

Negative interest rates and saving: an empirical analysis

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Abstract

With the interest rate levels decreasing to a lower level than ever before, research about the economic consequences of this becomes indispensable. In this thesis, I investigate the effect of the interest rate on the savings behaviour of consumers. I found that consumers mainly base their savings decisions on the nominal interest rate instead of the real interest rate. This collides with the standard economic assumption of rationality. Second, I found that it is possible to diminish the influence of the nominal interest rate on savings decisions by providing information about the importance, meaning and computation of real interest rates. Also, I found that consumers act loss averse in the case of a negative interest rate. Once the interest rate drops slightly below zero, consumers solidly decide to withdraw money from their bank accounts and keep it at home. An unfavourable situation, not only for the economy, but also regarding the huge personal financial risks attached to storing money at home.

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1. Introduction

In the summer of 2019, it was the front-page story in the Netherlands: a private bank lowered the interest rate on private savings to beneath 0%. For the time being only for wealthy individuals who own more than 2.5 million euros, but this was enough to kindle a national debate about the possible effects and the undesirability of a negative interest rate for consumers.

While I will not dwell on the cause of this low interest rate, fact is that the decline in interest rates is expected to continue and that economists predict that also the less rich may have to deal with a negative savings interest rate in the future.

In the news, there has been much speculation on the effect of a negative interest rate on the savings behaviour of consumers. Consumers would, for example, leave their bank, invest all their savings in (risky) projects or would even keep their savings in cash under their mattress. These different scenarios made me curious to know what would really happen. Therefore, my thesis has the following research question:

“What is the effect of the savings interest rate on the savings behaviour of consumers?”

I am especially interested in the trade-off between saving and spending and in whether people decide to keep cash at home in case of a negative interest rate. Based on current economic literature and theory about savings and consumer behaviour, I formulated the following hypotheses:

Hypothesis 1: Without information provision, consumer behaviour responds more strongly to the nominal interest rate compared to the real interest rate.

Hypothesis 2: Information provision about real interest rates induces consumers to make more rational decisions regarding their assessment of whether to spend versus save.

Hypothesis 3: If the nominal interest rate falls only slightly below zero, consumers react strongly by solidly willing to withdraw money from their savings account and store it at home.

These hypotheses will be tested by means of a survey experiment. In this survey, I ask questions about the (intended) savings behaviour of consumers as a result of different interest and inflation rate scenarios that I provide.

The structure of this thesis is as follows. First, I describe the theoretical framework on which my research is based. Thereafter, I discuss my hypotheses. Then, the set-up of the experiment is considered and thereafter the results of the experiment. The thesis closes with a conclusion on the main findings, a discussion of the results and suggestions for further research.

2. Theoretical framework

This chapter starts with a definition of the main concepts that I use in this thesis. Thereafter, I discuss the theories that form the foundation of my experiment. The chapter closes with a summary of the literature in the field of savings behaviour of consumers.

2.1. Concepts: interest rates, inflation, saving

2.1.1. Interest rate

One of the central concepts in this thesis is the interest rate. Because banks use many ways to calculate and to pay out interest, I decided to explicitly formulate the definition of interest rate that is used in my thesis. If in this thesis a nominal interest rate of 2.0% is mentioned, this signifies a 2.0% yearly nominal interest rate on an instant access savings account. In the survey, I clearly indicate this to the survey participants to make sure they have the same definition in mind.

In addition, I informed participants in the treatment group about how to calculate the real interest rate based on the inflation and nominal interest rates. I did this in a slightly simplified manner, namely by subtracting the inflation rate from the nominal interest rate (Fisher, 1930):

$$\textit{real interest rate} = \textit{nominal interest rate} - \textit{inflation rate}$$

This formula only holds for small nominal interest and inflation rates. Because in this survey experiment the rates are small enough, this is not a problem. In the remainder of this thesis, the real interest rate will be calculated using this formula.

