This situation implies that savers lose purchasing power over time when placing their money on savings.

Real interest rates are negative in circumstances of both positive and negative nominal interest rates whenever inflation surpasses them. If this is the case, individuals should

[1] For example, Swiss National Bank cut its deposit facility rate to -75 basis points (bps), which should be charged on banks exceeding twenty times the minimum reserve requirement (Basten and Mariathasan, 2018b).

behave similarly (if real interest rates are identical) in both circumstances and act in accordance with real interest rates. This should imply that people are able to understand the difference between nominal and real rates. However, the problem arises because individuals do not always think in real terms, but rather in nominal terms. An individual is labeled to be money-illusioned when he/she focus on nominal rather than real terms while making decisions (Shafir et al., 1997). A wide stream of literature confirms its emergence (Fehr and Tyran, 2005; Bakshi, 2009; Darriet et al., 2020; Mees and Franses, 2014). If this is the case, the behavior of individuals facing negative real interest rates, but in one case, positive, and in another case, negative nominal interest rates might differ. Especially because (money-illusioned) individuals facing positive nominal interest rates might consider them as gains, and individuals facing negative nominal interest rates might consider them as losses.

The main research question that this paper tackles is: Is there any difference in money illusion for positive versus negative nominal interest rates in the context of savings and investments? From that main research question, I derive the subsequent two research questions:

1. Are individuals less or more able to determine who is better off in economic terms when savers are presented with negative versus positive nominal interest rates?

2. By maintaining constant expected real returns and real interest rates and varying only their nominal representations as gains and losses, would individuals invest similarly irrespective of the sign of nominal interest rates?

The relevance of these two research questions is reflected in the study of the influence of NIRs on money illusion in savings and investment settings with various inflation rates. Hence, they could test the effectiveness of NIRs on savings and investment by considering money illusion in a more realistic environment than the previous literature related to NIRs (Ganzach and Wohl, 2018; Lian et al., 2018; Baars et al., 2020; Bracha, 2020). Solving the first research question might aid us in grasping the savings behavior if individuals face both nominal rates and inflation in the NIRs region. In particular, if individuals in

the NIRs region are more money-illusioned than in the PIRs region, their saving decisions might be detrimental to their financial well-being. The second research question might help us understand whether money-illusioned individuals take more risk in the NIRs region compared to the PIRs region.

To answer the first research question, in Study 1, I adopt a survey design based on Problem 1 in Shafir et al. (1997) paper. This study includes in total three conditions. The first (Positive) condition is a replication of Problem 1 adjusted for the context of the savings. Participants are asked to imagine two individuals living in two different US states. The first individual lives in a state wherein inflation is set to 0%, and the bank offers a positive interest rate of 2% on the one-year fixed-term deposit. The second individual lives in a state wherein the expected inflation is 4%, and the bank offers a 5% nominal interest rate. Subsequently, I ask participants to indicate who is better off by opening a fixed-term deposit in economic terms. In the second condition (Positive/Negative), I drop nominal interest rates by 4% for both individuals and keep inflation at the same level as in the first condition. The first individual faces negative nominal interest rates (-2%), while the second faces positive interest rates (1%). In real terms, the difference between the two is similar to the first condition. Participants are then asked the same question as in the first condition. In the last condition (Negative), I drop further interest rates by 4% such that interest rates are negative for both individuals. For the first person, it is -6%, whereas for the second it is -3%. I repeat then the same question as in the first and the second condition.

In all three conditions, the first individual is better off in economic terms than the second individual. However, the second individual is provided a 3% higher nominal interest rate than the first individual. Hence, money illusioned participants who do not consider inflation might be more likely to perceive the second individual to be better off. On the contrary, participants who are not money illusioned should predict that the first individual is better off.

To answer the second research question, I conduct Study 2. In this study, I adopt a

between-experimental design with the inflation rate being the between factor to answer this research question. This experiment involves two conditions: Inflation (4%) and Deflation (-2%) conditions. All participants in the experiment are informed that they will make one investment decision with two investment alternatives: a deposit account and a stock index fund. A variable that is kept constant across conditions is the real return on the stock index fund (at 3% above the inflation rate) and the real interest rate on the deposit account (at -1% below the inflation rate). Hence, real rates and real returns are constant irrespective of the condition. However, I present nominal expected returns and nominal interest rates as gains and losses. If not money illusioned, participants should invest similarly irrespective of the condition to which they belong. To explain money illusion, I elicit participants' subjective risk-taking inclination with the DOSPERT scale (Blais and Weber, 2006), and financial literacy with the aid of three questions from Lusardi (2008). Financial literacy could serve as a significant explanatory variable for money illusion in both studies since it includes a question concerning the impact of real interest rates on savings. Since Study 2 investigates risk-taking behavior, it is of particular interest to elicit participants' subjective risk-taking inclination.

The original approach, which introduces losses (i.e., NIRs) in investigating an individual's money illusion, provides insightful results for individual money illusion and savings behavior. First, I show in Study 1 that individuals focus more on nominal terms when introduced with NIRs than when exclusively presented with PIRs while considering savings decisions. In particular, comparing the mean correct answers to the question related to money illusion in this study, only 50% of individuals in Positive/Negative and Negative conditions provide a correct answer to this question compared to 80% in Positive condition. This result confirms that money illusion increases when NIRs are introduced. Study 2 results imply that individuals offered nominal negative interest rates exhibit a higher risk appetite than those offered positive nominal interest rates. However, these results are statistically insignificant, and further investigation in this regard is required.

The further investigation of Study 1 by using the binary logit model delivers additional insights. To begin with, the results of this investigation confirm the hypothesis that indi-

viduals facing negative nominal interest rates are more money illusioned than individuals facing positive nominal interest rates. Furthermore, this money illusion is explained by the financial literacy question that explains whether individuals consider the impact of inflation on purchasing power, i.e., whether they can determine the real interest rate. The association between financial literacy and money illusion is negative, i.e., a higher financial literacy reduces money illusion. Hence, financial literacy is particularly relevant in the NIRs region since money illusion increases with NIRs compared to PIRs. To conclude, it is of particular interest to increase financial literacy when NIRs are introduced.

This paper contributes to the behavioral finance literature, negative interest rate literature, and banks' decision-making process. This paper contributes to the behavioral finance literature by investigating money illusion in the context of saving. Besides, unlike Shafir et al. (1997) that focus mainly on positive nominal interest rates (see Problem 1), this study involves conditions wherein participants are asked to evaluate the mixture of nominal interest rates (positive and negative) and negative nominal interest rates. Contribution to the negative interest rate literature mirrors in comparing negative and positive nominal interest rates and inflation. In particular, I examine the perception of individuals when both negative interest rates and inflation are included in their decisions and could have an impact. Besides that, I help banks to understand whether and why individuals with negative nominal interest rates might behave differently than individuals considering positive nominal interest rates. This understanding of individuals' savings behavior might help banks adapt their policies by taking more risks in order to retain their profits.

The remainder of the paper is organized as follows. Section 4.2 reviews the relevant literature. Section 4.3 describes the experimental setting and presents hypotheses. Section 4.4 reports the results. Section 4.5 concludes.

4.2 Literature Review

There is experimental evidence showing the existence of money illusion. According to Shafir et al. (1997), money illusion relates to an inclination to think in nominal rather than real monetary terms. From a standard economic theory point of view, it represents a lack of rationality. Whenever individuals focus more on nominal prices and nominal wealth instead of real prices and real wealth, they are subject to money illusion.

Shafir et al. (1997) conduct several surveys in the US to investigate money illusion. One of their experiments related to earnings considers two individuals, Ann and Barbara, who graduated from the same college a year apart. Both took similar jobs upon graduation. Ann started with a yearly salary of \$30,000. During the first year, there was no inflation, and in her second year, she received an increase of 2% (\$600) in salary. Barbara also started with a yearly salary of \$30,000. During the first year on the job, inflation was 4%, and in the second year, Barbara received a 5% (\$1,500) increase in salary. In real terms, Ann received a 1% higher raise (i.e., 2%) in salary than Barbara (i.e., 1%). In nominal terms, it is exactly the opposite, and Barbara received a 3% higher increase (i.e., 5%) than Ann (i.e., 2%). Participants in the study indicate who was doing better in economic terms as Ann and Barbara entered the second year of the job. Most individuals estimated that Ann was doing better, as real terms suggest. However, when asked who felt happier entering the second year of the job, the vast majority answered Barbara, whose increase in nominal (and not real) terms is higher. Hence, their higher focus, in this case, is a nominal representation of outcomes. Finally, they were asked who would be more likely to leave the company if offered a job from another company. Most subjects answered that Ann is more likely to leave the present position, although Barbara's real salary increase is higher than Ann's. Hence, subjects focused more on nominal than real terms, all in line with money illusion.

Fehr and Tyran (2005) examine the effect of money illusion on forming individuals' expectations regarding prices. These authors conduct experiments to answer this research question. In their experiment, subjects are in the role of firms and choose a nominal price

in several periods. They are free to change prices at zero cost at any period they desire. After the pricing decision, each firm receives information about the aggregate price level and payoff. Payoffs are presented in real and nominal terms depending on conditions. This experiment has a pre-shock and post-shock period. The former serves the purpose of equilibrating the system. The latter observes how firms adjust nominal prices to the monetary shock (i.e., inflation) in various conditions. The results could be summarized as follows. When presented with real payoffs, only 35% of the subjects adjusted nominal prices to shock. The situation is even more dramatic for firms with nominal payoff. In particular, only 11% of the subjects adjusted nominal prices after the shock. Hence, money illusion exists, even for individuals presented with real instead of nominal payoffs. For individuals who are presented with a nominal payoff, the money illusion is more striking.

Bakshi (2009) tests experimentally whether money illusion exists among master students in economics. The assumption is that money illusion can be easily eradicated through economics training. That being said, money illusion should be nonexistent among students of economics. This author conducts an experiment based on a 30x30 payoff table with multiple Pareto-ranked equilibria. In total, there were ten periods, i.e., rounds. This game is symmetric, where each subject's real payoff depends on his/her price and the average price of other players. All subjects are shown the payoff table and depicted regarding the outcome of an action in the group. This was a pricing game wherein subjects had to decide upon their own price and expect the average price of others. The payoff table is depicted by using nominal payoffs. The real payoff is calculated by dividing the nominal payoff by the other people's average price. For the performance of everyone, it is the real payoff that matters. This game has two equilibria that differ: one nominal equilibrium and the other that is real. Instead of choosing prices leading to the real equilibrium, individuals chose over several periods (55% to 70% of the time) prices leading to nominal equilibrium. To conclude, the assumption that individuals who are well-equipped in economics and have more periods to learn to avoid money illusion do indeed avoid money illusion does not hold in this experiment.

Mees and Franses (2014) examine how individuals in China respond to changes in inflation and prices in China, i.e., the money illusion, using the questionnaire of Shafir et al. (1997) (see the second paragraph in this section). When economic terms are emphasized, most participants correctly assessed the above scenario in real rather than nominal terms. On the contrary, when considering happiness and likelihood to leave the job, most participants predicted that the individual who is better off in nominal but not real terms is happier and less likely to leave the job.

Another important term related to money illusion is nominal loss aversion. Before explaining nominal loss aversion, I start with loss aversion. Loss aversion is frequently defined as "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 (Kahneman and Tversky, 1979; Tversky and Kahneman, 1992). For instance, a loss of $100 has two times higher negative subjective value than a positive value associated with an equivalent gain. Nominal loss aversion then represents an interaction between loss aversion and money illusion (Stephens and Tyran, 2012). According to Stephens and Tyran (2012), real losses loom larger in people's minds when they lose money than when purely nominal gains hide them.

Stephens and Tyran (2012) apply survey experiments to investigate how nominal representations shape perceptions of losses in real terms. They investigate the effect of nominal loss aversion by presenting a given real loss as a nominal gain vs. nominal loss. Subjects in their survey are presented with hypothetical housing transactions, each involving a house's purchase and subsequent sale. The purchase price of a house is the same in all conditions. In the high-inflation condition, inflation is 31%, the house is sold at a nominal gain of 25.8%, but at a real loss of 4%. In low inflation condition, inflation is 2%, and a house is sold at a nominal loss of 2%. Hence, the real loss is similar in both conditions. Subsequently, participants in both conditions are asked how advantageous is the purchase and sale of the house. Housing transactions involving losing money are viewed more unfavorably than transactions involving gaining money for a given real loss of 4%. Hence, nominal losses are more salient than gains for a given real loss.

In a more recent study, Darriet et al. (2020) investigate money illusion at the individual level in the context of financial choices and study its relationship with financial literacy and numeracy. Financial literacy is the elementary knowledge concerning compounding, inflation, and diversification (Lusardi and Mitchell, 2011). In their experiment, Darriet et al. (2020) use two questions to check whether individuals comprehend interest rates and one question to measure the individual's understanding of the inflation concept. In order to measure an individual's numeracy, participants have to compare six pairs of ratios and choose the correct ones for which they receive monetary rewards. These authors adopt incentivized experimental design with a choice task to answer their research question. This task comprises a series of questions wherein individuals must choose one of two bonds for each choice task. Both bonds have the same initial value. They differ in return and inflation. One bond has the highest real value and one the highest nominal value for each choice. Participants are then asked to choose the one with the highest real return. If they do so, they receive fifty cents as a reward for each correct answer in a task. These authors find that the average mean error rate among participants is 31%, i.e., on average, they provided 69% correct answers on a choice task. They find that individuals with higher financial literacy show a lower likelihood of conducting errors, indicating that more financially literate individuals are less inclined to money illusion. However, for numeracy, these authors do not find a significant result. To conclude, even in this simple choice task, individuals, notably less financially literate, show significant money illusion.

4.3 Research Design

This article involves two experiments to study money illusion. The same participants take part in both experiments. Participants receive a fixed amount of $1 for participation in both and a premium. This premium depends on the performance of the investment decision in the second experiment. Both experiments are entirely designed in oTree (Chen et al., 2016).

