WP 2020/5

Olivier Corneille, Catherine D'Hondt, Rudy De Winne,
Emir Efendic and Aleksandar Todorovic

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

LOUVAIN FINANCE

LFIN

Voie du Roman Pays 34, L1.03.01

B-1348 Louvain-la-Neuve

Tel (32 10) 47 43 04

Email: lidam-library@uclouvain.be

https://uclouvain.be/en/research-institutes/lidam/lfin/working-papers.html

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

O. Corneille,† C. D'Hondt,‡ R. De Winne,§ E. Efendic,¶ and A. Todorovic‖

January 21, 2020

Abstract

Using an online experiment, we examine to what extent people are ready to bear negative interest rates (NIR hereafter) on their savings. We find some tolerance to NIR, i.e. people being willing to let money in the bank, rather than spend it, and thereby accepting to have less at some later time than now. This tolerance strongly depends on the amount of savings, time horizon, individual savings behavior, and anchoring. Specifically, the higher the amount, the lower the tolerance to NIR, which is consistent with a *reverse* magnitude effect. As time horizon increases, the tolerance to NIR decreases. Regular savers are more likely to tolerate NIR than non-regular savers, which is consistent with the status quo bias. We also find a higher tolerance to NIR on savings when participants are anchored towards NIR on savings first, i.e. when participants are presented first with NIR and then with positive interest rates (PIR hereafter).

Keywords: negative interest rate, savings account

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

1 Introduction

Interest rates refer to a percentage premium of money paid at a specified date for delaying consumption and risk-taking (Fisher, 1930). Any interest rate is made of two parts: the risk-free rate and the risk premium. The higher the risk (i.e. uncertainty about outcomes), the higher the risk premium. The risk-free rate captures the time value of money, which allows any 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 can 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). NIR constitute a historical precedent as well as a paradigm shift. Instead of offering gratification for delaying consumption, NIR

*The authors gratefully acknowledge the support from the ARC grant 18/23-089.

†Psychological Sciences Research Institute, UCLouvain ; e-mail address: olivier.corneille@uclouvain.be

‡Louvain Finance (LIDAM), UCLouvain ; e-mail address: catherine.dhondt@uclouvain.be

§Louvain Finance (LIDAM), UCLouvain ; e-mail address: rudy.dewinne@uclouvain.be

¶Psychological Sciences Research Institute, UCLouvain ; e-mail address: emir.efendic@uclouvain.be

‖Louvain Finance (LIDAM), UCLouvain ; e-mail address: aleksandar.todorovic@uclouvain.be; Corresponding author

deliver punishment. In practice, this means that banks would require their depositors to pay to leave money on their savings accounts (which some already started to do).[1]

NIR are essentially viewed as a monetary policy tool aiming 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 should not tolerate NIR because they are associated with sure losses. Because individuals are indeed "punished" for saving money when NIR are applied, they should prefer either spending it, investing it, or lending it. Hence people are not expected to tolerate NIR on their savings (Lilley and Rogoff, Lilley and Rogoff; Block, 1978). The reality, however, is more puzzling. On the one hand, there is some empirical evidence that NIR may effectively promote risk-taking and spending, but mainly among institutional investors (Maggio and Kacperczyk, 2017; Hong and Kandrac, 2018). On the other hand, in several countries that are experiencing all-time low rates or NIR, aggregate household savings seem rather demonstrate the opposite since savings are still increasing (Europe, 2019).

Because NIR on regular savings accounts flips the standard practice on its head, it is of utmost importance to better understand to what extent are people ready to accept a situation wherein they have to pay some interests to banks (in addition to traditional bank fees)[2] for letting money on their savings accounts. A growing body of research investigates the decision-making process of individuals under low or negative rates. Most of the authors focus on investment decisions and risk-taking and their results relate low or negative rates to higher appetite for risk (Bracha, 2016; Ganzach and Wohl, 2018; Lian et al., 2018; Baars et al., 2019).[3] In this paper, we adopt another approach to lift the veil on what leads people to tolerate NIR on their savings. For that purpose, we build on Efendic et al. (2019) who are the first, to the best of our knowledge, to investigate various factors that may modulate people's tolerance for NIR on savings. According to these authors, individuals show a surprisingly large tolerance for NIR when the only alternative is to take one's savings out of the bank. Moreover, they show that this tolerance fluctuates as a function of the size of the savings, the size of NIR, and some individual characteristics such as age and risk-taking inclinations.

To investigate to what extent people are ready to bear NIR on their savings, we use an online experiment on Prolific to determine intertemporal preferences based on a set of binary choices between spending money today or saving it for the future.[4] Crucially, what is innovative in our setting is that we present participants with

[1] Alternative Bank Schweiz AG in Switzerland is one of the first banks to require depositors to pay to leave money with it (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 it will apply NIR for wealthy depositors while the Dutch online broker DeGiro plans to apply NIR on deposits exceeding €2,500.

[2] Interest rates differ from bank fees. For regular savings accounts, bank fees refer to nominal fees for accounts set-up and maintenance, as well as transactional services. Such fees can be on time, ongoing, 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 any comparison of different risk-free amounts of money at various points in time

[3] Bracha (2016) reports no difference in investment decisions between situations with positive and negative interest rates. While not directly dealing with NIR, Ganzach and Wohl (2018) provides evidence that the lower the risk-free rate the higher the demand for risky assets. Baars et al. (2019) 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.

[4] In the literature, two methods are used to measure intertemporal preferences - the matching-based and the choice-based method. In the former, participants are provided with a given amount 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 just to select one option to express

future values of savings that can be higher, equal or *lower* than the present value of savings at their disposal. As explained before, lower future values of savings would imply that NIR have been applied to a deposit. Based on participants' intertemporal preferences for 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 keep on saving money. Subsequently, using the indifference points and the corresponding present values of savings, we are then able to infer annual implicit discount rates that make meaningful comparisons across amounts and horizons possible. In our setting, the discount rate refers to the annualized interest rate at which the decision-maker is willing to keep on saving 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 NIR to PIR), the sequence of choices provides increasing future amounts of savings, which are predefined on an annual interest rate of -4%, -2%, 0%, 2%, and 4%, respectively. By contrast, in the Descending condition (from PIR to NIR), the sequence of future amounts is reversed, i.e. future amounts are predefined on an annual interest rate of 4%, 2%, 0%, -2%, and -4%, respectively. 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 NIR, compared to the Descending condition.