2.1.2. Inflation

I explained the concept of inflation to the survey participants in the following way: “The inflation is the rate at which the average price level in the economy increases. If the inflation level is 2.0%, the average prices of all goods and services increase at a rate of 2.0% per year. This means that every year, your savings will buy a 2.0% lower quantity of goods.” In the remainder of this thesis, I use this same definition of inflation (Burda & Wyplosz, 2013).

2.1.3. Saving

In my thesis I used the Keynesian definition of saving: saving is the amount of income that you do not spend: $S = Y - C$ (Keynes, 1936). This means that I assume that income is either spent on consumption or saved.

2.2. Theories: money illusion and loss aversion

In this chapter, I will discuss the economic theories that lay the foundation for my survey experiment.

2.2.1. Money illusion

The term 'money illusion' is invented by economist Irving Fisher. He discovered that a lot of people mistakenly think of money in nominal instead of real terms (Fisher, 1928). As a result, people confuse the nominal value of money with the real value. The real value determines the quantity of goods that people can purchase with their money.

Diamond, Shafir & Tversky (1997) further investigated this phenomenon. They performed a survey experiment to examine the reaction of people to variations in inflation and prices. They found that people often evaluate economic decisions in both real and nominal values, but that the nominal value predominates. The interaction between these two evaluations causes a bias towards a nominal evaluation. Next to that, the researchers discovered that in situations in which economic terms are emphasized, respondents reacted more strongly to the real, rather than the nominal value.

Thaler & Benartzi (2004) designed a savings program in which they tried to incentivize workers to save a larger proportion of their income. They did this by letting people agree upfront to dedicate a part of their scheduled wage increase to the savings program. The researchers discovered that workers experience increases in their income in nominal dollars. This increased the willingness to take part in the savings program, because the nominal increase in income is usually above the real increase. This outcome supports the findings of Fisher and of Diamond et al. that people often think of money in nominal instead of real terms.

In my thesis, I used the theory on money illusion for the design of my experiment. I want to investigate whether people also suffer from money illusion when making decision based on interest rates, instead of monetary values. The finding that emphasising economic terms might mitigate the effects of money illusion incited me to incorporate an emphasis on economic terms in my survey experiment (the treatment). I will examine whether this treatment diminishes the effect of the level of the nominal interest rate and therefore the money illusion.

2.2.2. Loss aversion

Loss aversion, as discovered by Kahneman & Tversky (1991), means that people weigh losses more heavily than gains. This means that losses of equivalent magnitude are more painful than the satisfaction of a gain of the same size yields.

According to the theory of loss aversion, whether something is regarded as a gain or a loss is dependent on a reference point. Usually, this point is someone's current assets, but it can also be someone's expectations or aspirations of future wealth. When the reference point is someone's current assets, putting away an item is regarded as a loss, while acquiring something new is regarded as a gain.

Since utility functions are concave, the marginal utility of an additional unit of wealth diminishes. This already means that a loss causes more utility loss than an equivalent gain yields so that losses weigh more heavily than gains. Kahneman & Tversky discovered that the utility function shows a kink at the reference point. This means that a loss from this reference points leads to a large decrease in utility, while a gain from this reference point yields only a small increase in utility.

What does this theory have to do with negative interest rates? A nominal interest rate of 0% could act as a natural reference point. Interest rates below this point will then be perceived as a loss by consumers, and they will find a negative interest rate of 1% more painful than that they are satisfied by a positive interest rate of 1%.

The term 'loss aversion' is part of a more elaborate theory on how people deal with decisions under uncertainty: the prospect theory (Kahneman & Tversky, 1979). According to this theory, as a result of loss aversion, people become risk-seeking if they face losses with high probabilities.

A negative interest rate on savings is an example of a loss with a high probability and might therefore elicit risk-seeking behaviour by consumers. Consumers could start taking excessive risks with their savings in order to avoid the negative interest rate, for example by investing all their money in stocks and shares or keeping money at home. Both choices bear the risk of losing all money or investments.

Another concept within the prospect theory is 'diminishing sensitivity'. This means that the sensitivity of people to gains and losses decreases once these gains or losses are higher. For example, an additional loss of 10 euros from a bank account with a balance of -100 euros to -110 euros is perceived as less bad than the same loss from -1 euro to -11 euros.