4.3.1 Study 1

The research design adopted for Study 1 is a survey based on a paper of Shafir et al. (1997). It involves in total three conditions to which participants are randomly assigned (Figure 4.4 provides more details on the definition of conditions). The first condition (Positive) is a reproduction of Problem 1 of Shafir et al. (1997) and represents the baseline condition to which the other two conditions will be compared (for more details regarding the decision-making process, refer to Figures 4.1, 4.2, and 4.3). However, the context is related to savings decisions. Participants in the study are asked to imagine two individuals living in two different US states having the same amount of money to save the following year. The first person lives in a state wherein the expected inflation for the next year is zero. A bank offers this person a one-year fixed-term deposit at a positive interest rate of 2%. The second person lives in a state where the expected inflation for the next year is 4%. A bank offers this person a one-year fixed-term deposit at a positive interest rate of 5%.

Both individuals face positive nominal interest rates. However, the first one is better off in real economic terms since the real interest rate is approximately 1% higher than the second one's. The second individual is better off in nominal economic terms than the first since the nominal interest rate is 2% higher. What matters for individuals is the real interest rate and not the nominal interest rate because the real interest rate is adjusted for the inflation rate (see more details regarding the determination of real rates in Appendix 7.3.1).

For the second condition (Positive/Negative), I reduce nominal interest rates by 4% for both individuals. This setting implies that the nominal interest rate is now negative (-2%) for the first individual, whereas for the second individual, it remains positive (1%). In this case, the former individual faces a nominal loss, whereas the second individual faces a nominal gain. As for the first condition, the second individual is better off in nominal, whereas the first individual is better off in real terms. However, suppose individuals are nominally loss averse. If this is the case, participants might perceive the first individual to be much worse off than the second individual in the Positive-Negative than in the

Positive condition, which leads to the higher money illusion in the former than in the latter condition.

In the third condition (Negative), I reduce further nominal interest rates by 4%. This situation implies that the first and second individuals face nominal interest rates of -6% and -3%, respectively. As for the first condition, the second individual is better off in nominal, whereas the first individual is better off in real terms.

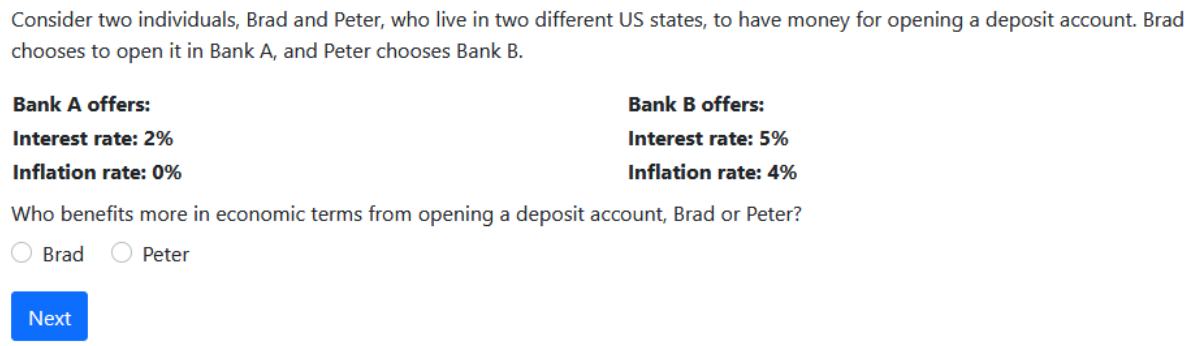

Figure 4.1: Computer screen—decision-making in the Positive condition

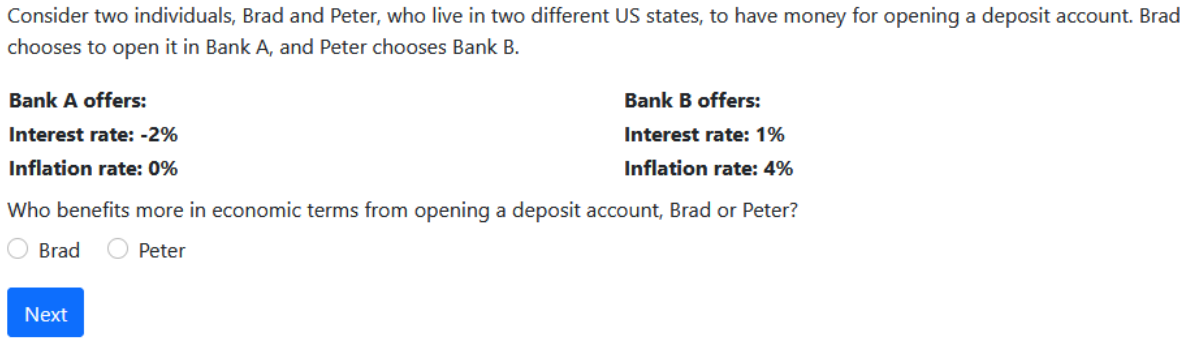

Figure 4.2: Computer screen—decision-making in the Positive/Negative condition

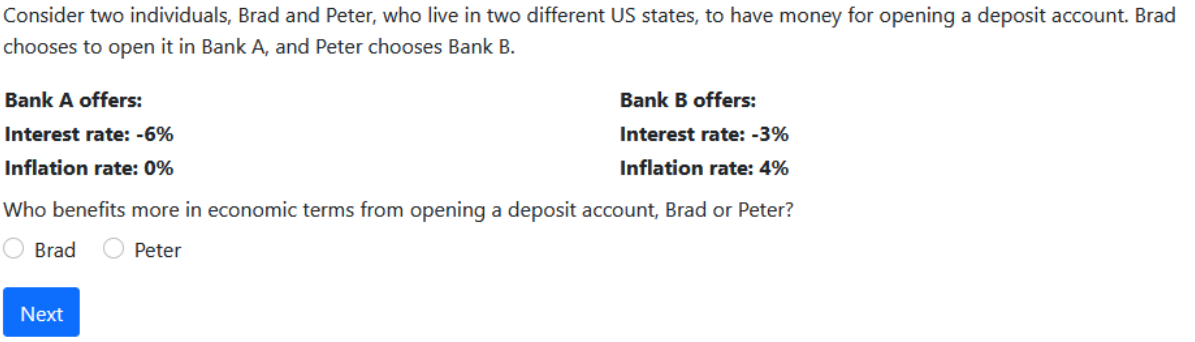

Figure 4.3: Computer screenshot—decision-making in the Negative condition

What differentiates this study from Shafir et al. (1997) is the context and conditions related to interest rates. This context is related to savings in the bank, which is a relevant question for banks, with savings being an essential funding source. Besides, in this experiment, I present participants situations wherein individuals are offered both negative and positive nominal interest rates, whereas Shafir et al. (1997) focuses exclusively on positive nominal interest rates.

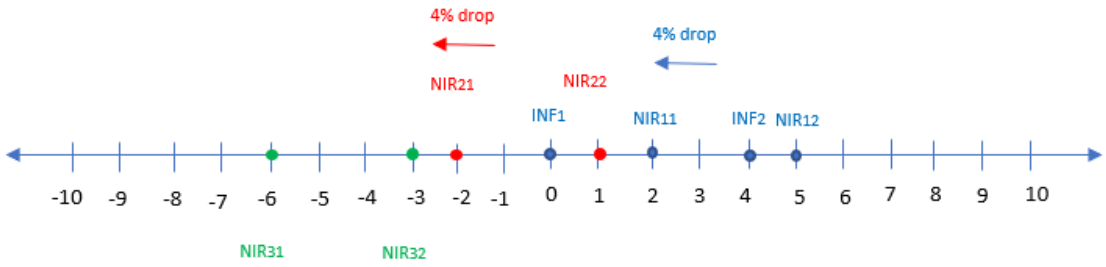

Figure 4.4: Description of conditions

This figure presents nominal interest rates for both individuals in all three conditions. Blue, red, and green dots on the horizontal line represent nominal interest rates for Positive, Positive/Negative, and Negative conditions, respectively.

4.3.2 Study 2

This experiment introduces a between factor design, with the inflation rate being the between factor to which each participant is randomly assigned. This experiment involves two conditions: Inflation (4%) and Deflation (-2%) conditions (for more details regarding the decision-making process in both conditions, please refer to Figure 4.5 and Figure 4.6).[2] All participants in the experiment are instructed to make one investment decision with two investment alternatives: a deposit account and a stock index fund. Participants are informed that a deposit account is a risk-free asset, whereas a stock index fund is a risky

[2]In our experiment, the Deflation condition could potentially bias individuals' decisions. In particular, individuals are less familiar with the term deflation than inflation and could therefore mix these two terms. This could potentially be a shortcoming of this study.

asset (with a risk premium of 4% above the risk-free asset). They are also informed that the interest rate on the deposit account could vary depending on the monetary policy set by the Central Bank. The currency used in this experiment is the $ (US dollar). The total amount invested in the decision must add up to 100%, i.e., they need to invest all their money. After the investment decision, participants are informed about their performance. More specifically, participants are provided with information on the global performance for both assets in both absolute and relative terms and the performance for each asset separately.

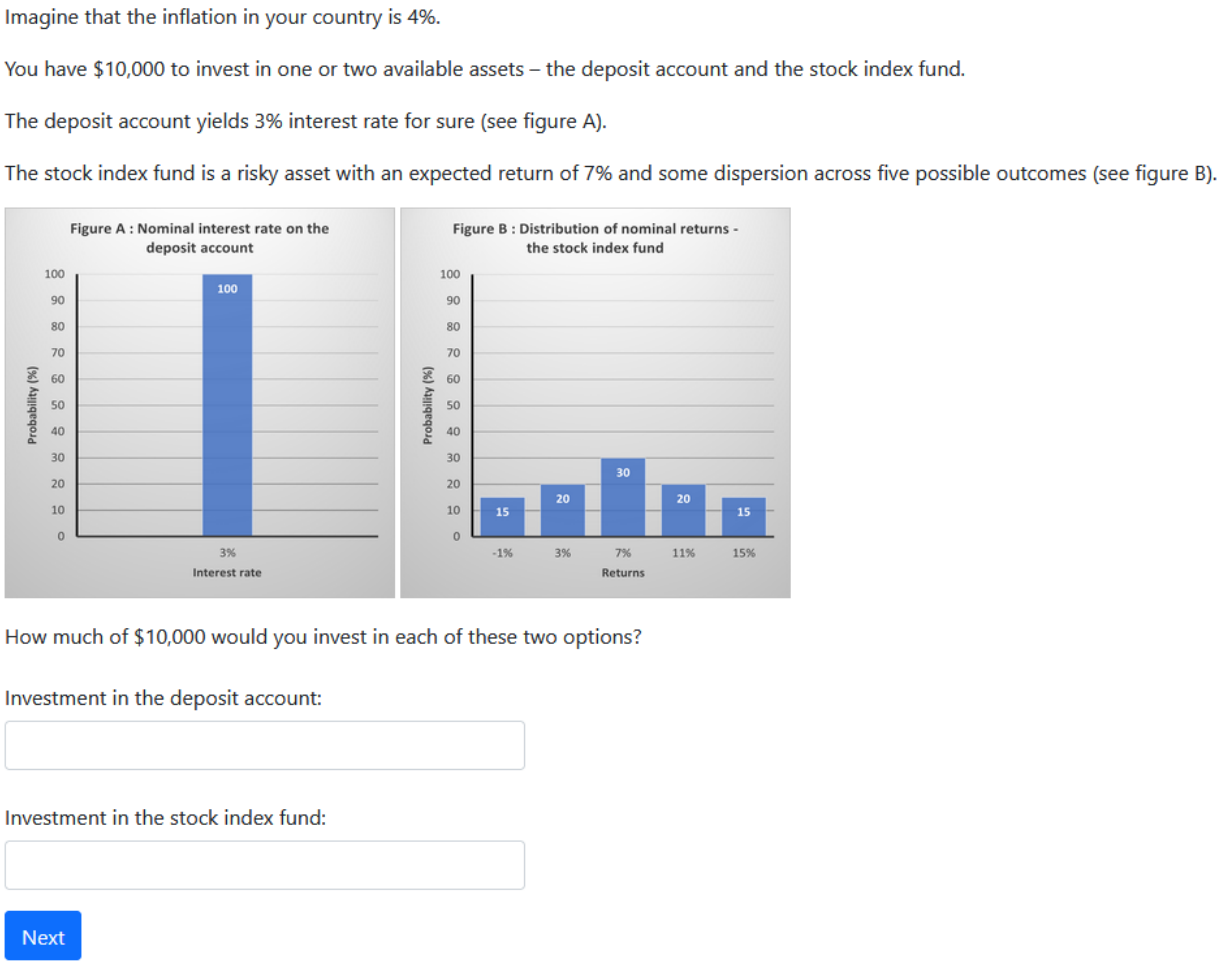

Figure 4.5: Computer screen—decision-making in the Inflation condition

A variable that is kept constant across all conditions is the real return on the stock index fund and the real interest rate on the deposit account (see Table 4.1 for more details). Following the trend of negative real interest rates since 2017 (more details regarding development of interest rates in the EU are provided in Appendix 7.3.2), I keep real