This piece of experimental research is innovative on several points. First, we determine annual implicit interest rates on savings for different amounts and time horizons allowing for people to express negative discounting. Second, our two anchoring conditions allow us to compare decisions made by individuals depending on whether they face first NIR or PIR. We should also stress that the range of interest rates in our experiment varies from -4% to 4%, while previous research only consider slightly negative rates. In addition, we relate discount rates to decision-makers' savings behavior and financial literacy. Lusardi (2008) finds that financially literate individuals are more likely to save money. Financially literate individuals observe better the benefits of saving and investing, which is related to the better selection of investment opportunities (Anantanasuwong, 2019). This author points out that higher financial literacy is associated with more retirement savings.

The main results of the paper can be summarized as follows. Participants show intertemporal preferences that do reveal they are ready to accept lower future values (i.e. accept a NIR) on savings, and this depends on several factors. First, participants are more likely to tolerate NIR for the low amount of savings ($500) than for the high amount ($20,000). This result is consistent with the *reverse* magnitude effect. One possible reasons for this is that interests to be paid appear lower in absolute terms for the small amount of savings than the corresponding ones for the large amount of savings. Second, annual implicit interest rates are positively associated with time horizon - the longer the horizon, the lower the tolerance to NIR. Moreover, consistent with the status quo bias, participants who save money regularly are more likely to tolerate NIR, compared to the ones who are not regular savers. Finally, participants who face first future values implying NIR (Ascending condition) are more likely to tolerate NIR, compared to the participants who face first future values implying PIR (Descending condition).

The remainder of the paper is organized as follows. Section 2 reviews the relevant literature and presents our hypotheses. Section 3 describes our experimental setting. Section 4 reports the results. Section 5 concludes.

their preferences, this approach is easy to understand. However, how the sequence of choices is presented can potentially bias decisions. Therefore, one needs to control for the sequence of choices when applying this choice-based method.

2 Literature and Hypotheses

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 on a bank account and get back $120 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).[5] 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. Uncertainty of human life can decrease the value of future monetary outcomes ("A bird in the hand is worth two in the bush"). People can think about an accident that might happen before they take their future reward. This could make immediate monetary options more favorable than future ones. In the same vein, expectations about available resources in the future[6] 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"). By 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 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 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; 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

[5] In the cases of losses, the decision-maker is offered 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 immediately the debt because the money available in one year is not enough to pay entirely the debt ($105 < $110).

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

magnitude effect. Thaler (1981) finds a negative relationship between the size of gains and discount rates. For a larger size of gains, discount rates are lower, compared to the smaller size of 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 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, with a distinction between an interest rate frame and a money frame.[7] For gains, they find a negative relationship between outcome size and discount rates regardless of the prevailing frame, which is consistent with a *conventional* magnitude effect. However, these authors 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 increases too (i.e. interest rates are higher for large losses than for smaller ones). Accordingly, people would prefer to receive $4.2 after one year instead of $5 today, compared to $4,200 after one year instead of $,5000 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 NIR is higher for small than for large amounts, which supports the *reverse* magnitude effect.

Mental accounting could also explain the magnitude effect, suggesting that decision-makers have different mental accounts for small and large amounts. 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 discriminate discount rates for both 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 the discount rate. Thaler (1981) reports that when people are asked the amount of money they would require in one month/one year/ten years to make them indifferent to obtain $15 now, their responses are $20, $50 and $100, respectively, which implies an annual interest rate[8] of 345% for the one-month horizon, 120% for a one-year horizon and 19% over a ten-year horizon. Such differences in discount rates are potentially due to the compounding effect, which is hard to consider because of interests on interests that accumulate. Decision-makers who do not understand 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 will increase too, but at a decreasing rate.[9] Since the compounding effect is more prominent as the time horizon increases, this phenomenon is more likely for longer than for shorter horizons. However, in the case of losses, neither positive nor negative correlation between time horizon and discount rates has been observed.

[7] 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 returns of alternative outcomes are directly presented to participants (instead of the monetary values).

[8] using continuous compounding formula

[9] Let us consider an example for gains. Decision-makers are confronted between choosing $1,000 today or $1,100 in a year. After that first decision, they are confronted between choosing $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) produces a higher interest rate and could be more likely to accept the second option compared to the first one.

Discount rates also depend on financial literacy. Lusardi and Mitchell (2011) defines it as the 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, they find that financially literate people are more likely to save money. Focusing on the impact of financial literacy on time preferences, Lahav et al. (2015) find that higher financial literacy decreases subjective discount rates.[10] Anantanasuwong (2019) examine how financial literacy impacts retirement savings, and indicates that financially literate individuals save more for retirement.

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 ascending, descending or random. Immediate outcomes in the ascending order are displayed from the lowest to the 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 show first $1,000 today 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 the descending order, slightly lower discount rates in the ascending order, and the lowest discount rates in the random order. They explain these results by the influence of past responses on future ones.

2.3 Why might people accept bearing NIR on their savings?

Although NIR are often viewed as a monetary policy tool aiming at boosting risk-taking and/or spending (Lilley and Rogoff, Lilley and Rogoff), aggregate household savings are still increasing in countries experiencing all-time low rates[11] or NIR (Europe, 2019). Such an observation is puzzling and raises the critical question: why might people accept bearing NIR on their savings?

At the root of the implementation of NIR is the belief that NIR can boost economic growth as individuals (just as financial institutions and firms) would be penalized for hoarding money when they could rather spend it, lend it, or invest it. Because individuals tend to be loss averse (i.e. losses loom larger than gains)[12] and may regard NIR as a sure loss, they should not tolerate NIR. Nevertheless, in reality, facts may turn out to be different. There are at least three reasons why people might show some tolerance for NIR.