Both concepts of diminishing sensitivity and reference points indicate that information provision about real interest rates increases the quality of the savings decisions of consumers. The effect of the information provision works in two ways. First, as a result of the information provision, people realize that they have to focus on the level of the real instead of nominal interest rate. This possibly changes the reference point from 0% nominal interest rate to 0% real interest rate. Second, as a result of the information provision, people realize that the real interest rate is already negative, and thus, that they

are already facing a loss (the negative interest rate). Due to diminishing sensitivity, the informed people react less strongly to the additional loss compared to the uninformed people in the survey.

2.3. Literature

In this chapter, I look at the existing economic literature on the effect of a negative savings interest rate. The possibility of a negative interest rate is something new. In most economic literature and models, this scenario is not incorporated. As a result, my thesis and experiment are mainly based on economic theory and not so much on existing empirical literature in this field. In this chapter, I will summarize the literature that forms the foundation of my analysis.

2.3.1. Intertemporal choice

To implement the economic theories into my survey experiment and to carefully design the survey, I developed a theoretical model. In this model, I tried to predict the survey responses of my survey participants on the base of economic literature and theories. The theory that forms the foundation of my model is the intertemporal choice model. This model is developed by the economist Irving Fisher (1930).

The intertemporal choice model describes consumption decisions of people at different points of time. The decisions at the current point of time influence the possibilities at future points of time. For example, if someone decides to save 10 euros in year 1, then this increases his spending power in year 2 by 10 euros plus interest. If someone decides to spend all his money in year 1 and borrow 10 euros, then his budget in year 2 is his income in year 2 minus his loan from year 1 and interest.

According to the theory, if a perfectly rational person faces a trade-off between consuming now and consuming later (saving), he looks at both the nominal interest rate and inflation. The nominal interest rate tells him how much interest he receives if he decides to save part of his income for later. The inflation tells him about the increase in prices and what the quantity of goods is that he can buy with his money in the next period.

One of the most important assumptions of the intertemporal choice model is that people are rational. This means that people make consistent and informed decisions that benefits them the most. This idea can be traced back to Adam Smith (1846). For example, the intertemporal choice model assumes that decisions of consumption levels at different periods of time are not influenced by (irrelevant) external factors. This is a strong assumption and does not always hold in the real world. For example, Li (2007) found out that people decided to save less (and consume more in the current period) when they are shown pictures of desserts.

Corneille et al. (2020) used the temporal choice model as a framework for their research. They presented survey participants different binary choice sets which contained a possibility to receive an amount x now or an amount $x + y\%$ later. The researchers investigated to what extent people tolerate a negative y , and via that way, they tried to get an idea of how strong people react to a negative interest rate on their savings.

Corneille et al. found that the willingness to tolerate a negative interest rate on savings depends on the level of savings, where a higher level of savings leads to a lower tolerance for negative interest rate. Also, the individual savings behaviour (irregular savers are less willing to bear a negative interest rate) and the time span (the shorter, the more tolerant) has an effect on the tolerance to a negative interest rate.

2.3.2. Prospect theory

Another opposition of the rationality assumption was found by Kahneman and Tversky (1979) in their prospect theory. The prospect theory models decision-making under uncertainty. In the previous chapter I explained that this theory gives predictive deviations from the rationality assumption, for example by stating that people are loss averse and have a diminishing sensitivity to gains and losses. The prospect theory is still authoritative in economic literature on decision-making.

2.3.3. Money illusion

The prospect theory is not the only systematic deviation on rational decision-making. Fisher (1928) discovered in his paper about money illusion that a lot of people mistakenly think of money in nominal instead of real terms.

In 1997, Diamond, Shafir and Tversky conducted an experiment to learn more about the underlying psychological process of money illusion. By examining the reactions of people to variations in inflation and prices, they found that people often evaluate economic decisions in both real and nominal values. It is the interaction between these two evaluations that causes a bias towards a nominal evaluation. The researchers also found that in situations in which economic terms are emphasized, respondents look at the real, rather than nominal value.