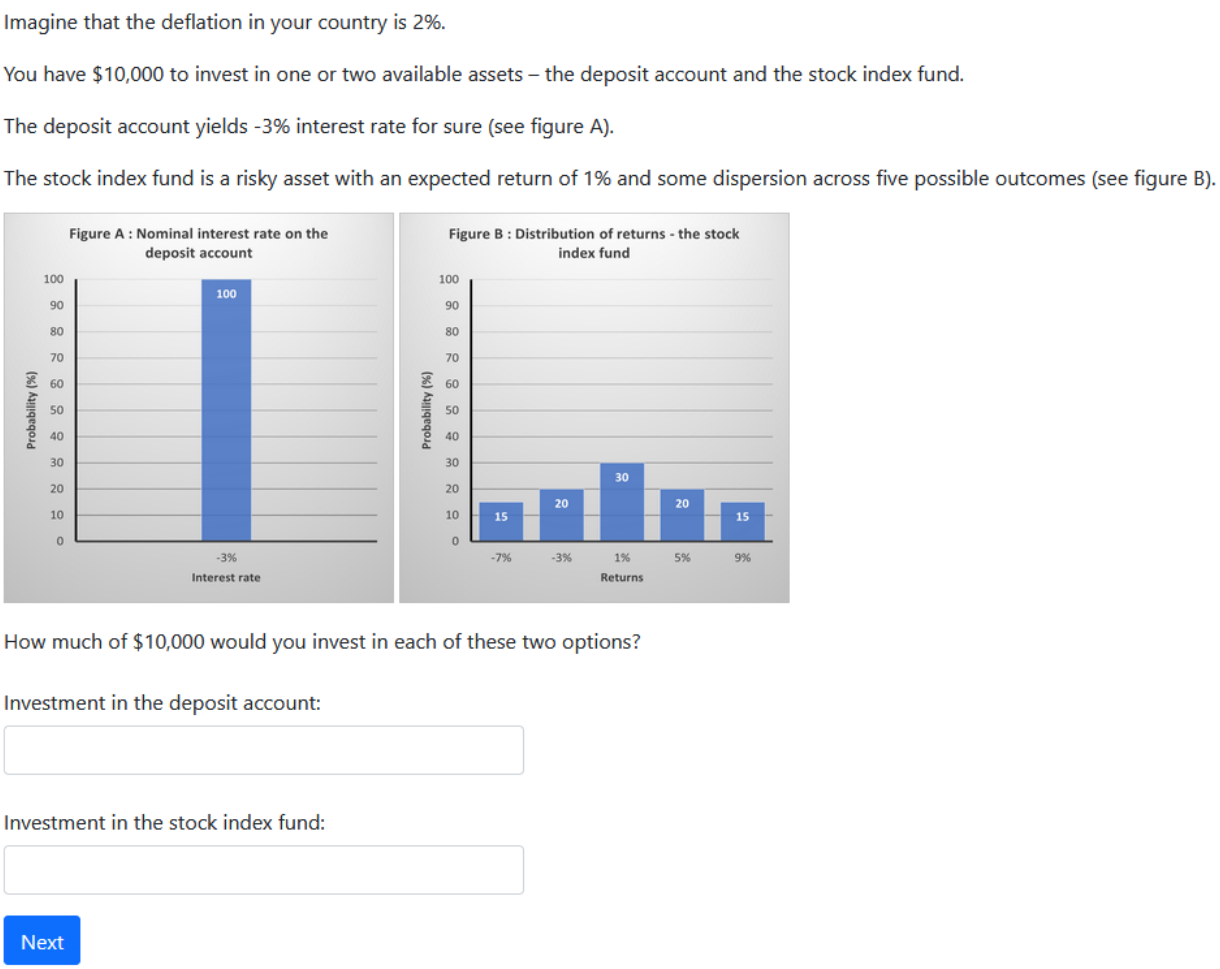

Figure 4.6: Computer screenshot—decision-making in the Deflation condition

interest rates below inflation such that real rates are negative across conditions (-1%). I keep expected returns in real terms also constant at 3% in both conditions. With that being said, if not money illusioned, participants should invest similarly irrespective of their condition.

What differentiates these two conditions is the representation of investment alternatives. The expected nominal return of the stock index fund is positive in both conditions and represents a risky gain (7% in Inflation and 1% in Deflation condition). In Inflation condition, a deposit account involves a sure nominal gain of 3% presented in the form of a nominal interest rate. However, in the Deflation condition, the same option represents a sure nominal loss of -3%. Hence, whereas in one condition, it represents a sure nominal gain, in another condition, it represents a sure nominal loss. In absolute terms, due to nominal loss aversion, a negative subjective value assigned to a sure nominal loss surpasses

a positive subjective value assigned to a nominal gain. Hence, due to this nominal loss aversion, individuals in the Deflation condition are more likely to invest in the stock index fund than individuals in the Inflation condition. [3]

To enable participants' better understanding of investment alternatives, I present the two figures before they make the investment decision (same as the ones presented in Figures 4.7 and 4.8). Figure 4.7 presents a nominal interest rate on the deposit account in the Inflation condition (inflation is 4%) and its corresponding probability. Figure 4.8 shows the distribution of the expected nominal returns of the stock index fund in the Inflation condition.

Table 4.1: Real Interest Rates of the Risk-Free and Real Expected Return of the Risky Asset - Study 2

Condition	Expected Nominal Return	Nominal Interest Rate	Inflation	Real interest rate	Expected Real Return
Inflation	7.0%	3.0%	4%	-1%	3%
Deflation	1.0%	-3.0%	-2%	-1%	3%

This table reports expected nominal returns, nominal interest rates, inflation, the expected real returns, and the real interest rates in Inflation and Deflation conditions. Expected real returns and real interest rates are determined based on Fisher's formula (rounded to an integer). As this table indicates, the real interest rates and expected real returns are -1% and 3%, respectively, whatever the condition.

[3] I note that the probability of loss of the stock index fund also differs between these two conditions, which could be a drawback of the experimental design mobilized. Specifically, the probability of a loss of the stock index fund in the Inflation condition is 0.15 (nominal return is -1%), whereas it increases to 0.35 cumulatively in the Deflation condition (0.20 probability of a nominal return of -3% and 0.15 probability of -7% of a nominal return). This situation could lead to a higher loss aversion in the Deflation condition and a lower loss aversion in the Inflation condition. However, as the analyses indicate in the Results section, this is not the case in the experiment.

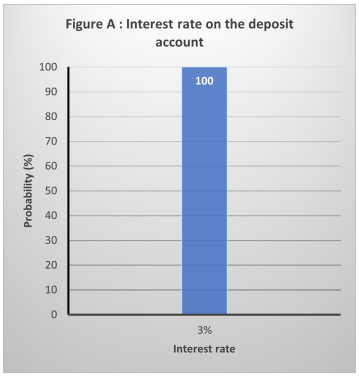

Figure 4.7: Interest rate on the deposit account in Inflation condition

This figure shows the nominal interest rate on the deposit account in the Inflation condition. The horizontal axis refers to the interest rate on the deposit account, while the vertical axis refers to the probability of occurrence for this risk-free rate (which is 100% by definition).

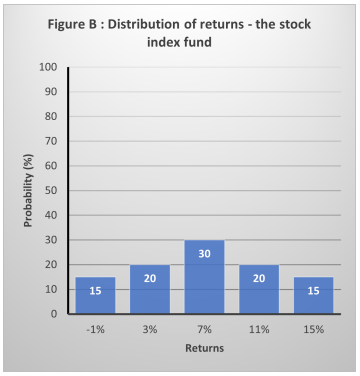

Figure 4.8: Distribution of the stock index fund nominal returns in the Inflation condition

This figure presents the distribution of the nominal returns on the stock index fund in the Inflation condition. The horizontal axis refers to the five possible outcomes for the stock index fund, while the vertical axis refers to their respective probabilities of occurrence.

Participants receive a premium in this experiment. This premium is an additional amount of money that depends on the participant's performance (i.e., realized return on the invested amount) in the investment decision. The premium is the sum of $X and the realized return made in the investment decision. In the Inflation condition, the premium is a sum of $0.4 and $X amount. To calculate $X, one must multiply the realized return by 10. For instance, if the realized return is 10%, $X is equal to $1 (10% * 10). In this example, the premium is $1.4 ($0.4 + $1). In the Deflation condition, the premium is a sum of $1 and $X amount. To calculate $X, one must multiply the realized return by 10. For instance, if the realized return is 10%, $X is equal to $1 (10% * 10). In this example, the premium is $2 ($1 + $1).

4.3.3 Hypotheses

For Study 1, the following hypotheses are derived:

Hypothesis 1: Participants in both Positive/Negative and Negative conditions are more

money illusioned than participants in the Positive condition. This situation occurs due to nominal loss aversion, and individuals attach a higher subjective negative value to a nominal loss than a positive subjective value to an equivalent nominal gain. Compared to the Positive condition wherein both individuals face positive nominal interest rates (2% and 5% for the first and second individual, respectively), the first individual faces a negative nominal interest rate of -2% and -6%, in Positive/Negative condition and Negative conditions, respectively. The second individual in Positive/Negative and Negative conditions is offered a positive nominal interest rate of 1% and a negative nominal interest rate of -3%. Compared to the Positive condition wherein we present participants with the first individual who faces a positive interest rate of 2%, in the Positive/Negative and Negative conditions, we present participants with the first individual who faces a negative interest rate of -2% and -6%, respectively. The subjective negative value associated with negative nominal interest rates (i.e., for the first individual in both Positive/Negative and Negative conditions) due to loss aversion exceeds the positive value associated with positive nominal interest rates (i.e., in the Positive condition). Hence, money-illusioned participants in both Positive/Negative and Negative conditions are more likely to predict that the second individual is better off than participants in the Positive condition. This situation would lead to an incorrect answer since the second individual is worse off in real terms than the first individual.

For Study 2, I derive the following hypothesis:

Due to a nominal loss aversion, participants in the Deflation condition are more likely to invest in the stock index fund than participants in the Inflation condition. The nominal interest rate offered on a deposit account in the Deflation condition denotes a nominal loss (-3% is the annual interest rate), while it represents a nominal gain in the Inflation condition (3% is the annual interest rate).The negative value associated with a nominal loss outreaches the positive value of a nominal gain in absolute terms due to nominal loss aversion. Next, the stock index fund delivers the positive expected nominal return of 1% and 7% in Deflation and Inflation conditions, respectively. If participants are money-illusioned, we should observe a higher risk-taking behavior in the Deflation condition than

in the Inflation condition. In the former condition, the only choice to avoid a nominal loss is to invest in the stock index fund since the deposit account delivers a negative interest rate, whereas the stock index fund delivers a positive expected nominal return. By contrast, participants are expected to invest more money in the deposit account since the deposit account delivers a nominal gain in the Inflation condition. Hence, participants in the Deflation condition are more likely to invest their money in the stock index fund than participants in the Inflation condition.

4.4 Results

4.4.1 Descriptive statistics - Full sample

For this experiment, I recruited 153 participants via Prolific, which is an online crowd-sourcing platform [4]. To better define the sample, I use prescreening options offered by Prolific. In particular, I requested from Prolific US citizens who are between 18 and 65 years of age and whose first language is English.

[4]In total, 162 people participated, but 9 participants dropped off from the experiment.

Table 4.2: Descriptive statistics about the sample of participants

Variable	Full sample	Study 1			Study 2	
		Positive	Positive/Negative	Negative	Deflation	Inflation
Age	30	32	30	29	31	30
Male (in %)	31	35	34	24	39	24
Financial literacy (0 - 3 score)	2.20	2.33	2.23	2.02	2.23	2.16
Low financial literacy (in %)	14	12	17	14	12	17
High financial literacy (in %)	34	37	23	33	34	34
Highest financial literacy (in %)	46	49	47	41	48	43
Real rate question (in %)	62	75	58	53	66	58
Risk tolerance (1 - 7 score)	2.83	2.80	2.80	2.90	2.71	2.96

Table 5.3 provides descriptive statistics for the full sample as well as for the Study's 1 and Study's 2 conditions, respectively. The same participants took part in both studies. 'Financial Literacy' refers to the individual financial literacy of each participant. It takes value 0 if the participant answered all three financial literacy questions incorrectly and three if he/she answered correctly to all three financial literacy questions. 'Low Financial Literacy,' 'High Financial Literacy,' and 'Highest Financial Literacy' refer to the proportion of individuals that answered one, two, and three financial literacy questions correctly, respectively. 'Real Rate Question' refers to the proportion of individuals who correctly answered the second financial literacy question related to inflation. 'Risk tolerance' refers to the subjective risk-taking inclination elicited using the six questions about gambling and investing in the DOSPERT scale. This measure of risk tolerance is calculated as the average of the scores on these questions, on a scale ranging from 1 (extremely unlikely to take a risk) to 7 (extremely likely to take a risk).

Table 5.3 provides the descriptive statistics for the full sample of participants, as well as Study's 1 and Study's 2 conditions, respectively. The same participants took part in both Study 1 and Study 2. Focusing on the full sample, the mean age of participants is 30, and almost one-third of them are males. The average financial literacy score is 2.20 since participants answered more than two financial literacy questions correctly [5]. 14% of all participants answered one financial literacy question correctly. The correct answer to two financial literacy questions provided 34% of all participants. Finally, almost half of the full sample (46%) provided correct answers to all three financial literacy questions. A question of particular importance for our Study is the second financial literacy question related to understanding the impact of inflation on the real rate. Almost two-thirds of all participants answer correctly to this question. The average risk tolerance across all participants is about 2.83 on a scale ranging from 0 (extremely unlikely to take a risk) to 7 (extremely likely to take a risk).[6]

Participants in Study 1 are randomly assigned to Positive, Positive/Negative, and Negative conditions. In terms of age, participants are similar across these three subsamples. I note that participants in Positive and Positive/Negative conditions are of a similar age (35 and 34 years old on average, respectively). In contrast, participants in the Negative condition are younger (on average, 24 years old). In terms of Financial Literacy, participants in all three conditions answer at least two questions correctly on average. I note that on average, more participants in the Positive/Negative condition answer one financial literacy question correctly than in both Positive and Negative conditions. On the contrary, only 23% of participants in Positive/Negative condition on average answer two financial literacy questions correctly, compared to 37% and 33% in Positive and Negative conditions, respectively. Participants in all three conditions are similar in answering all three financial literacy questions correctly (more than 40% on average). I note that three-thirds of participants in the Positive condition answered the second financial literacy question related to understanding the impact of inflation on the real rate. At the same time, this

[5]Based on the answers to the three questions taken from the Financial Literacy Questionnaire (available in Appendix 7.3.4), I calculate financial literacy as the average of the scores on these three questions.

[6]Based on the answers to the six questions taken from the DOSPERT scale (available in Appendix 7.3.3), I calculate risk tolerance as the average of the scores on these three questions.

number is below 60% in both Positive/Negative and Negative conditions, respectively. Finally, average risk tolerance is similar across all three subsamples.