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. By doing so, people aim at ensuring the security of future payments. This precautionary motive is especially related to the uncertainty regarding future incomes. When uncertainty is high, people will save and/or save even more to mitigate this uncertainty (Aizenman et al., 2015). This can lead to precautionary savings, i.e. extra savings (Lugilde et al., 2019). As uncertainty increases, the current savings increase too (Merrigan and Normandin, 1996). Over the last decade, uncertainty has increased in many countries because of economic, political, and/or financial disturbances. Increasing uncertainty could

[10] The authors define subjective discount rate as the rate at which individuals trade current and future values. It is assumed to be higher for individuals who are more focused on the present, and lower for those who are more future oriented.

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

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

explain why aggregate household savings are still increasing, despite all-time low rates or NIR.

The next reasons rather relate to how people prefer saving money. *Safekeeping* is one of the oldest function in banking (Lord, 1984). On that aspect, banks obviously add-value since saving money at the 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. Bank deposits are often considered as advantageous (or even necessary) to easily manage one's money (e.g., for online payments, access, transfer, etc.).[13] Such a practicality is important in a more and more cash-less 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 be in favor of saving money at the bank.

We should eventually 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 (2013) documents that a lack of trust in banks and memories of past banking crises are important determinants of why individuals prefer holding assets in cash rather than at banks. In addition, he reports that cash preferences are negatively related to wealth and financial literacy, but positively related to risk aversion.

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 NIR are associated with losses, we expect a *reverse* magnitude effect,[14] 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 NIR for lower savings. However, in our setting, each participant makes a set of choices involving either a positive or a negative interest rate, whatever the anchoring condition. In the Descending condition, participants first face future values implying PIR (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, the misunderstanding of the compounding effect could have the opposite impact, compared to gains. Let us take a simple example to illustrate that. Imagine decision-makers have to choose between taking $1,000 today or keeping on saving that amount to get $900 in one year. After that first decision, they have to choose between taking $1,000 today or keeping on saving it to get $590.49 in 5 years. The interests are negative and amount to -$100 for one year and - $409.51 for 5 years, respectively. Although both future amounts are based on an annual interest rate of -10%, losing $409.51 in interests after 5 years might seem more acceptable than losing $100 in a single year. On the other hand, for NIR, another aspect could come into play: people might be simply reluctant to accept recurrent losses. Put differently, it might be harder to commit on losses for a longer time horizon. Consequently, we hypothesize that annual implicit interest rates will be higher for longer time horizons.

[13] Bank safe-deposit boxes bring safekeeping but not such a practicality that is offered by bank deposits.

[14] Since our participants are not directly provided with interest rates, we are in a monetary frame. However, since they are requested to take 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).

Participants should then be more likely to tolerate NIR when saving for shorter horizons. Again, the strength of this relationship could differ depending on the anchoring condition. In the Descending condition, participants face first future amounts implying PIR, which makes them start in the domain of gains. By contrast, in the Ascending condition, participants face first future amounts implying NIR, which put them directly in a frame of losses. Participants could face NIR in both conditions, but the anchoring difference could generate a positive but weaker relationship between annual interest rates and 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 NIR on savings, compared to the ones who are not regular savers. This hypothesis builds on the status quo bias, which refers to the situation when people prefer things to stay 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 explains that decision-makers feel worse when bad consequences result from action rather than inaction. In our setting, the status quo bias could lead participants to keep on saving money (inaction) rather than taking money from the bank (action). Drive for consistency is the belief that past decisions are optimal. In our setting, this could make decision-makers disregard new information to keep the original decisions (i.e. keep on saving money in the bank whatever the updated conditions).

The fourth hypothesis is linked to financial literacy, i.e. general knowledge regarding compounding, inflation and diversification (Lusardi and Mitchell, 2011). The more financially literate participants are expected to be more tolerant to NIR on savings than the less financially literate participants. This hypothesis is consistent with Lusardi (2008), who finds that financial literacy is positively related to savings and plans for retirement. A low level of financial literacy may stimulate immediate consumption instead of savings (regardless of the offered conditions).

The fifth hypothesis aims at controlling for the sequence of choices. Consistent with the anchoring bias,[15] we assume that the annual implicit interest rates in the Ascending condition are lower than in the Descending condition. In the Ascending condition, anchors are the lowest future values that imply NIR, which should make participants more tolerant to NIR. In the Descending condition, anchors imply PIR, which should make participants less tolerant to NIR. Such expectations might also be related to the satisficing behavior (Itzkowitz et al., 2015). 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 acceptable option in the Descending condition.