The experiment of Diamond, Shafir and Tversky gave more insight into the underlying psychological processes of money illusion. According to the authors, one important part of this psychological process is framing. This means that the way possible outcomes are presented influences the decision of individuals.

Framing was introduced by McNeil et al. (1988). They discovered it by conducting an experiment in which they presented different treatment options for lung cancer to experiment participants. The possible outcomes were stated in terms of mortality rate or in survival rate. The experiment showed that people made different treatment decisions, based on the way the possible outcomes are presented.

Diamond, Shafir and Tversky applied these results to the phenomenon of money illusion. They state that money illusion is mainly the result of two different frames. Nominal values are easier to understand and are often adequate for the short term, whereas real monetary values are more complicated but necessary to find out the true value of a transaction. In general, people are aware that they need to look at the real value of a transaction. Yet, because people often operate on a short-term basis and because the nominal value is easier to understand, people mainly take the nominal values into account, while knowing at the back of their mind that they should also do 'something' with the real values. As a result, both frames mix and result in a bias in the assessment of true values of transactions: money illusion.

While the theory of money illusion was first only applied to monetary values, Wilcox (1990) investigated whether this theory also holds when assessing different levels of interest rates. Wilcox finds empirical evidence that consumers look at nominal instead of real interest rates when deciding about their level of expenditure.

One explanation that the author provides is that consumers face the nominal interest rate as a constraint if they want to spend more money than they currently have. Borrowing money is against nominal interest rates. As a result, the attention of consumer is strongly drawn towards the nominal interest rate.

2.3.4. Economic forecasts

Not only behavioural characteristics influence the way people make financial decisions. Roth and Wohlfart (2018) investigated the effects of macroeconomic outlooks on economic behaviour and expectations. They did this by conducting an online survey experiment. Participants receive different forecasts that estimate the probability of an economic recession. There are two different types of the survey: 'high recession treatment' and 'low recession treatment'.

Roth and Wohlfart found that respondents take the macroeconomic forecasts into account when deciding about their consumption levels. Also, consumers update their beliefs about their financial situation in the future as a result of the forecast. People who received the more negative forecast about the economy decided for example to limit their spending on non-durable goods. This

experiment shows that people adjust their financial decisions based on economic information provided in online surveys.

Coibion, Gorodnichenko and Ropele (2018) examined the causal effect of inflation expectations on firms' economic decisions. They informed a randomly selected half of the surveyed firms about the current inflation rate. The other group did not receive this information. The researchers found that the inflation expectations between both groups differ, and that this influences firms' economic decisions. Firms with higher inflation expectations increase their prices, have a higher credit demand and reduce their workforce. This shows that providing objective and publicly available information about the economy (in this case the inflation rate) drastically influences the economic decision of people.

2.3.5. Lower bound on interest rates

With the ongoing decrease of interest rates, the public became more and more critical about the course of the European Central Bank. One important argument for maintaining a low interest rate is that it is believed to stimulate economic growth. However, Brunnermeier and Koby (2016) warn for a very low interest rate. They found that the positive economic effects are being reversed once the interest rate drops below a certain level: the lower bound.

The lower bound is the smallest interest rate that the central bank can set before the economy enters a liquidity trap. A liquidity trap is a situation in which savings rates are high, in combination with low interest rates, but that this combination does not lead to an increase in aggregate demand. As a result, monetary policy that was aimed at stimulating demand by increasing the money supply becomes ineffective (Buera et al., 2014 and Keynes, 1936). The lower bound is the lowest effective interest rate in which monetary policy is still effective.

According to Brunnermeier and Koby, the cause of the reversed effect of a low interest rate is the banking sector. Because of the low interest, the gap between interest income and the amount of interest paid out by banks or other financial institutions (the net interest margin), becomes too small to justify the extra risk that borrowing money involves. As a result, banks become more reluctant to lend money. This has a negative effect on the economy.