Participants are randomly assigned to Deflation and Inflation treatment in Study 2. Again, similarly to Study 1, participants are similar across these two subsamples. However, a difference appears in terms of gender wherein in the Deflation condition, almost 40% are males, whereas 24% represent males in the Inflation condition. Participants in both conditions answer two financial literacy questions correctly. One financial literacy question is answered by slightly more participants in Inflation (17%) than in Deflation treatment (12%). For both high and highest financial literacy, I find similar results across these two conditions. The second financial literacy question related to the real rates is answered by slightly more participants in the Deflation (66%) than Inflation (58%) condition. Finally, average risk tolerance is similar across these two subsamples.

In the final analysis of this subsection, I decompose participants by gender and observe their answers to the variables of interest for both Study 1 and Study 2. Focusing on the correct answers related to Study 1, I note that two-thirds of all males provide correct answers, whereas around 54% females answer correctly to this question. This difference of more than 10% of correct answers favors males. Hence, money illusion is higher among female than male participants. Focusing now on risk appetite, I note that males on average invest almost two-thirds of the endowed investment amount to the stock index fund, whereas females invest less than 50%. Hence, the results of this analysis show that male participants are more willing to take risks than their female counterparts.

Table 4.3: Correct answers in Study 1 and investment in the stock index fund in Study 2 by gender

Gender	Correct answers - Study 1 (%)	Investment in the stock - Study 2 (%)
Male	66.67	64.67
Female	55.24	48.53

This table presents the average correct answer to the money illusion question in Study 1 and the average investment in the stock index fund in Study 2 by gender.

4.4.2 Univariate analysis

The first hypothesis assumes nominal loss aversion, i.e., the proportion of correct answers that the individual one is better off is lower in both Positive/Negative and Negative conditions than in the Positive condition. Table 4.4 reports the results, Panel A the differences in proportions between Positive and Positive/Negative conditions, and Panel B the differences in proportions between Positive and Negative conditions.

To begin with, in the Positive condition, the proportion of correct answers that the first individual is better off exceeds 78%. As assumed in the first hypothesis, this proportion drops below 50% in both Positive/Negative and Negative conditions. This situation implies that more than 50% participants in both Positive/Negative and Negative conditions incorrectly picked the second individual to be economically better off. The difference in proportions of almost 30% is significant at the 1% level and favors the Positive condition. This evidence provides robust support for the first hypothesis.

Table 4.4: Differences in correct answers - Study 1

Panel A : **Difference between Positive and Positive/Negative conditions**	
Positive	78.43%
Positive/Negative	49.06%
Difference	29.37%
t-value	3.25
p-value	0.0008
Panel B : **Difference between Positive and Negative conditions**	
Positive	78.43%
Negative	48.98%
Difference	29.45%
t-value	3.18
p-value	0.0010

This table reports the proportion of participants providing correct answers that the individual one is better off in economic terms in Positive, Positive/Negative, and Negative conditions. Subsequently, the differences between these proportions are presented, and the corresponding t-values and p-values from one-sided two-sample t-tests. Panel A refers to the differences in these proportions between Positive and Positive/Negative conditions, while Panel B refers to the differences in proportions between Positive and Negative conditions.

The second hypothesis assumes that the proportion invested in the risky asset is higher in the Deflation condition than in the Inflation condition. This situation occurs due to

nominal loss aversion because the nominal interest rate on the deposit account in the Deflation condition represents a nominal loss, whereas, in the Inflation condition, it represents a nominal gain. Table 4.5 reports the results of this hypothesis. As hypothesized, participants in the Deflation condition invest on average more in the risky asset (almost 56% of their investment money) than participants in the Inflation condition (around 51% of their investment amount). Although this difference in proportions invested in the risky asset favors the Deflation condition, it is not significant at any conventional level. This finding does not support the second hypothesis.

Table 4.5: Risk-taking - Study 2

Deflation	56.50%
Inflation	50.64%
Difference	5.86%
t-value	1.20
p-value	0.1170

This table reports the average proportions of money invested in the risky asset depending on whether the participant is in Deflation or Inflation condition, the differences between these average proportions, and the corresponding t-values and p-values from one-sided two-sample t-tests.

4.4.3 Multivariate analysis

Two binary logit models are estimated to test the first hypothesis, wherein the dependent variable, $Money\_illusion_i$ is set to one when the participant chooses individual one to be better off in economic terms (i.e., the correct answer) and zero otherwise. The first model (see below in Equation 4.1) includes the following independent variables to explain the dependent variable: $Positive\_Negative\_cond_i$, $Negative\_cond_i$, and financial literacy, Age and Gender as control variables. $Positive\_Negative\_cond_i$ is a binary variable set to one if a participant is in Positive/Negative condition and zero if he/she is in Positive condition. $Negative\_cond_i$ is a binary variable set to one if a participant is in the Negative condition and zero if he/she is in the Positive condition. Financial literacy is coded using three binary variables ($D\_Low\_literacy_i$, $D\_High\_literacy_i$, $D\_Highest\_literacy_i$), which are set to one when financial literacy of a participant is low, high, and the highest,

respectively. *Age* is a variable that refers to the age of the participant. D_Male_i is a binary variable that takes value one if a participant is male and zero otherwise.

$$\begin{aligned} Money\_illusion_i = \beta_0 + \beta_1 Positive\_Negative\_cond_i + \beta_2 Negative\_cond_i + \\ \beta_3 D\_Low\_literacy_i + \beta_4 D\_High\_literacy_i + \beta_5 D\_Highest\_literacy_i + \\ \beta_6 Age_i + \beta_7 D\_Male_i + \epsilon_i \end{aligned} \tag{4.1}$$

Table 4.6 reports results for the first binary logit model related to Study 1. The first model (Model 4.1) includes the aforementioned independent variables. The sign of a coefficient for the first independent variable is negative and highly statistically significant. This situation implies that when a participant is in the *Positive_Negative_cond*, he/she is less likely to provide a correct answer that individual one is better off in economic terms than when he/she is in *Positive_cond*. In plain words, only presenting participants with a negative nominal interest rate makes them more likely to be money illusioned and incorrectly answer this question. All else being equal, the odds of a participant not being money illusioned and answering correctly decreases by 77.50% when he/she is in *Positive_Negative_cond* compared to *Positive_cond*. Results are similar for *Negative_cond*. All else being equal, the odds of a participant not being money illusioned and answering correctly decreases by approximately 77.50%% when he/she is in *Negative_cond* compared to *Positive_cond*. These findings strongly support the first hypothesis. The results are statistically insignificant for all three variables related to financial literacy. [7] The sign of a coefficient for a variable *Age* is negative and weakly statistically significant, which implies that when a participant is older, the likelihood of providing the correct answer and thereby being less money-illusioned decreases compared to a younger participant. All else being equal, the odds of a participant not being money-

[7] A potential explanation for these insignificant results is that the distribution for this variable is not normal (after performing a normality test, we fail to reject the null hypothesis that the distribution for this variable is normal, which is significant at the 1% level). Specifically, the mean literacy is 2.20 (on a scale that fluctuates from 0 (financially illiterate) to 3 (the highest level of financial literacy), the mode financial literacy is 3, and the median financial literacy is 2. The distribution is skewed to the right, which entails that most participants show the highest levels of financial literacy.

illusioned drops by 4.40% if he/she is older compared to a younger participant. The result is statistically insignificant for a variable related to gender (D_Male).

Table 4.6: Money illusion in Study 1 with financial literacy questions

Parameter	Estimate	OR
Intercept	2.5011***	
Positive_Negative_cond	-1.4902***	0.2250
Negative_cond	-1.4936***	0.2250
D_Low_literacy	-0.6932	0.5000
D_High_literacy	-0.6214	0.5370
D_Highest_literacy	0.4000	1.4920
Age	-0.0345*	0.9660
D_Male	0.3442	1.4110
N	153	

This table reports the results of the first binary logit model wherein the dependent variable is set to one when the participant chooses the individual one to be better of in economic terms (i.e., the correct answer), and zero otherwise (see Equation 4.1). Independent variables in this model are $Positive\_Negative\_cond_i$, $Negative\_cond_i$, and financial literacy as a control variable. $Positive\_Negative\_cond_i$ is a binary variable that takes value one if a participant is in Positive/Negative condition, and zero if he/she is in Positive condition. $Negative\_cond_i$ is a binary variable that takes value one if a participant is in the Negative condition and zero if he/she is in Positive condition. Financial literacy is coded using three binary variables ($D\_Low\_literacy_i$, $D\_High\_literacy_i$, $D\_Highest\_literacy_i$), which are set to one when financial literacy of a participant is low, high, and the highest, respectively. Age refers to the age of the participant. D_Male_i is a binary variable that takes value one if a participant is male and zero otherwise. ***, **, and * indicate significance at 1%, 5%, and 10%, respectively. N gives the number of observations. OR refers to odds ratios.

Besides Model 4.1 whose results are presented in Table 4.6, I estimate the second binary logit model (Model 4.2) with the same dependent variable (i.e., $Mmoney\_illusion$), two independent variables related to condition (i.e., $Positive\_Negative\_cond_i$ and $Negative\_cond_i$), and two control variables related to sociodemographics (Age, and D_Male). However, instead of three variables related to financial literacy, I use a dummy variable related to Question 2 in Financial Literacy Questionnaire (for more details, refer to Appendix 7.3.4). The dummy variable is D_Real_rate, and it takes value one if a participant answers correctly to this question and zero otherwise. This question delivers an answer to whether a participant understands the relation between interest rate and inflation, and it explains money illusion.

$$Money\_illusion_i = \beta_0 + \beta_1 Positive\_Negative\_cond_i + \beta_2 Negative\_cond_i + \beta_3 D\_Real\_rate_i + \beta_4 Age_i + \beta_5 D\_Male_i + \epsilon_i \quad (4.2)$$

Table 4.7 reports results for the second binary logit model related to Study 1. The second model includes the aforementioned (Model 4.2) independent variables. Again, as in Model 4.1, the coefficient for the first independent variable is negative and highly statistically significant. This situation implies that when a participant is in the *Positive_Negative_cond*, he/she is less likely to provide a correct answer that individual one is better off in economic terms than a participant in *Positive_cond*. Thus, only presenting participants in *Positive_Negative_cond* with a negative nominal interest rate makes them more likely to be money illusioned and incorrectly answer this question. All else being equal, the odds of a participant not being money illusioned and answers correctly decreases by approximately 73.40% when he/she is in *Positive_Negative_cond* compared to *Positive_cond*. Results are similar for *Negative_cond*. All else being equal, the odds of a participant not being money illusioned and to answer correctly decreases by 71.90% when he/she is in *Negative_cond* compared to *Positive_cond*. The coefficient is positive and highly statistically significant for the variable related to financial literacy. When a participant answers correctly on the second financial literacy question related to the real interest rate, he/she is less likely to be money illusioned and is more likely to provide a correct answer that individual one is better off in economic terms. All else being equal, the odds of a participant not being money illusioned and providing a correct answer to the money illusion question increases by approximately 179.30% when he/she provides a correct answer to this question than when a participant provides an incorrect answer to this question. In plain words, a person who understands the impact of inflation on real interest rates is less likely to be money illusioned than a person who does not understand this relationship between inflation and real interest rates. Unlike weakly significant results related to the variable *Age* in Model 4.1, the results are statistically insignificant in Model 4.2. The results are statistically insignificant for variable *D_Male* as well.

Table 4.7: Money illusion in Study 1 with real interest rate question

Parameter	Estimate	OR
Intercept	1.3563*	
Positive_Negative_cond	-1.3250***	0.2660
Negative_cond	-1.2696***	0.2810
D_Real_rate	1.0270***	2.7930
Age	-0.0265	0.9740
D_Male	0.3605	1.4340
N	153	

This table reports the results of the second binary logit model wherein the dependent variable is set to one when the participant chooses the individual one to be better off in economic terms (i.e., the correct answer, and zero otherwise (see Equation 4.2). Independent variables in this model are $Positive\_Negative\_cond_i$, $Negative\_cond_i$, and D_Real_rate as a control variable. $Positive\_Negative\_cond_i$ is a binary variable that takes value one if a participant is in Positive/Negative condition and zero if he/she is in Positive condition. $Negative\_cond_i$ is a binary variable that takes value one if a participant is in the Negative condition and zero if he/she is in Positive condition. D_Real_rate is a dummy variable that takes value one if a participant can determine the real interest rate on Question 2 in Financial Literacy Questionnaire (see Appendix 7.3.4), and zero otherwise. Age refers to the age of the participant. D_Male_i is a binary variable that takes value one if a participant is male and zero otherwise. ***, **, and * indicate significance at 1%, 5%, and 10%, respectively. N gives the number of observations. OR refers to odds ratios.

To test the hypothesis for Study 2, I conduct two fractional logit models, wherein the dependent variable Inv_stock_i represents the proportion invested in the risky asset. The first model (Model 4.3) includes the following independent variables: $Deflation_i$, $Risk\_tol_i$ (a control variable), financial literacy, and Age and Gender as control variables. $Deflation_i$ is a binary variable set to one if a participant is in the Deflation condition and zero if he/she is in the Inflation condition. Risk tolerance ($Risk\_tol_i$) is the participant's average score based on the answers to the six questions taken from the DOSPERT scale, which ranges from 1 (extremely unlikely to take a risk) to 7 (extremely likely to take a risk). Financial literacy is coded using three binary variables ($D\_Low\_literacy_i$, $D\_High\_literacy_i$, $D\_Highest\_literacy_i$), which are set to one when financial literacy of a participant is low, high, and the highest, respectively. The independent variable Age refers to the age of a participant. The last independent variable D_Male refers to the gender of a participant, and it takes value one if he/she is male and zero otherwise.

$$Inv\_stock_i = \beta_0 + \beta_1 Deflation_i + \beta_2 Risk\_tol_i + \beta_3 D\_Low\_literacy_i + \beta_4 D\_High\_literacy_i + \beta_5 D\_Highest\_literacy_i + \beta_6 Age_i + \beta_7 D\_Male_i + \epsilon_i \quad (4.3)$$

Table 4.8 summarizes results for the first fractional logit model associated with Study 2. This model (Model 4.3) comprises the aforementioned independent variables. Surprisingly, for the independent variable $Deflation$, the sign is negative but insignificant. As expected, the coefficient is positive but insignificant for the second independent variable. The coefficients are positive but statistically insignificant for all three financial literacy dummy variables in the model. The coefficients for the two sociodemographic variables (Age and D_Male) are statistically insignificant.