3 Experimental setting

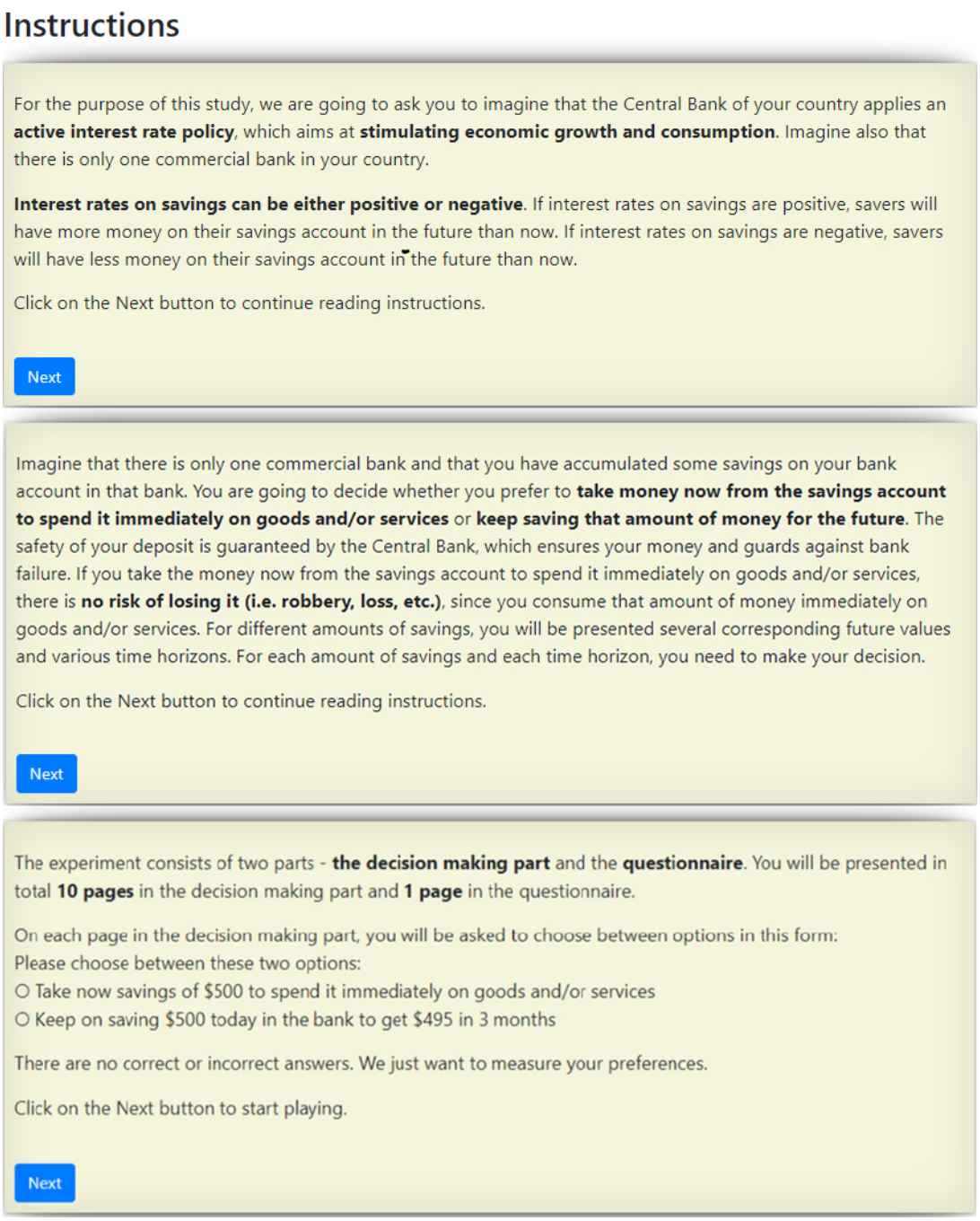
The experiment is conducted using oTree (Chen et al., 2016). All participants are directed to imagine that the Central Bank of their country applies an active interest rate policy, which aims at stimulating economic growth and consumption. They are also asked to imagine there is only one commercial bank in their country, and that they have accumulated some savings on 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 taking their

[15] Anchoring is a particular form 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, 1974).

money from the bank to spend it immediately on goods and/or services or keeping on saving during a given horizon. There is no risk, either when they take money from the bank to spend it nor when they save it in the bank for the future. The full instructions are presented in Figure 1.

The experiment includes 10 web pages that deal with various amounts of savings 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 and 10 years, respectively. Each participant faces 10 pages with different amounts and horizons but the order of the savings amount ($20,000 versus $500) and horizons are randomized to avoid the order effect for immediate outcomes (Robles and Vargas, 2007).

Our experiment is a mixed design with one factor that is between-subject, the anchoring condition (Ascending vs. Descending), and two factors that are within: time horizon and amount of savings. In both anchoring conditions, each page includes from one to five binary choices. In each choice, the first option is taking money from the bank to spend it immediately on goods and/or services while the second option refers to keeping on saving it 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 is increasing from the first to a fifth binary choice, with future amounts predefined on an annual interest rate of -4%, -2%, 0%, 2%, and 4%, respectively. Once the participant decides to keep on saving money for the future, he/she moves to another page. For example, if a participant in the first binary choice 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. In the Descending condition, the sequence of future outcomes is reversed - future amounts are predefined on an annual interest rate of 4%, 2%, 0%, -2% and -4%, respectively. Figure 3 displays the decision-making process in the Descending condition.



Instructions

For the purpose of this study, we are going to ask you to imagine that the Central Bank of your country applies an **active interest rate policy**, which aims at **stimulating economic growth and consumption**. Imagine also that there is only one commercial bank in your country.

Interest rates on savings can be either positive or negative. If interest rates on savings are positive, savers will have more money on their savings account in the future than now. If interest rates on savings are negative, savers will have less money on their savings account in the future than now.

Click on the Next button to continue reading instructions.

Next

Imagine that there is only one commercial bank and that you have accumulated some savings on your bank account in that bank. You are going to decide whether you prefer to **take money now from the savings account to spend it immediately on goods and/or services** or **keep saving that amount of money for the future**. The safety of your deposit is guaranteed by the Central Bank, which ensures your money and guards against bank failure. If you take the money now from the savings account to spend it immediately on goods and/or services, there is **no risk of losing it (i.e. robbery, loss, etc.)**, since you consume that amount of money immediately on goods and/or services. For different amounts of savings, you will be presented several corresponding future values and various time horizons. For each amount of savings and each time horizon, you need to make your decision.

Click on the Next button to continue reading instructions.

Next

The experiment consists of two parts - **the decision making part** and the **questionnaire**. You will be presented in total **10 pages** in the decision making part and **1 page** in the questionnaire.

On each page in the decision making part, you will be asked to choose between options in this form:
Please choose between these two options:
O Take now savings of $500 to spend it immediately on goods and/or services
O Keep on saving $500 today in the bank to get $495 in 3 months

There are no correct or incorrect answers. We just want to measure your preferences.

Click on the Next button to start playing.

Next

Figure 1: Computer screenshot of instructions

Our experiment includes a questionnaire presented after the decision making part with 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, respectively (Meier and Sprenger, 2013). The question about the 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 between these items and annual implicit interest rates. The specific questions are available in Appendix A.