Table 4.8: Money illusion in Study 2 with financial literacy questions

Parameter	Estimate	OR
Intercept	-2.2401	
Deflation	-0.1216	0.8855
Risk_tol	0.2713	1.3117
D_Low_literacy	0.7873	2.1975
D_High_literacy	0.7648	2.1486
D_Highest_literacy	1.7883	5.9793
Age	0.0174	1.0176
D_Male	0.1820	1.1996
N	153	

This table reports the results of the binary logit model related to Study 2 wherein the dependent variable Inv_stock_i is the proportion invested in the risky asset. Independent variables are $Deflation_i$ and $Risk\_tol_i$ as a control variable. $Deflation_i$ is a binary variable set to one if a participant is in the Deflation condition and zero if he/she is in the Inflation condition. Risk tolerance ($Risk\_tol_i$) is the participant's average score based on the answers to the six questions taken from the DOSPERT scale, which ranges from 1 (extremely unlikely to take a risk) to 7 (extremely likely to take a risk). Financial literacy is coded using three binary variables ($D\_Low\_literacy_i$, $D\_High\_literacy_i$, $D\_Highest\_literacy_i$), which are set to one when financial literacy of a participant is low, high, and the highest, respectively. Age refers to the age of the participant. D_Male_i is a binary variable that takes value one if a participant is male and zero otherwise. ***, **, and * indicate significance at 1%, 5%, and 10%, respectively. N gives the number of observations. OR refers to odds ratios.

The second fractional logit model (Model 4.4) to test hypothesis two involves the same dependent and independent variables as Model 4.3, except financial literacy. Instead of three variables related to financial literacy, I use a dummy variable related to Question

2 in Financial Literacy Questionnaire (for more details, refer to Appendix 7.3.4). The dummy variable is D_Real_rate, and it takes value one if a participant answers correctly to this question and zero otherwise. This question delivers an answer to whether a participant understands the relation between interest rate and inflation, and it explains money illusion.

$$Inv\_stock_i = \beta_0 + \beta_1 Deflation_i + \beta_2 Risk\_tol_i + \beta_3 D\_Real\_rate_i + \beta_4 Age_i + \beta_5 D\_Male_i + \epsilon_i \tag{4.4}$$

Table 4.9 reports results for the second fractional logit model related to Study 2. This model (Model 4.4) comprises the aforementioned independent variables. Surprisingly, for the independent variable $Deflation$, the sign of a coefficient is negative but insignificant. As expected, for the second independent variable, the coefficient is positive but insignificant. Variable related to financial literacy (D_Real_rate) exhibits a positive but insignificant coefficient. The results for two sociodemographic variables (Age and D_Male) are statistically insignificant.

Table 4.9: Money illusion in Study 2 with real interest rate question

Parameter	Estimate	OR
Intercept	-2.0351*	
Deflation	-0.0468	0.9543
Risk_tol	0.3154	1.3708
D_Real_rate	0.0752	1.0781
Age	0.0397	1.0405
D_Male	0.4020	1.4948
N	153	

This table reports the results of the binary logit model related to Study 2 wherein the dependent variable Inv_stock_i is the proportion invested in the risky asset. Independent variables are $Deflation_i$, $Risk\_tol_i$ and D_Real_rate as control variables. $Deflation_i$ is a binary variable set to one if a participant is in Deflation condition and zero if he/she is in Inflation condition. Risk tolerance ($Risk\_tol_i$) is the participant's average score based on the answers to the six questions taken from DOSPERT scale, which ranges from 0 (extremely unlikely to take a risk) to 7 (extremely likely to take a risk). ***, **, and * indicate significance at 1%, 5%, and 10%, respectively. D_Real_rate is a dummy variable that takes value one if a participant can determine the real interest rate on Question 2 in Financial Literacy Questionnaire (see Appendix 7.3.4), and zero otherwise. Age refers to the age of participant. D_Male_i is a binary variable that takes value one if a participant is male and zero otherwise. ***, **, and * indicate significance at 1%, 5%, and 10%, respectively. N gives the number of observations. OR refers to odds ratios.

Since there might be a reverse causality issue in the equation 4.4, i.e., the risk-taking (Inv_stock) can impact the knowledge regarding the understanding of inflation on the real interest rate (D_Real_rate), I mobilized an instrumental variable approach. In the first step, I estimated an ordinal least square regression as presented in the equation 4.4. Subsequently, I employed D_Real_rate as dependent variable, and the set of independent variables are $Deflation_i$, $Risk\_tol_i$, Age_i, and D_Male_i. Besides these independent variables, in this equation I mobilized, I have used two instrumental variables: $Compounding$ and $Diversification$ (for more details, please refer to the equation 4.5). The former variable is a dummy variable that takes a value one if a participant understands the compounding concept and consequently answers correctly on Question 1 in Financial Literacy Questionnaire (see Appendix 7.3.4), and zero otherwise. The latter variable is a dummy variable that takes value one if a participant understands the power of compounding and consequently answers correctly on Question 3 in the Financial Literacy Questionnaire (see Appendix 7.3.4), and zero otherwise. In the second step, I used the estimate of the D_Real_rate taken from the previous equation and estimated the model presented in the equation 4.6.

$$D\_Real\_rate_i = \beta_0 + \beta_1 Deflation_i + \beta_2 Risk\_tol_i + \beta_3 Age_i + \beta_4 D\_Male_i + \beta_5 D\_Diver_i + \beta_4 D\_Comp_i + \epsilon_i \tag{4.5}$$

$$Inv\_stock_i = \beta_0 + \beta_1 Deflation_i + \beta_2 Risk\_tol_i + \hat{\beta}_3 D\_Real\_rate_i + \beta_4 Age_i + \beta_5 D\_Male_i + \epsilon_i \tag{4.6}$$

Table 4.10: Money illusion in Study 2 - instrumental variable approach

Parameter	OLS regression for risk-taking	2SLS: first stage for real interest rate	2SLS: second stage for risk-taking
Intercept	-0.0392	0.2644***	-0.16198
Deflation	-0.0123	-0.0440	-0.0243
Risk_tol	0.0370	-0.0173	0.0285
D_Real_rate	0.2239		0.4600**
Age	0.0077	-0.0013	0.0062
D_Male	0.1377	-0.0196	0.1044
D_Diver		0.1056**	
D_Comp		0.7815***	
N	153	153	153

This table reports the results of three OLS regressions related to Study 2. The dependent variable in the first and the last column is Inv_stock_i, which represents the proportion invested in the risky asset. Independent variables for the first OLS regression are $Deflation_i$, $Risk\_tol_i$, Age, D_Male, and D_Real_rate as control variables. The dependent variable for the second OLS regression is D_Real_rate, which is a dummy variable that takes the value one if a participant can determine the real interest rate on Question 2 in Financial Literacy Questionnaire (see Appendix 7.3.4), and zero otherwise. The independent variables for this OLS regression are $Deflation_i$, $Risk\_tol_i$, Age, D_Male, D_Diver, and D_Comp. The final OLS regression involves the following independent variables: $Deflation_i$, $Risk\_tol_i$, Age, D_Male, and the estimate obtained from the second model for the variable D_Real_rate. $Deflation$ is a binary variable set to one if a participant is in the Deflation condition and zero if he/she is in the Inflation condition. Risk tolerance ($Risk\_tol_i$) is the participant's average score based 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). ***, **, and * indicate significance at 1%, 5%, and 10%, respectively. D_Real_rate is a dummy variable that takes the value one if a participant can determine the real interest rate on Question 2 in Financial Literacy Questionnaire (see Appendix 7.3.4), and zero otherwise. Age refers to the age of the participant. D_Male_i is a binary variable that takes value one if a participant is male and zero otherwise. D_Diver is a dummy variable that takes value one if a participant understands the compounding concept and consequently answers correctly on Question 1 in Financial Literacy Questionnaire (see Appendix 7.3.4), and zero otherwise. D_Comp is a dummy variable that takes value one if a participant understands the power of compounding and consequently answers correctly on Question 3 in the Financial Literacy Questionnaire (see Appendix 7.3.4), and zero otherwise. ***, **, and * indicate significance at 1%, 5%, and 10%, respectively. N gives the number of observations. OR refers to odds ratios.

Table 4.10 delivers outcomes of three OLS regressions shown in the equation 4.4. The first OLS regression illustrates the similar coefficients and significance as shown in Table 4.9. Subsequently, in the first step, I use two instruments (D_Diver and D_Comp) to estimate D_Real_rate. I observe that these independent variables significantly predict D_Real_rate (D_Diver and D_Comp positively at the 5% and 1%, respectively), which represents a condition to go for the second step in the instrumental variable approach. Unlike the first OLS regression, after performing the instrumental variable analysis (middle column of Table 4.10, I observe that for the variable D_Real_rate the sign of a

coefficient becomes significant at the 5% level and grows from 0.2239 in Model without instrumental variable approach to 0.4600 after mobilizing instrumental variable approach. In particular, if one understands the impact of inflation on the purchasing power, he/she invests 46% of his/her investment money in the stock index fund compared to the one who does not comprehend the impact of inflation on the purchasing power. Hence, more financially literate individuals who show solid knowledge regarding the impact of inflation on purchasing power tend to invest more money in risky assets. Hence, if we use the instrumental variable approach, understanding the impact of inflation on purchasing power is a variable that can explain an increase in the investment in the stock index fund.

4.5 Conclusion

This paper contributes to the growing body of literature on what drives the individual's savings behavior when NIRs are introduced. The novelty introduced in this research paper is a variable of particular interest in investment decisions: the inflation rate. Unlike past research that disregards the impact of the inflation rate on investment decisions in NIRs and PIRs regions (Bracha, 2020; Ganzach and Wohl, 2018; Lian et al., 2018; Baars et al., 2020; David-Pur et al., 2020), I run an experiment involving two studies wherein participants are randomly assigned to conditions with various levels of inflation rates. Building on Shafir et al. (1997) who postulate that individuals focus more on nominal rather than real terms (coined as money illusion), I posit in Study 1 that presenting individuals with positive nominal versus negative nominal interest rates alters the ability of individuals to determine which saver benefits more in economic terms when presented with these various nominal interest rates. In Study 2, by maintaining constant real return and real interest rates, due to the money illusion and nominal loss aversion, I posit that individuals who are offered negative nominal rates exhibit a higher appetite for risk than their counterparts offered with positive nominal interest rates. Specifically, in Study 1, I first check whether participants are more money illusioned and nominally loss averse when presented with savings conditions involving losses than with savings conditions

involving gains. In Study 2, I check whether the risk appetite increases when individuals are presented with negative nominal compared to the risk appetite when individuals are presented with positive nominal interest rates.

This novel and original approach delivers interesting results about money illusion among individuals. Overall, findings partially confirm that money illusion and nominal loss aversion explain why individuals behave differently in PIRs versus NIRs nominal regions, but only in Study 1 and not in Study 2. Related to the results of Study 1, since individuals focus more on nominal terms, they are less likely to determine who is better off in economic terms once they are presented with NIRs than PIRs. Once presented with saving options involving NIRs, they are more prone to be money illusioned and focus on nominal terms. Although in Study 2 I find that participants in the Deflation condition show a higher appetite towards risky asset than individuals in the Inflation condition, results are statistically insignificant. A low variation in financial literacy could be a potential reason for these results. In this experiment, 80% of all individuals show a high level of financial literacy and/or the highest level of financial literacy (i.e., answered two and/or three financial literacy questions correctly), and 62% of them understand the effect of inflation on real interest rates. Hence, a higher variation in financial literacy might be needed to provide additional insights for the risk appetite with money illusion in Inflation and Deflation contexts. Another explanation for this insignificance of results could occur due to individuals' low average risk tolerance in the experiment. In particular, on a scale from 1 - 7, the average risk tolerance for all individuals is 2.83, which implies that individuals are somewhat unlikely to take a risk. Therefore, future experiments should include a higher variation concerning a tolerance towards risk.

The result related to Study 1, when the interest rate drops below zero, provides new insights. Comparing the mean correct answers to the question related to the money illusion in this study, only 50% of individuals in Positive/Negative and Negative conditions provide the correct answer to this question compared to almost 80% in Positive condition. This result indicates that money illusion and nominal loss aversion increase with the introduction of NIRs. The results related to Study 2 indicate that when individuals are

proposed negative nominal interest rates, they are more risk-prone than individuals who are proposed with positive nominal interest rates (holding constant real returns on the risky asset and real interest rate on the risk-free asset). However, this higher risk appetite with negative nominal interest rates towards the risky asset does not exhibit statistical significance.

The result of Study 2 provides additional insights regarding risk-taking. In particular, after utilizing the instrumental variable approach, we obtain that individuals who can understand the impact of inflation on the real interest rate tend to take more risk than the ones who are unable to consider this impact of inflation on the real interest rate. This result implies that whatever the condition in the market, those who are more financially literate concerning interest rates tend to shift their money towards more risky assets.

The binary logit model related to Study 1 provides additional findings. Firstly, it confirms our findings that individuals facing negative nominal interest rates are more likely to be money illusioned than individuals offered with positive nominal interest rates. Secondly, this money illusion is explained by a financial literacy question that explains whether individuals can consider the impact of inflation on purchasing power, i.e., whether they can determine the real interest rate. When they can determine the real interest rate, they are less likely to be money illusioned. Hence, learning regarding financial literacy could reduce money illusion, which is an important finding of this paper.

Perception of inflation and its consequences on individuals' behavior could depend on the personal situation. In particular, individuals who earn lower income and have lower and/or no wealth might be impacted more by inflation than those who have a higher income and are better off financially. However, this could depend on the level of inflation. As long as interest rates are relatively low, both types of individuals might be impacted similarly. However, once inflation outreaches these relatively low levels and shifts towards high levels, less well-off individuals might be deprived more than the more well-off individuals. This situation occurs since individuals who are better off could use their additional resources to finance themselves in times of high inflation, whereas it might be more difficult for

individuals who earn relatively low-income and have not raised additional resources of money (who did not save the money for a rainy day).

This paper has both monetary policy and practical implications. From the economic policy point of view, it appears that NIRs policy's effectiveness occurs since individuals take more risk in the NIRs region than in the PIRs region. However, this difference in risk appetite is insignificant, and additional research concerning the relationship between risk appetite and the money illusion with NIRs is needed. This finding also has relevant implications for retail investors since they can take excessive risk in the NIRs region. Analyzing results related to saving decisions, individuals are more money illusioned with NIRs than PIRs, leading to suboptimal decisions once NIRs on deposits are introduced.

Chapter 5

Target Returns and Negative Interest Rates

Chapter Abstract

In this paper, we question whether it is the zero interest rate level or the target return that most impacts the risk-taking behavior of individuals when making investment decisions. In our experiment, we 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. We find that the prevailing reference point 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 the target return drives risk-taking more than does a zero-threshold.

Keywords: *Negative interest rates, Risk-taking, Target return*

JEL Classification: *G11, G21, G40, G41, G51*

5.1 Introduction

Negative interest rates (NIRs) are no longer hypothetical. Since the 2008 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).[1] 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.[2] Unlike positive interest rates (PIRs) that deliver some reward for patience and the postponement of consumption, NIRs entail a kind of punishment meant to stimulate economic growth through increased risk-taking and/or spending (Agarwal and Kimball, 2015; Kimball, 2015). Because NIRs punish banks, firms, institutional investors and regular people for hoarding money, under such conditions, these institutions and individuals should instead spend, invest, or lend their money.

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. For example, institutional investors in money market funds must take more risks because NIRs prevent them from earning positive returns through safe investments (Di Maggio and Kacperczyk, 2017b). 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).[3]

[1] According to Boungou (2020), the central banks of seven countries and/or regions have implemented this unconventional monetary policy measure: Bulgaria, Denmark, the Euro Area, Hungary, Sweden, and Switzerland.

[2] 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.

[3] 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 take 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.

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 towards 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 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 (2016) compares investment decisions under both 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. More recently, David-Pur et al. (2020) report two key findings from a series of lab experiments analyzing both borrowing and investment behavior under PIRs and NIRs. First, they find that a zero interest rate has the strongest impact on individuals' investment decisions relative to both PIRs and NIRs. Based on this result, David-Pur et al. (2020) conclude that zero interest rates are more efficient than NIRs at encouraging individuals to either borrow money or take risks. Second, they find 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 burgeoning literature on what stimulates the appetites of individuals for risk when facing NIRs. The novelty of our approach is the introduction of a new variable of interest into investment decisions, 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, 2016; 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, 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 (Heath et al., 1999; von Rechenberg et al., 2016).[4] 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

[4]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.

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 cumulative prospect theory 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.

The remainder of the paper is organized as follows. Section 5.2 reviews the relevant literature. Section 5.3 describes our experimental setting. Section 5.4 presents our hypotheses.

Section 5.5 reports the results. Section 5.6 concludes the paper.

5.2 Literature

5.2.1 Cumulative prospect theory

To formalize the impact of target returns on risk-taking behavior, we build on cumulative prospect theory (Tversky and Kahneman, 1992). This well-known model of decision-making under risk entails a value function derived from changes in wealth rather than total wealth.[5] Cumulative prospect theory (CPT hereafter) 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 current position (i.e., his/her reference point) 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 backwards S-shaped function, such that small (large) probabilities are overweighted (underweighted), while those in the middle match the decision weights.[6]

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.[7] 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 (i.e., certain

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

[6]Although this probability weighting function is defined independently for gains and losses, it exhibits similar curvature.

[7]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.

gains), risk-seeking in the face of highly probably losses (i.e., 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, the difference between an increase from 100 to 200 is greater than an increase from 1,000 to 1,100. Similarly, the difference between a loss of 100 to 200 is greater than an equivalent increase in loss from 1,000 to 1,100, which is consistent with a convex value function.

5.2.2 Goals as reference points

Heath et al. (1999) postulate that goals serve as reference points and change the value of outcomes as prospect theory predicts. Specifically, these authors focus on "mere" goals, which are defined as specific levels of performance with no discrete or discontinuous payoff.[8] To check their predictions, 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,

[8] 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.

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.[9] 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 towards 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 5.4, we formulate several hypotheses based on goal-setting effects and expected changes in risk preferences based on CPT.

5.3 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

[9]Larrick et al. (2009) present these conditions as the standard manipulation in the goal-setting literature.

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 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.

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.[10] For each decision, the total share invested must equal 100%; i.e., the participants need to invest all their money. 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 5.1 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.[11]

[10]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 (2016) and Ganzach and Wohl (2018), who also define the available funding so as to equalize the final payoffs in their experiments.

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

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 5.1).[12] 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 5.2 when the expected return is equal to 13%. 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 5.1).

[12]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 into 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 on financial markets. To the best of our knowledge, one exception is Bracha (2016) 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.

Table 5.1: Investment alternatives across decisions

Panel A: **High-target return condition**						
Decision	TR	R_F	R_F-TR	$E(R_s)$	RP_s	STD_s
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**						
Decision	TR	R_F	R_F-TR	$E(R_s)$	RP_s	STD_s
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%

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, RP_s is the risk premium on the stock index fund, and STD_s refers to the standard deviation of the stock index fund returns distribution.

To help participants understand the investment alternatives available in each decision, we provide them with graphical representations similar to Figures 5.1 and 5.2. Figure 5.1 shows the interest rate on the deposit account as well as the probability of earning that rate (which is always equal to 100%). Figure 5.2 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.[13]

[13]The advantage of such graphical representations is a better understanding of the decision 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.

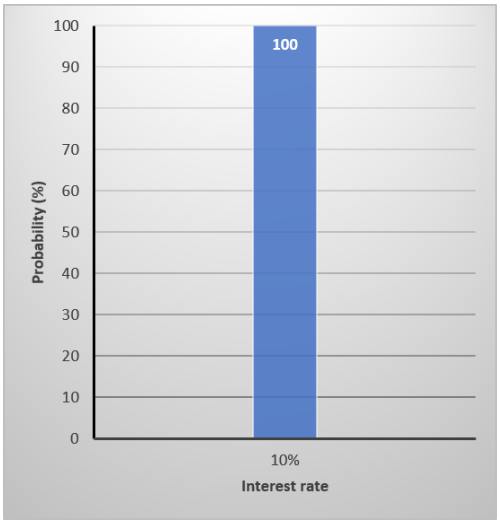

Figure 5.1: Interest rate on the deposit account

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).

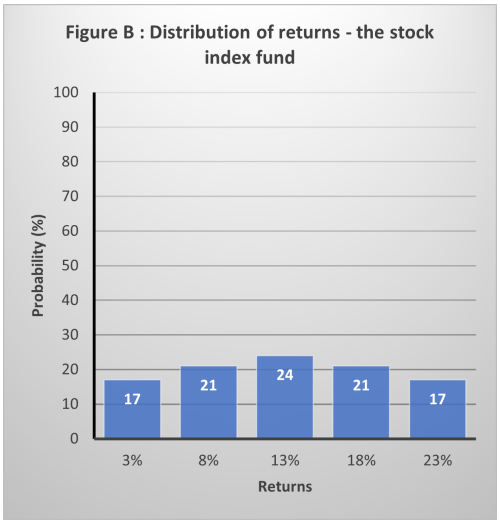

Figure 5.2: Distribution of the stock index fund returns

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.

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 x 4%) and a total reward of $2.30.

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 towards 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 7.4.2). 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.

5.4 Hypotheses

Figure 7.2 (in Appendix 7.4.1) 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 5.2.1.[14] However, what is depicted in Figure 7.2 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. For that purpose, we rely on the functional form of the value function and the weighting functions proposed by Tversky and Kahneman (1992) as well as their set of parameters. For the sake of brevity, our approach is detailed in Appendix

[14] 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.

7.4.3. It is noteworthy that, when computing CPT values, we consider, for each condition and each decision, two scenarios: (1) the reference point is the target return, and (2) the reference point is the zero-threshold.

Table 5.2 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 mainly 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 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 risky-free rate and the target return.

In Panel B of Table 5.2, 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.

A perfect match between the optimal allocations reported in Table 5.2 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.

Table 5.2: Optimal allocations to the risky asset (in %) based on CPT values

	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		

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.

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[15] does not perfectly appear in Panel A of Table 5.2 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 5.2, the opposite would be true in the high-target return condition if the reference point is the zero level (i.e., risk-seeking below

[15]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).

6% lower than above 6%.).

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 5.2, 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 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 5.2, 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.

5.5 Results

5.5.1 Descriptive statistics

We recruited 197 participants[16] 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 5.3 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).[17] 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.

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 in 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.[18] For risk tolerance, the average score is somewhat lower in the high-target

[16] We invited 200 persons to participate in our experiment, but 3 participants dropped out after reading the instructions.

[17] We calculate risk tolerance as the average of the scores on six questions taken from the DOSPERT scale (available in Appendix 7.4.2).

[18] Given the average actual target return reported by participants in the low-target return condition,

return condition (3.14 versus 3.31),[19] 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 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.

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 5.5.2 and 5.5.3 are not consistent with this worst case scenario.

[19]This difference is however not statistically significant.

Table 5.3: Descriptive statistics for the sample of participants

	Full sample				High-target return condition				Low-target return condition			
Variable	Mean	Median	Q1	Q3	Mean	Median	Q1	Q3	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			

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 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.

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 5.4 provides further information on the average share of money allocated into 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.[20]

Unsurprisingly, the actual average risky allocations in Table 5.4 do not exactly correspond to the optimal allocations reported in Table 5.2, 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.

Table 5.4: Allocations to the risky asset (in %)

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

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.

[20] 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.

5.5.2 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 5.5; 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%) 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.

Table 5.5: Risk-taking when the risk-free rate is above/below the target return

	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***	14.43***
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***	23.79***

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<.05; ** p<.01; *** p<.001.

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 5.2. 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 5.6 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). 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). Our second hypothesis is therefore validated.

Table 5.6: Variation in risk-taking demonstrating loss aversion

	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***	14.43***
Panel B : **Shift far from the target return (± 4%)**		
Δ4% below	12.60	21.39
Δ4% above	-4.75	-2.40
Difference	17.35***	23.79***

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<.05; ** p<.01; *** p<.001.

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 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 5.7 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.

Table 5.7: Variation in risk-taking and NIRs

Δ when R_F moves from 0% to -2%	3.76
Δ when R_F moves from 4% to 2%	2.30
Difference	1.46

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<.05; ** p<.01; *** p<.001.

5.5.3 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.[21] 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, 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,

[21] Because our dependent variable is bounded between 0 and 1, the use of OLS 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 7.4.4. They are qualitatively similar for our main variables of interest.

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:

$$Risk\_taking_{i,d} = \beta_0 + \beta_1 Low\_cond_i + \beta_2 Age_i + \beta_3 Male_i + \beta_4 Student_i + \beta_5 Risk\_tol_i + \beta_6 Dep\_acc_i + \beta_7 Stocks_i + \beta_8 Below\_target_{i,d} + \beta_9 Above\_target_{i,d} + \epsilon_{i,d} \tag{5.1}$$

We also estimate an alternative to the baseline model in which we split the two decision-level variables into the four following dummies: $Below\_4\%_{i,d}$, $Below\_2\%_{i,d}$, $Above\_2\%_{i,d}$, $Above\_4\%_{i,d}$, 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:

$$Risk\_taking_{i,d} = \beta_0 + \beta_1 Low\_cond_i + \beta_2 Age_i + \beta_3 Male_i + \beta_4 Student_i + \beta_5 Risk\_tol_i + \beta_6 Dep\_acc_i + \beta_7 Stocks_i + \beta_8 Below\_4\%_{i,d} + \beta_9 Below\_2\%_{i,d} + \beta_{10} Above\_2\%_{i,d} + \beta_{11} Above\_4\%_{i,d} + \epsilon_{i,d} \tag{5.2}$$

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 5.8; Model 1 corresponds to our baseline model (Eq. 5.1), Model 2 corresponds to the alternative (Eq. 5.2), 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 a

NIR.

Table 5.8: Fractional logit regressions for risk-taking behavior

Parameter	Model 1		Model 2		Model 3	
	Estimate	OR	Estimate	OR	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	

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%*, *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 a NIR. OR refers to odds ratios. N is the number of observations (i.e., decisions). Standard errors are clustered at the participant level. * p<.05; ** p<.01; *** p<.001.

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. 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 ($p<.05$). 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 ($p<.05$) 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, financial asset ownership) do not help explain the heterogeneity in risk-taking across participants.[22]

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 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

[22]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.

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 5.8 is the inclusion of an interaction term (*Low_cond***Below_*4%) that indicates situations in which participants in the low-target return condition face a 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.

5.6 Conclusion

This paper contributes to the growing body of literature on what stimulates the appetites of individuals for risk when facing NIRs. The novelty in our approach is the introduction of a variable of particular interest in investment decisions, that is, the target return. Unlike past research that has, by default, considered the zero-threshold to be the reference point (Bracha, 2016; 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 vs. 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.

Our results show 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. Unlike in our experiment, in which each participant was assigned a target return, regular people are likely to have some return objectives in mind when making real investment decisions. More importantly, return objectives (and financial objectives more generally) are key pieces of information that investment firms typically rely on for portfolio management. Such items are usually covered in investment policy statements (IPSs),[23] meaning that investors make their target returns explicit. 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 a NIR as an extra boost to risk-taking is particularly relevant among European Union member states where the Markets in Financial Instruments Directive (MiFID)[24] mandates a suitability assessment,[25] which is a kind of regulated IPS in which

[23]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).

[24]This piece of regulation came into force in November 2007 in European Union (EU) 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://ec.europa.eu/info/law/markets-financial-instruments-mifid-ii-directive-2014-65-eu_en`.

[25]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

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. One shortcoming of our approach is related to how we manipulate the between-subjects factor; i.e., we assign specific target returns to participants. As mentioned above, 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 a regulated IPS (such as the MiFID suitability assessment or any risk-return profile survey). 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 would be relevant. Another limitation of our experiment 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.

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.