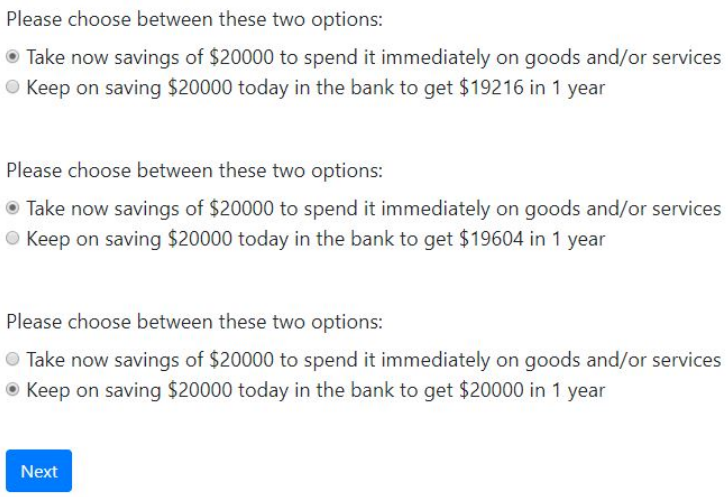


Figure 2: Computer screen - decision-making in the Ascending condition

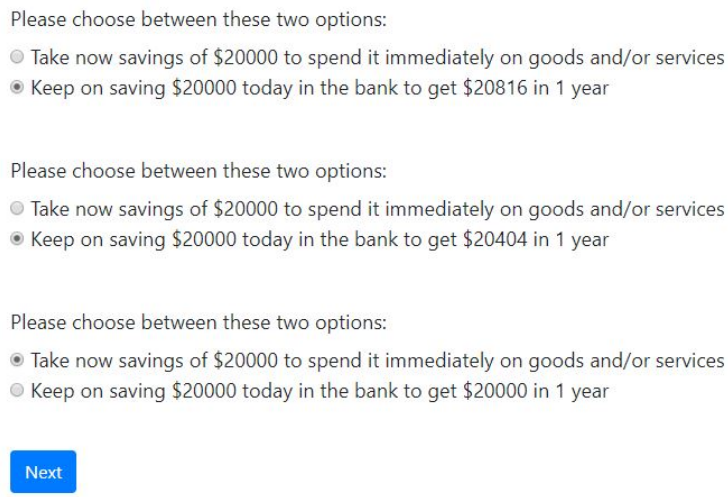


Figure 3: Computer screenshot - decision-making in the Descending condition

4 Results

4.1 Participants

We use Prolific Academic[16] to recruit participants with pre-screening based on age, nationality, and mother language. Participants are required to be both between 18 and 65 years old and U.S. citizens whose the first language is English. Our average participant is 34 years old. We have more females (102) than males (84). Females are on average older than males (35 versus 32 years). The majority of 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,

[16]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 recruiting a large number of participants, which provides a 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.

inflation, and diversification, respectively - see Appendix A). Since the score is an equally-weighted sum, its maximum is 3 when the three questions are answered correctly and its minimum is 0 when there is no correct answer. Hence, financial literacy is an ordinal variable, with four levels: 0 - the lowest level of financial literacy, 1 - low level of financial literacy, 2 - high level of financial literacy, and, 3 - the highest level of financial literacy. The average financial literacy in our sample is 2.33, which suggests that participants reach a relatively high score. More than half of participants (103 out of 186) have even the highest level of financial literacy (see Table 8 in Appendix B). Participants are best at compounding - 86% answered correctly (see Table 7 in Appendix B). 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 1 shows that the proportion of regular savers is lower among the 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 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 depending on financial literacy. Savings behavior is a binary variable - participants either save money regularly or not. Financial literacy is an ordinal variable with 0 and 3 for the lowest and the highest score, respectively. The score is built on the number of correct answers provided to the three questions addressing compounding, inflation, and diversification, respectively. These questions are available in Appendix A.

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. In the second step, we use the indifference points to calculate the corresponding annual implicit interest rates.

In Panel A of Table 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 keeping on saving 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 presents the average annual implicit interest rates that are based on the indifference points reported in Panel A. Consequently, the average implicit interest rates are lower in the Ascending condition than the corresponding ones in the Descending condition.

Table 2: Average indifference points and 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: **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 annual implicit interest rates. There are two anchoring conditions - Ascending versus Descending - and two amounts of savings - $500 versus $20,000. Five time horizons are considered - 6 months, 1, 2, 5, and 10 years.

Figure 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 assumes a *reverse* magnitude effect. We conduct a paired t-test for mean comparison in annual implicit interest rates between low and high amounts for each time horizon. Table 3 reports the results, in Panel A for the Ascending condition and in Panel B for the Descending condition. In both anchoring conditions, the difference between annual implicit interest rates for 6 months, 1, 2, 5 and 10 years is negative and significant at the %1 level. These univariate findings reveal a *conventional* magnitude effect in both anchoring conditions - average annual implicit interest rates are significantly lower for the high amount of savings. This evidence does not bring support to our first hypothesis.

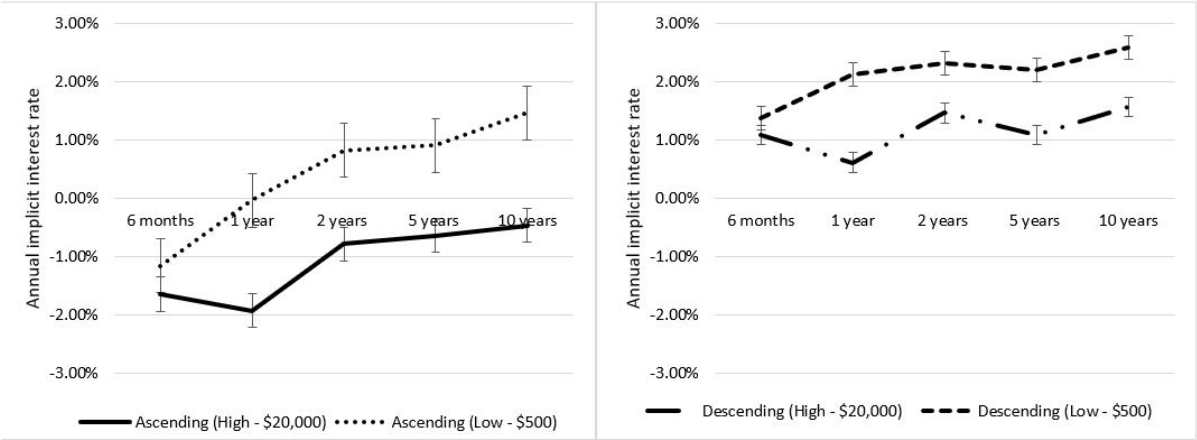


Figure 4: Average annual implicit interest rates

.

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

Table 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 average annual interest rates related to both high and low amounts, 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 the anchoring bias (and/or the satisficing behavior), average annual implicit interest rates are expected to be lower in the Ascending condition, compared to the corresponding ones in the Descending condition. Table 4 reports the results of a two-sample t-test addressing the differences in average annual implicit interest rates between the two anchoring conditions. In the Ascending condition, for both high and low amounts, annual

implicit interest rates are always significantly lower than 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 4, the proportion of decisions that tolerate NIR is higher in the Ascending condition (54.89%) than in the Descending condition (20.95%). The details regarding acceptance of NIR, i.e. how many decisions where participants keep on savings with NIR, are provided in Appendix C.

Table 4: Differences in average annual implicit interest rates - anchoring bias

	Time Horizon				
Condition	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 average annual implicit interest rates for high and low amounts separately, the corresponding t-value and p-value. Panel A focuses on the differences in annual implicit interest rates for the high amount of savings while Panel B refers to the low amount of savings.

4.3 Tolerance to NIR

To address the tolerance to NIR, 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 include both individual-varying and decision-varying variables. Individual-varying variables are age, gender, savings behavior, financial literacy, and the anchoring condition. Gender is defined as a binary variable ($Gender_i$), which is set to one for men. Savings behavior is captured by a binary variable ($Regular_saver_i$), which is equal to one for participants who are regular savers. Financial literacy is also 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.[17] To control for the anchoring condition, we use an additional binary variable ($Ascending_group_i$) set to one for

[17] We also estimate the logit model wherein we replace the binary variables for financial literacy by compounding, which is coded as a dummy variable 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 get overall similar findings (available upon request).

participants in the Ascending condition. Time horizon and amount of savings are the two decision-varying variables. Time horizon is included using four binary variables ($D_Year_1_{i,d}$, $D_Year_2_{i,d}$, $D_Year_5_{i,d}$, $D_Year_10_{i,d}$) set to one when time horizon is 1, 2, 5, and 10 years, respectively. The amount of savings is also coded as a binary variable ($High_amount_{i,d}$), which 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 10 in Appendix D). Since we deal with panel data (ten decisions per participant, across 186 participants), we cluster standard errors by participant (Petersen, 2009) when estimating the resulting model :

$$\begin{aligned} TTNIR_{i,d} = \beta_0 + \beta_1 Age_i + \beta_2 Gender_i + \beta_3 D_Year_1_{i,d} + \beta_4 D_Years_2_{i,d} + \beta_5 D_Years_5_{i,d} + \\ \beta_6 D_Years_10_{i,d} + \beta_7 Ascending_group_i + \beta_8 High_amount_{i,d} + \beta_9 Regular_saver_i \\ + \beta_{10} D_Low_literacy_i + \beta_{11} D_High_literacy_i + \beta_{12} D_Highest_literacy_i + \epsilon_{i,d} \end{aligned} \tag{1}$$

Table 5: Tolerance to NIR

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 1). The set of explanatory variables include 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, D_Year_10 are binary variables set to one when 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. $High_amount$ 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. $D_Low_literacy$, $D_High_literacy$, $D_Highest_literacy$ are binary variables set to one when financial literacy is low, high, and the highest, respectively. ***, **, * 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 5 presents the results for two versions of the above logit model. Our baseline model (Model 1) includes the aforementioned independent variables. Focusing on decision-varying variables, the tolerance to NIR is negatively related to both the amount of savings and time horizon, at the 1% level (except for the 1-year horizon). When the amount of savings is high, the tolerance to NIR is less likely, compared to when the amount of savings is low. All things being equal, the odds of a decision accepting NIR decreases by about 44% when the amount of savings is high. In other words, the higher the amount at stake, the lower the tolerance to NIR. This finding is consistent with the *reverse* magnitude effect in our first hypothesis. For the four time horizons (1, 2, 5, and 10 years), the likelihood to tolerate NIR is lower, compared to the 6-month horizon. The odds of a decision accepting NIR decreases when time horizon increases. More precisely, compared to the 6-month horizon, the odds of a decision accepting NIR on savings is multiplied by a factor of 0.9974 (i.e. decreases by 0.26%) when time horizon is 1 year. For a 10-year horizon, the odds of a decision tolerating NIR on savings is multiplied by a factor of 0.3655 (i.e. decreases by 63.45%). Shorter horizons are then associated with a higher tolerance to NIR, compared to longer horizons. This result supports our second hypothesis.

Looking at individual-varying variables, the results for both the anchoring condition and the savings behavior are statistically significant. As far as the anchoring condition is concerned, our hypothesis is confirmed. Participants in the Ascending condition are much more likely to tolerate NIR, compared to participants in the Descending condition. The odds of accepting NIR on savings is higher by a factor of 4.9990 in the Ascending condition, compared to the Descending condition. This strong result is consistent with the anchoring effect. Alternatively, it might also be consistent with the satisficing behavior, i.e. participants are more likely to tolerate NIR in the Ascending condition because NIR are presented first. Regular savers are more likely to tolerate NIR than non-regular savers, which confirms our third hypothesis built on the status quo bias. The odds of a participant tolerating NIR on savings increases by 67.44% when he/she is a regular saver. We find no significant results for financial literacy, which brings no support for our fourth hypothesis. Age and gender are usual control variables. We know from the literature that younger people are more likely to save, compared to middle-aged individuals (Heckman and Hanna, 2015), and that the latter save little compared to the older generations who oversave (Furnham and Argyle, 1998). As for gender, previous evidence suggests that women save less than men (Ohlund, 2017). We find however no significant relationship between either age or gender and the tolerance to NIR on savings.