Chapter 6

General Conclusion

This doctoral dissertation aims at studying the impact of individual and contextual factors that determine individuals' behavior when faced with ultra-low and negative interest rates. Since the time for the doctoral dissertation is limited, it could only partially study this impact of factors on ultra-low and negative interest rates. This research could be broadened, and it exceeds the scope of one doctoral dissertation. However, we provide experimental tests to study this impact, summarized below.

6.1 Main results and contributions

Chapter 2 questions intertemporal preferences to infer people's willingness to tolerate NIRs on their savings. Using an online experiment, we find that people tolerate NIRs, i.e., people are willing to hold money in the banks rather than spend it and consequently have less money in the future. This tolerance depends on several factors. To begin with, we find that the tolerance decreases for high amounts of savings compared to the low amount of savings, in line with a reverse magnitude effect. Next, we find a negative association between tolerance to negative interest rates and time horizons. Specifically, as the time horizon increases, the tolerance to negative interest rates decreases. We also find that regular savers are more likely to tolerate negative interest rates, consistent with

the status quo bias. Finally, we find that, in line with anchoring, individuals who are offered first with NIRs are more likely to tolerate NIRs on their savings than individuals offered first with PIRs.

The aim of Chapter 3 is to study the impact of both PIRs and NIRs together with procedures and costs on status quo bias in savings. When analyzing results obtained from an online experiment, we find a lower bias towards the status quo with NIRs than with PIRs. Specifically, when a saver has to pay the bank to save money, he is more likely to leave the bank than a saver who is offered a reward to keep money in the bank. Next, this status quo bias increases when one goes through procedures and pays opening fees to shift from the current bank to another bank. There is an interaction between one individual being a saver, paying these opening fees, and going through procedures when desiring to shift from the current to a new bank. If this interaction holds, the bias towards the status quo increases. Finally, we find that financial literacy impacts the status quo's bias. Specifically, with high (low) levels of financial literacy, the status quo bias increases (decreases).

Chapter 4 inquiries the impact of NIRs and PIRs on money illusion for individuals' saving and investments decisions involving risk-taking. In the online experiment that we use as a methodology, we find that individuals show a higher money illusion when facing NIRs than PIRs in their saving decisions. An important factor explaining money illusion is financial literacy. In particular, we find that financial literacy reduces money illusion.

The first objective of Chapter 5 is to determine, by utilizing prospect theory, whether the target return serves as a reference point and impacts individuals' risk-taking behavior while making decisions. The second objective is to test whether the target return remains the prevailing reference point when the risk-free rate turns out negative. We find that target returns are drivers of risk-taking in investment decisions using an online experiment. Besides, we find that the target return remains the prevailing reference point when the risk-free rate drops below zero. Unlike other authors who implicitly assume the zero interest rate as the reference point, we find that the explicit target return is the reference

point for individuals when making their investment decisions.

The main contribution of our findings across papers is that individuals indeed are willing to tolerate negative interest rates on savings. I need to point out that this is the case for individuals who save money regularly, have a lower amount of savings in the bank, save for a shorter time horizon, and show lower levels of financial literacy. Financial literacy seems to explain reactions to NIRs significantly.

It is noteworthy mentioning which circumstances and individual characteristics drive risk-taking when individuals face NIRs. Given results across chapters 3 and 4, individuals who take more risk with NIRs are the ones who show a higher level of financial literacy and predominantly are males. By contrast, individuals who take relatively less risk are predominantly females who show low financial literacy. Hence, it is crucial to recognize the type of individual characteristics while predicting the reactions of individuals towards NIRs.

6.2 NIRs effectiveness and managerial implications

This dissertation could not fully cover the impact of NIRs on individuals. However, we want to emphasize the effectiveness of this unconventional monetary policy on different stakeholders: retail investors, banks, and policy-makers. In the end, we discuss some potential ideas for future research.

Retail Investors. To begin with, in order for retail investors to make better decisions in the NIRs region (and in general), their financial literacy should increase. With increased financial literacy, they can better compare the costs and benefits of each investment alternative they face. Once they determine these costs and benefits, they could opt for the optimal one(s). Next, we observe that NIRs lead to the reduction of status quo bias. Hence, the introduction of NIRs could lead investors to think about alternatives other than the risk-free ones (since they deliver losses), which could benefit their well-being.

Banks. Banks offering NIRs on deposits could face a change in the behavior of their depositors. In particular, there is a threat that they could lose depositors who have relatively high deposits and save for longer time horizons. This behavior of depositors could be particularly threatening for commercial banks, which are highly deposit funded compared to less deposit funded banks. Our research shows that it might be challenging to acquire new clients who must pay to save money with the banks. Consequently, this could lead to a reduction in bank profits.

Policy-makers. We find partial experimental evidence regarding the effectiveness of this monetary policy. In particular, we observe that depositors who save a large amount of money for longer time horizons show low tolerance to NIRs, and hence, this result might imply that they opt for consumption and/or investments in risky assets. Besides, since an increase in financial literacy reduces NIRs tolerance, more financially literate people might be the ones who change their behavior by taking more risks while making investment decisions. Finally, individuals who are not saving money in the bank could be reluctant to place their money on savings and instead take more risks.

Although this doctoral dissertation delivers insightful findings, it is also subject to some limitations. A potential limitation of our work is that our methodology to investigate the impact of NIRs on individuals' savings and investment decisions involves experiments. Although experiments serve better in the cause-effect relationship, it would be beneficial to study whether empirical data supports findings presented in our experiments. This empirical analysis could serve as a complementary analysis, which would make the results of our essays more robust in case of matching findings.

Our work delivers implications for stakeholders, i.e., banks. As long as interest rates are positive, bank managers should not be afraid of losing their depositors. However, as our results in Chapter 3 indicate, there is a menace of losing depositors with the introduction of NIRs. This position posits a particular threat for banks if deposits represent a considerable part of their liabilities on the balance sheet. Since maintaining and acquiring new clients might be a more challenging objective with NIRs, banks must find a way to discover

additional funding sources (by issuing more equity). On the assets side, since loans become cheaper for borrowers and could reduce interest rate margins, bank managers should focus on other investments, such as securities (e.g., stocks), due to higher expected returns than loans.

In our future work, while investigating individual investment decisions, we could expand the number of investment options to approximate our work towards reality and the number of options individuals face in reality. By so doing, it would be easier to compare experimental findings with empirical findings mentioned in the previous paragraph. It would also be helpful to test whether the number of investment options impacts the individuals' savings and investment behavior when facing NIRs.

Another essential aspect that can be investigated is the storage costs of hoarding cash outside of the bank (for instance, at home). Although, in this case, individuals do not pay money in terms of NIRs to the bank, they face certain costs to keep money at home. They must have facilities (i.e., secured rooms) to keep money at home, especially if more significant amounts of money are to be kept. Besides, there is a risk involved with the money at home, i.e., it is subject to burglaries. As long as these storage costs are lower than the NIRs that have to be paid to save money in the bank, it is the optimal solution to keep money at home. In the reversed situation (i.e., storage costs outreach the interest that must be paid to the bank), it is an optimal solution to keep money in the bank to reduce the risk and costs. Hence, it could be relevant for future research to investigate whether and in which circumstances individuals would rather keep money in the bank than hoard it at home (depending on the amount, their facilities, risk of burglary, etc.)

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Chapter 7

Appendix

7.1 What leads people to tolerate negative interest rates on their savings?

7.1.1 Financial literacy – questions

QUESTION 1: Suppose you have $100 in a savings account and the interest rate is 2% per year. After 5 years, how much do you think you would have in the account if you leave the money to grow?

- More than $102
- Exactly $102
- Less than $102
- Do not know
- Refuse to answer

QUESTION 2: Imagine that the interest rate on your savings account is 1% per year and inflation is 2% per year. After 1 year, how much would you be able to buy with the money in this account?

- More than today
- Exactly the same
- Less than today
- Do not know
- Refuse to answer

QUESTION 3: Please tell me whether this statement is true or false. "Buying a single company's stock usually provides a safer return than a stock mutual fund."

- True
- False
- Do not know
- Refuse to answer

7.1.2 Financial literacy – statistics

Table 7.1: Financial literacy by component

Question	Percentage	N
Compounding	86%	160
Inflation	76%	141
Diversification	70%	130

This table provides the percentage of participants who correctly answered each question addressing financial literacy. N gives the number of participants.

Table 7.2: Financial literacy score

Financial literacy score	Percentage
0	4.81%
1	13.37%
2	26.20%
3	55.61

This table provides the percentage of participants who received each financial literacy score. Computed using the questions presented in Appendix 7.4.2, the score is an ordinal variable with four levels: 0 for the lowest level of financial literacy, 1 for a low level of financial literacy, 2 for a high level of financial literacy, and 3 for the highest level of financial literacy.

7.1.3 Acceptance of NIRs

Table 7.3: Acceptance of NIRs

Description	Ascending condition	Descending condition
Percentage of decisions indicating acceptance of NIRs	54.89%	20.95%
Number of decisions indicating acceptance of NIRs	505	199
Total number of decisions	920	950

This table reports the proportion of decisions indicating acceptance of NIRs in both the Ascending and Descending conditions.

7.1.4 Correlations

Table 7.4: Spearman correlations

Spearman correlation coefficients						
	Savings amount	Anchoring condition	Horizon	Savings behavior	Financial literacy	Annual implicit interest rate
Savings amount	1	0	0	0	0	0.24862***
Anchoring condition	0	1	0	-0.04728**	0.02657	-0.33066***
Horizon	0	0	1	0	0	0.14993***
Savings behavior	0	-0.04728**	0	1	-0.06501***	-0.11109***
Financial literacy	0	0.02657	0	-0.06501***	1	-0.06434***
Annual implicit interest rate	0.24862***	-0.33066***	0.14993***	-0.11109***	-0.06434***	1

This table provides the Spearman correlation coefficients for six variables: savings amount, anchoring condition, time horizon, savings behavior, financial literacy, and annual implicit interest rate. The savings amount is a binary variable set to one when the amount of savings is high ($20,000). The time horizon is can be 6 months (expressed in years, i.e., 0.5), 1 year, 2 years, 5 years, or 10 years. The anchoring condition is a binary variable set to one for the Ascending condition (and zero for the Descending condition). Savings behavior is a binary variable set to one for regular savers. Financial literacy is an ordinal variable with four levels: 0 for the lowest level of financial literacy, 1 for a low level of financial literacy, 2 for a high level of financial literacy, and 3 for the highest level of financial literacy. The annual implicit interest rate is a discrete numerical variable that can take -4, -3, -1, 1, 3, or 4%. ***, **, and * indicate significance at 1%, 5%, and 10%, respectively.

7.2 Negative Interest Rates and Status Quo Bias

7.2.1 Financial literacy - Questions

QUESTION 1: Suppose you had $100 in a savings account and the interest rate was 2% per year. After 5 years, how much do you think you would have in the account if you left the money to grow?

- More than $102
- Exactly $102

- Less than $102
- Do not know
- Refuse to answer

QUESTION 2: Imagine that the interest rate on your savings account was 1% per year and inflation was 2% per year. After 1 year, how much would you be able to buy with the money in this account?

- More than today
- Exactly the same
- Less than today
- Do not know
- Refuse to answer

QUESTION 3: Please tell me whether this statement is true or false. "Buying a single company's stock usually provides a safer return than a stock mutual fund."

- True
- False
- Do not know
- Refuse to answer

7.2.2 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.

7.2.3 Loss Aversion Questionnaire - Statements

For each of the following statements, please indicate the extent to which you agree with the statement (1 = strongly disagree, 5 = strongly agree).

Statement 1: If I lose a sweater at home, I keep on searching until I find it.

Statement 2: I really don't care if someone talks bad about me behind my back.

Statement 3: I would feel very down if I got fired, even if I know I will find a similar job.

Statement 4: I would hate it if a colleague thought that I'm not as good in my job now as I was before.

Statement 5: In marriage, a woman should keep her own last name.

Statement 6: In a relationship, I would hate not having my separate group of friends.

Statement 7: Losing your house to a fire is bad, but I would manage.

Statement 8: I think eventually I could cope with losing the ability to walk.

Statement 9: I tend to keep old stuff around.

Statement 10: If my reputation in the company takes a blow, I wouldn't want to come to work anymore.

Statement 11: If I can't find the documents I'm looking for, I get real nervous.

Statement 12: Once I've acquired a position in the company, I wouldn't want to take a step back.

Statement 13: I would feel very emotional if my car (bike) would be stolen.

Statement 14: I don't care if my boss thinks less of me than I'm really worth.

Statement 15: I don't like throwing away stuff.

Statement 16: I wouldn't care if I had to move to a smaller place.

Statement 17: I'd rather quit than get fired.

Statement 18: I would never accept a job that has less pay than my previous/current one.

Statement 19: I wouldn't like it if the company changed our way of working.

Statement 20: I don't care what people would think if I was suddenly unemployed.

7.2.4 Status quo bias depending on gender

Table 7.5: Differences in status quo choices between male and female participants

Male	18.12%
Female	22.31%
Difference	-4.23%
t-value	-1.00
p-value	0.3174

This table reports the proportion of male and female participants choosing the "Bank B" (i.e., the status quo option), the differences between these proportions, and the corresponding t-values and p-values from one-sided two-sample t-tests.

7.3 Negative Interest Rates and Money Illusion

7.3.1 Determination of Real Rates

Table 7.6: Real Interest Rates in Study 1

Condition	Individual 1 Deposit Rate	Inflation	Real rate 1	Individual 2 Deposit Rate	Inflation	Real rate 2	Real Rate 1 - Real Rate 2
Positive-Nominal	2%	0%	2.00%	5%	4%	0.96%	1.04%
Positive/Negative-Nominal	-2.00%	0%	-2.00%	1.00%	4%	-2.88%	0.88%
Negative-Nominal	-6.00%	0%	-6.00%	-3.00%	4%	-6.73%	0.73%

This table reports deposit rates, inflation, real rates, and difference in real rates for Positive-Nominal, Positive/Negative-Nominal, and Negative-Nominal conditions, respectively. Real rates are determined based on Fisher's formula. As this table indicates, the difference in real rates is negative, i.e., it is always lower for Individual 1, irrespective of the condition.