Our hypothesis about the *reverse* magnitude effect formulates 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 5. The interaction variable exhibits a negative coefficient at the 5% level. The relationship between the amount of savings and the tolerance to NIR depends on the anchoring condition. When the amount is high, the likelihood to accept NIR is lower in the Ascending condition, compared to the Descending condition. This is consistent with a stronger *reverse* magnitude effect in the Ascending condition. The odds of tolerating NIR decreases by 36.30% for the high amount of savings if a participant is in the Ascending condition.

4.4 Heterogeneity in annual implicit interest rates

As a side analysis, we investigate heterogeneity in annual implicit interest rates with an OLS regression, in the Ascending and the Descending conditions separately. For that purpose, we estimate two models wherein the dependent variable is the annual implicit interest rate associated with a given decision[18] and the set of independent variables is the same as in our baseline logit model (see Model 1 in Table 5), except the anchoring condition. Table 6 provides the results with clustered standard errors 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 the annual implicit interest rate. This finding supports our first hypothesis. In addition, the marginal effect appears stronger in the Ascending condition as expected. As 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 6-month horizon. The increase is about 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 time horizon in the Descending condition, but the corresponding coefficient estimates are weaker. These results bring support to our second hypothesis. When participants are regular savers, 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 about the status quo bias. As for financial literacy, the results are again not statistically significant. In line with our previous findings, we also find no significant results for age and gender.

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

Table 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 either -4, -3, -1, 1, 3, or 4%. The set of explanatory variables include 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, D_Year_10 are binary variables set to one when 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. $D_Low_literacy$, $D_High_literacy$, $D_Highest_literacy$ are binary variables set to one when financial literacy is low, high, and the highest, respectively. ***, **, * indicate significance at 1%, 5%, and 10%, respectively. N gives the number of observations. Standard errors are clustered by participant.

5 Conclusion

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

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

We extend the previous literature by relating the tolerance to NIR to savings behavior, financial literacy, and the anchoring bias. Regular savers are more likely to tolerate NIR than non-regular savers, which is consistent with the status quo bias. As for the anchoring effect, we find a higher tolerance to NIR on savings when par-

ticipants are anchored towards NIR on savings first (Ascending condition). We find no significant results for financial literacy.

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 NIR. Our findings indeed confirm that people may be ready to keep on saving money (instead of spending it), even if this makes them lose some money for sure. This is an important finding for policymakers and banks, when considering the implementation of NIR on bank deposits. Our results provide relevant insights about some important factors (amount of money at stake, time horizon), conditions (facing first NIR versus PIR), or individual characteristics (savings behavior, financial literacy) that can affect this propensity. When interest rates are very low or already negative, the tolerance to NIR is more likely to increase. Large and small depositors should be treated differently, since small depositors appear more likely to tolerate NIR on savings. Different treatments could also fit to regular and non-regular savers, since the latter less likely to tolerate NIR.

Our experimental findings, as ecologically valid they may be, cannot entirely reflect the dynamics and complexity of individual savings behaviors in reality. In particular, one shortcoming might be that participants face a binary option in our setting, i.e. keep on saving money or spend it immediately (on goods and/or services). We do not propose other alternatives, like investing in the stock market or reimbursing existing debts. Such possible extensions are considered for further research.

Appendices

A 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

B Financial literacy - Statistics

Table 7: Financial literacy by each component

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

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

Table 8: 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 depending on their financial literacy score. Computed using the questions presented in Appendix A, the latter is an ordinal variable, with four levels: 0 - the lowest level of financial literacy, 1 - low level of financial literacy, 2 - high level of financial literacy, and, 3 - the highest level of financial literacy.

C Acceptance of NIR

Table 9: Acceptance of NIR

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

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

D Correlations

Table 10: Spearman Correlation

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). Time horizon is can be either 6 months (expressed in years - 0.5), 1, 2, 5, and 10 years. The anchoring condition is a binary variable set to one for the Ascending condition (and to zero 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 - the lowest level of financial literacy, 1 - low level of financial literacy, 2 - high level of financial literacy, and, 3 - the highest level of financial literacy. Annual implicit interest rate is a discrete numerical variable that can take either -4, -3, -1, 1, 3, or 4%. ***, **, * indicate significance at 1%, 5%, and 10%, respectively.

References

Agarwal, R. and M. Kimball (2015). Breaking through the Zero Lower Bound. Technical report, IMF Working Paper WP/15/224. Washington: International Monetary Fund, October.

Ainslie, G. and N. Haslam (1992). Hyperbolic discounting. In G. L. . J. Elster (Ed.), *Choice over time*, pp. 57–92. New York, NY, US: Russell Sage Foundation.

Aizenman, J., E. Cavallo, and I. Noy (2015). Precautionary strategies and household saving. *Open Economies Review 26*(5), 911–939.

Altavilla, C., L. Burlon, M. Giannetti, and S. Holton (2019). Is there a zero lower bound? The effects of negative policy rates on banks and firms. ECB Working Paper.

Anantanasuwong, K. (2019). How Financial Literacy Impacts Retirement Savings: The Role of Present Bias and Exponential Growth Bias. *Available at SSRN 3364781.*

Baars, M., H. Cordes, and H. Mohrschladt (2019). How Negative Interest Rates Affect the Risk-Taking of Individual Investors: Experimental Evidence. *Finance Research Letters* (in press, available online).

Block, W. E. (1978). The Negative Interest Rate: Toward a Taxonomic Critique. *Journal of Libertarian Studies 2*(2), 121–124.

Bracha, A. (2016). Investment Decisions and Negative Interest Rates. *Federal Reserve Bank of Boston Working Paper* (No. 16-23).

Breuer, W., C. K. Soypak, and B. I. Steininger (2018). Conventional or Reverse Magnitude Effect for Negative Outcomes: A Matter of Framing. *Available at SSRN 2176784*.

Brown, B. (2018). Negative Interest Rates and the War Against Cash. In *The Case Against 2 Per Cent Inflation*, pp. 149–163. Springer.

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

Efendic, E., C. D'Hondt, R. De Winne, and O. Corneille (2019). Moderating Factors of People's Tolerance for Negative Interest Rates. Working paper.

Europe (2019). European Commission, Directorate-General for Economic and Financial Affairs. *European economic forecast: Spring 2019*.

Fisher, I. (1930). *Theory of interest: as determined by impatience to spend income and opportunity to invest it*. Augustusm Kelly Publishers, Clifton.

Furnham, A. and M. Argyle (1998). *The psychology of money*. Psychology Press.

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

Hardisty, D. J., K. C. Appelt, and E. U. Weber (2013). Good or bad, we want it now: Fixed-cost present bias for gains and losses explains magnitude asymmetries in intertemporal choice. *Journal of Behavioral Decision Making 26*(4), 348–361.

He, P., L. Huang, and R. Wright (2008). Money, banking, and monetary policy. *Journal of Monetary Economics 55*(6), 1013–1024.

Heckman, S. and S. D. Hanna (2015). Individual and institutional factors related to low-income household saving behavior. *Journal of Financial Counseling and Planning 26*(2).

Hong, G. and J. Kandrac (2018). Pushed Past the Limit? How Japanese Banks Reacted to Negative Interest Rates. *IMF Working Paper 18/131*.

Itzkowitz, J., J. Itzkowitz, and S. Rothbort (2015). ABCs of trading: Behavioral biases affect stock turnover and value. *Review of Finance 20*(2), 663–692.

Kahneman, D. and A. Tversky (1979). Prospect theory: An analysis of decision under risk. *Econometrica 47*(2), 363–391.

Kimball, M. S. (2015). Negative interest rate policy as conventional monetary policy. *National Institute Economic Review 234*(1), R5–R14.

Lahav, E., M. Rosenboim, T. Shavit, et al. (2015). Financial literacy's effect on elicited subjective discount rate. *Economics Bulletin 35*(2), 1360–1368.

Lian, C., Y. Ma, and C. Wang (2018). Low Interest Rates and Risk-Taking: Evidence from Individual Investment Decisions. *The Review of Financial Studies 32*(6), 2107–2148.

Lilley, A. and K. Rogoff. The Case for Implementing Effective Negative Interest Rate Policy. *Strategies for Monetary Policy*.

Lord, R. A. (1984). The Legal History of Safekeeping and Safe Deposit Activities in the United States. *Ark. L. Rev. 38*, 727.

Lugilde, A., R. Bande, and D. Riveiro (2019). Precautionary Saving: A Review of the Empirical Literature. *Journal of Economic Surveys 33*(2), 481–515.

Lusardi, A. (2008). Household saving behavior: The role of financial literacy, information, and financial education programs. Technical report, National Bureau of Economic Research.

Lusardi, A. and O. S. Mitchell (2011). Financial literacy around the world: an overview. *Journal of pension economics & finance 10*(4), 497–508.

Maggio, M. D. and M. Kacperczyk (2017). The unintended consequences of the zero lower bound policy. *Journal of Financial Economics 123*(1), 59 – 80.

Meier, S. and C. D. Sprenger (2013). Discounting financial literacy: Time preferences and participation in financial education programs. *Journal of Economic Behavior & Organization 95*, 159–174.

Merrigan, P. and M. Normandin (1996). Precautionary saving motives: an assessment from UK time series of cross-sections. *The Economic Journal 106*(438), 1193–1208.

Musch, J. and U.-D. Reips (2000). A brief history of Web experimenting. In *Psychological experiments on the Internet*, pp. 61–87. Elsevier.

Ohlund, S. (2017). Why Can't a Woman Invest More Like a Man? Gender Differences in Investment Behaviour. *Gender Differences in Investment Behaviour (March 14, 2017)*.

Peer, E., L. Brandimarte, S. Samat, and A. Acquisti (2017). Beyond the Turk: Alternative platforms for crowd-sourcing behavioral research. *Journal of Experimental Social Psychology 70*, 153–163.

Petersen, M. A. (2009). Estimating standard errors in finance panel data sets: Comparing approaches. *The Review of Financial Studies 22*(1), 435–480.

Read, D., S. Frederick, and M. Scholten (2013). DRIFT: An analysis of outcome framing in intertemporal choice. *Journal of Experimental Psychology: Learning, Memory, and Cognition 39*(2), 573.

Robles, E. and P. A. Vargas (2007). Functional parameters of delay discounting assessment tasks: Order of presentation. *Behavioural processes 75*(2), 237–241.

Samuelson, W. and R. Zeckhauser (1988). Status quo bias in decision making. *Journal of risk and uncertainty 1*(1), 7–59.

Stix, H. (2013). Why do people save in cash? Distrust, memories of banking crises, weak institutions and dollarization. *Journal of Banking & Finance 37*(11), 4087–4106.

Thaler, R. (1980). Toward a positive theory of consumer choice. *Journal of Economic Behavior & Organization 1*(1), 39–60.

Thaler, R. (1981). Some empirical evidence on dynamic inconsistency. *Economics letters 8*(3), 201–207.

Tversky, A. and D. Kahneman (1974). Judgment under uncertainty: Heuristics and biases. *science 185*(4157), 1124–1131.

Urminsky, O. and G. Zauberman (2015). The psychology of intertemporal preferences. *The Wiley Blackwell handbook of judgment and decision making 2*, 141–181.

Zauberman, G. and J. G. Lynch Jr (2005). Resource slack and propensity to discount delayed investments of time versus money. *Journal of Experimental Psychology: General 134*(1), 23.