7.3.2 Deposit Rates in European Union

It is essential to understand the development of real interest rates since they represent either a decrease or increase in an individual's purchasing power. An increase in the purchasing power occurred in the European Union from 2011 to 2016 because real annual deposit rates were positive, i.e., nominal annual deposit rates exceeded annual inflation. The highest positive real annual deposit rate was in 2016 - 1.64% (see Figure 7.1 for more details).

A decrease in purchasing power appeared in 2017 and persisted until 2021 since real annual deposit rates were negative, i.e., inflation exceeded nominal annual deposit rates. The most striking and negative real annual deposit rate was -1.25% in 2017 (Figure 7.1 provides more details).

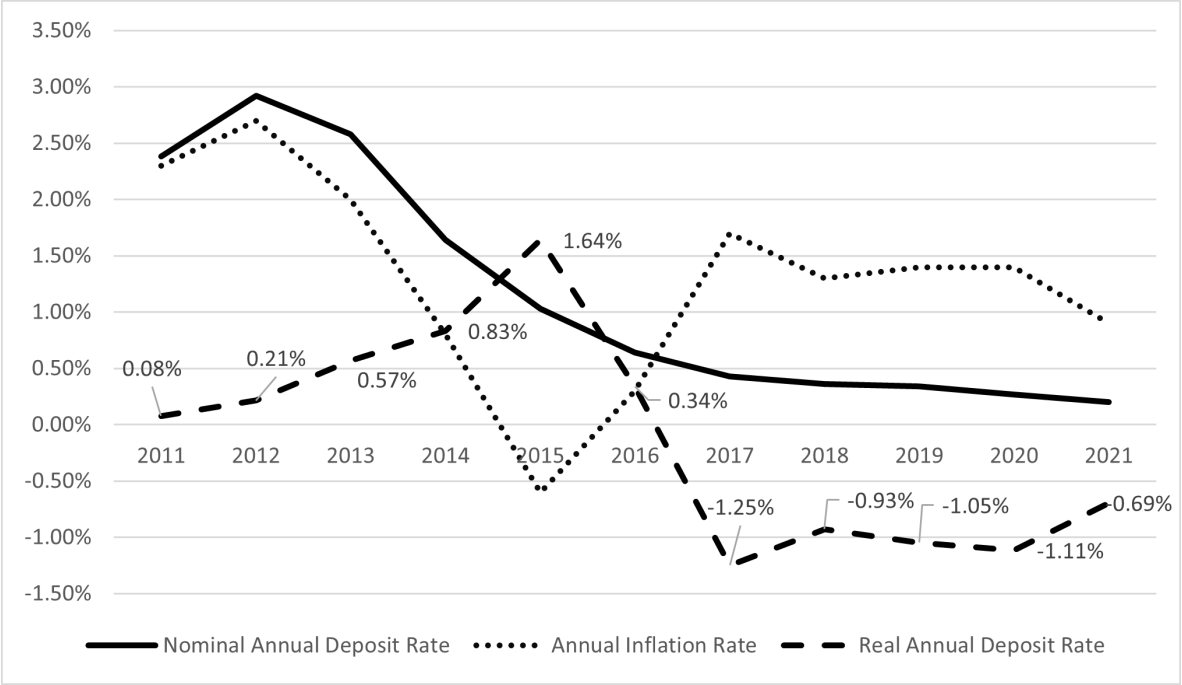

Figure 7.1: Nominal deposit rates, inflation rates, and real deposit rates from 2011 to 2021 in EU

This figure presents the development of nominal annual deposit rates (solid line), annual inflation rates (dotted line), and real annual deposit rates (dashed line) in the European Union countries from 2011 to 2021. Fisher's equation serves as the basis for determination real annual deposit rates (Source: Eurostat (2021).

7.3.3 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.

7.3.4 Financial literacy - Questions

QUESTION 1: Suppose you had $100 in a savings account and the interest rate was 2% per year. After 5 years, how much do you think you would have in the account if you left the money to grow?

- More than $102
- Exactly $102
- Less than $102
- Do not know
- Refuse to answer

QUESTION 2: Imagine that the interest rate on your savings account was 1% per year and inflation was 2% per year. After 1 year, how much would you be able to buy with the money in this account?

- More than today
- Exactly the same
- Less than today
- Do not know
- Refuse to answer

QUESTION 3: Please tell me whether this statement is true or false. "Buying a single company's stock usually provides a safer return than a stock mutual fund."

- True
- False
- Do not know
- Refuse to answer

7.3.5 Correlations - Study 1

Table 7.7: Spearman correlations - Study 1

Spearman correlation coefficients							
	Money_illusion	Positive_Negative_cond	Negative_cond	Financial literacy	D_Real_interest_rate	Age	D_Male
Money_illusion	1	-0.1445*	-0.1373**	0.1948**	0.2770***	-0.0557	0.1078
Positive_Negative_cond	-0.1445*	1	-0.4997***	0.0179	-0.0540	0.0031	0.0406
Negative_cond	-0.1373*	-0.4997***	1	-0.1057	-0.1278	-0.13372*	-0.1018
Financial literacy	0.1948*	0.0179	-0.1057	1	0.79431***	0.23089***	0.2690***
D_Real_interest_rate	0.2770***	-0.0540	-0.1278	0.7943***	1	0.0623	0.1799**
Age	-0.0557	0.0031	-0.1337*	0.2309***	0.0623	1	0.1536*
D_Male	0.1078	0.0406	-0.1018	0.2690***	0.1799**	0.1536*	1

This table provides the Spearman correlation coefficients for seven variables: Money_illusion, Positive_Negative_cond, Negative_cond, financial literacy, D_Real_interest_rate, age, and gender. $Money\_illusion_i$ is set to one when the participant chooses individual one to be better off in economic terms (i.e., the correct answer) and zero otherwise. $Positive\_Negative\_cond_i$ is a binary variable set to one if a participant is in Positive/Negative condition and zero if he/she is in Positive condition. $Negative\_cond_i$ is a binary variable set to one if a participant is in the Negative condition and zero if he/she is in the Positive condition. Financial literacy is an ordinal variable with four levels: 0 for the lowest level of financial literacy, 1 for a low level of financial literacy, 2 for a high level of financial literacy, and 3 for the highest level of financial literacy. *D_Real_interest_rate* is a dummy variable that takes value one if a participant can determine the real interest rate on Question 2 in Financial Literacy Questionnaire (see Appendix 7.3.4), and zero otherwise. *Age* refers to the age of the participant. D_Male_i is a binary variable that takes value one if a participant is male and zero otherwise. ***, **, and * indicate significance at 1%, 5%, and 10%, respectively.

7.3.6 Correlations - Study 2

Table 7.8: Spearman correlations - Study 2

Spearman correlation coefficients							
	Inv_stock	Deflation	D_Real_interest_rate	Financial literacy	Risk_tol	Age	D_Male
Inv_stock	1	-0.0982	-0.2164***	0.4153***	0.2969**	0.2426***	0.2346***
Deflation	-0.0982	1	-0.0859	-0.0510	-0.1518	-0.0541	-0.1646**
D_Real_interest_rate	0.2164***	-0.0859	1	0.7943***	0.2830**	0.0623	0.1799**
Financial literacy	0.4153***	-0.0510	0.7943***	1	0.2641**	0.23089***	0.2690***
Risk_tol	0.2969**	-0.1518	0.2830**	0.2641**	1	0.1537	0.4499***
Age	0.2426***	-0.0541	0.0623	0.2309***	0.1537	1	0.1536*
D_Male	0.2346***	-0.1646**	0.1799**	0.2690***	0.4499**	0.1536*	1

This table provides the Spearman correlation coefficients for seven variables: Inv_stock, Deflation, D_Real_interest_rate, financial literacy, Risk_tol, age, and gender. Inv_stock_i represents the proportion invested in the risky asset. $Deflation_i$ is a binary variable set to one if a participant is in the Deflation condition and zero if he/she is in the Inflation condition. *D_Real_interest_rate* is a dummy variable that takes value one if a participant can determine the real interest rate on Question 2 in Financial Literacy Questionnaire (see Appendix 7.3.4), and zero otherwise. Risk tolerance ($Risk\_tol_i$) is the participant's average score based on the answers to the six questions taken from the DOSPERT scale, which ranges from 1 (extremely unlikely to take a risk) to 7 (extremely likely to take a risk). Financial literacy is an ordinal variable with four levels: 0 for the lowest level of financial literacy, 1 for a low level of financial literacy, 2 for a high level of financial literacy, and 3 for the highest level of financial literacy. *Age* refers to the age of the participant. D_Male_i is a binary variable that takes value one if a participant is male and zero otherwise. ***, **, and * indicate significance at 1%, 5%, and 10%, respectively.

7.4 Target Returns and Negative Interest Rates

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

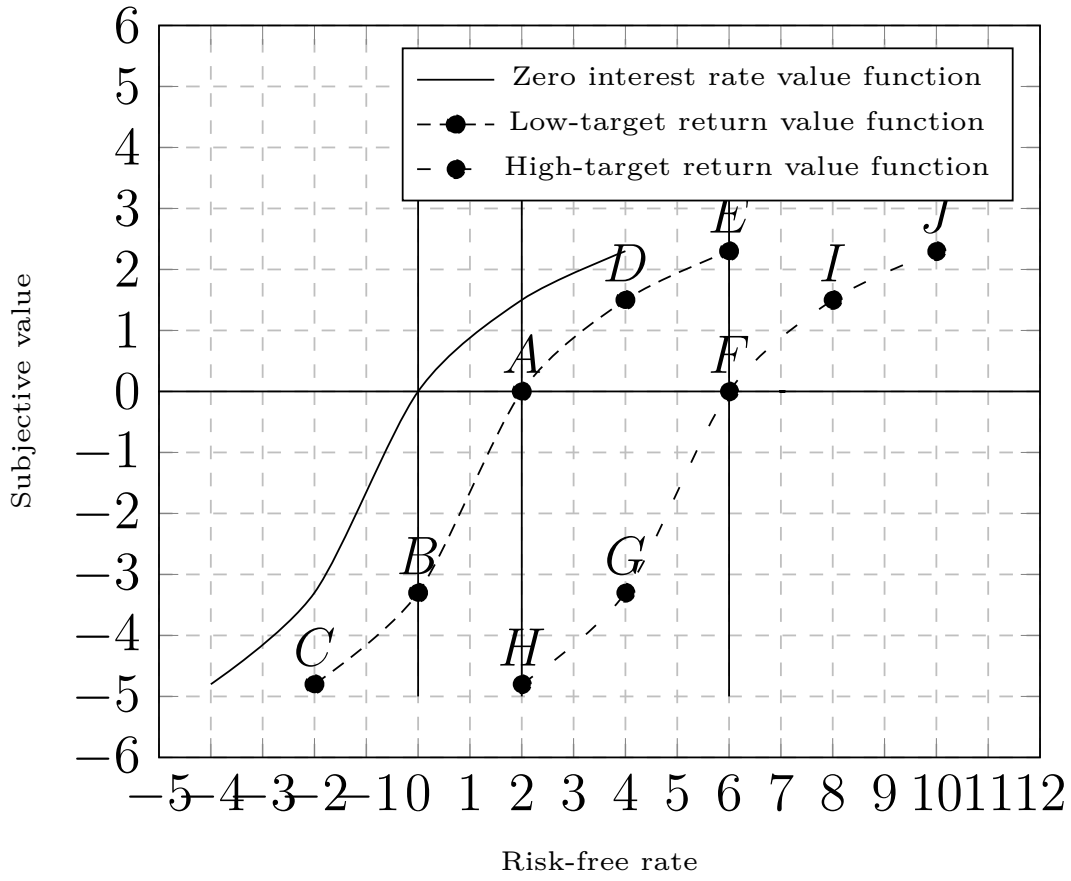

Figure 7.2: Value function curves for risk-free rate outcomes depending on the level of the reference point based on prospect theory.

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.

7.4.2 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.

7.4.3 Computation of the optimal allocations based on Cumulative Prospect Theory

In order to build Table 5.2, we use the CPT of Tversky and Kahneman (1992) with their function specifications [see Equations (5) and (6) on page 309] and their parameters:

- $\lambda = 2.25$, the loss aversion parameter
- $\alpha = \beta = 0.88$, powers for gains and for losses
- $\gamma = 0.61$ 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 5.1, 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 non-zero 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:

- -3% with a probability of 17%
- 2% with a probability of 21%
- 7% with a probability of 24%
- 12% with a probability of 21%
- 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). However, with the optimal allocation reported in Table 5.2, that is, 27% in the risky asset and 73% in the risk-free asset, 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-interest rate level.

7.4.4 OLS regression results

Table 7.9: OLS regression models for risk-taking behavior

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

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%*, *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 a NIR. N is the number of observations (i.e., decisions). Standard errors are clustered at the participant level. * p<.05; ** p<.01; *** p<.001.

Louvain School of Management
Doctoral Thesis Series

ESSAYS ON INDIVIDUAL REACTIONS TO ULTRA-LOW AND NEGATIVE INTEREST RATES

Aleksandar TODOROVIC

Negative interest rates are no longer hypothetical. Their goal is to stimulate economic growth and consumption by stimulating at the individual level both risk-taking and spending. Standard finance is turned upside down with its implementation since borrowers receive a reward for taking credits, and depositors must pay to delay their consumption. Since it turns standard finance upside down and is unprecedented, it is essential to understand individuals' reactions to negative interest rates in various contexts. This thesis involves four experimental research studies on individuals' reactions towards negative interest rates in contexts of savings and investments. When explaining these reactions, I include various phenomena related to biases in decisions (i.e., status quo bias and money illusion).

Aleksandar Todorovic was born in Serbia. He has been a doctoral researcher for Louvain Finance research center (LFIN) at UCL - Louvain School of Management since 2018. He received a master's degree in Economic Behavior and Governance from the University of Kassel in Kassel, Germany. As a doctoral researcher, he was a visiting researcher at the Alfred Weber Institute at the Heidelberg University (Heidelberg, Germany) and participated in several international conferences. His research focuses on behavioral economics and behavioral finance.