2.3.6. Image of the banking industry

When the news about the possible negative interest rate on private savings became public, a heated national debate started. Bankers were accused of being greedy and dishonest and banks quickly became one of the least trusted companies. Cohn, Fehr, Maréchal (2014) investigated the business culture and the degree of honesty in the banking industry. They did a surprising finding.

The researchers conducted an experiment. Participants had to toss coins and report the outcome of the toss. For every head, they received a small fee. There was no supervision during the tossing of the coins and the reporting of the outcome. However, after the experiment was done the researchers could retrieve the honesty of each group, because the probability of getting heads was always the same.

Participants were divided into three groups: bankers, non-bankers and students. Part of these participants were reminded of their professional identity (that they were a banker or practised another profession). The researchers found that the group with bankers were on average more honest compared to the other two groups. However, when bankers got reminded of their professional identity, they became on average the least honest. This means that it might not especially be the bankers itself, but more their environment and business culture that make bankers in some circumstances more susceptible to deceit. The authors state that re-establishing an honest culture in the banking sector is very important.

3. Hypotheses

In this chapter, I introduce my hypotheses about the effects of the savings interest rate on the savings behaviour of consumers.

3.1. Hypothesis 1: Nominal interest rate is most important

Hypothesis 1: Without information provision, consumer behaviour responds more strongly to the nominal interest rate compared to the real interest rate.

When deciding about how much money to spend or save, rational consumers look at the real interest rate. This way, they take into account the fact that the value of money decreases over time due to inflation. However, according to the theory of money illusion from Fisher (1928), most consumers think in terms of nominal values rather than real values. With this hypothesis, I test whether this is also the case for the savings decisions of consumers.

I expect that the survey participants in the control group solidly change their savings decision when moving from scenario 1 to scenario 2. Since the only difference between the two scenarios is the nominal interest rate and inflation rate (and the resulting real interest rate is constant), a change in savings decision would show an increased sensitivity to the nominal interest rate and will point towards money illusion.

3.2. Hypothesis 2: Information provision induces more rational decisions

Hypothesis 2: Information provision about real interest rates induces consumers to make more rational decisions regarding their assessment of whether to spend versus save.

With this hypothesis, I test whether the information provision to the treatment group about the difference between real and nominal interest rates influences their decision about whether to spend or save. I expect that survey participants in the treatment group react less strongly to changes in the nominal interest rate (while the real interest rate does not change) compared to participants in the control group.

3.3. Hypothesis 3: Strong reaction to interest rates below zero

Hypothesis 3: If the nominal interest rate falls only slightly below zero, consumers react strongly by solidly willing to withdraw money from their savings account and store it at home.

This hypothesis tests whether the theory of loss aversion from Kahneman & Tversky (1991) applies to situations in which consumers face negative interest rates on savings. I expect that this is the case and that participants solidly choose to store money at home, even if the interest rate becomes only slightly negative.

4. Experiment

In this chapter, the experiment set up and the calculation of the minimum sample size is being discussed.

4.1. Survey set up

The experiment is set up as follows. I designed an online survey based on my hypotheses and theoretical model. The survey is carried out online and the link to the survey is shared via social media networks such as WhatsApp, LinkedIn and Facebook. There are no restrictions on who can fill out the survey. Participants can interrupt filling out the survey and continue at another moment, as long as this is within one week of answering the first question. It is not possible to complete the survey twice.

The survey starts with introductory questions about household composition, education level of the participant and savings behaviour. Participants could indicate that they either have (a) no savings, (b) saved a minimal amount to use in case of emergency or (c) more savings than needed in case of emergency. In case a survey participant does not have savings, the survey tries to identify whether

this is a conscious decision. The participants that indicated to have savings are requested to indicate what type of savers they are. They can either state that they (a) save a fixed amount on a regularly basis or (b) save irregularly (for example, only in case of a financial windfall).

After the questions about savings behaviour, participants proceed to questions about interest rates and inflation. This is still before intervention. Participants are asked what the level of nominal interest rate on their instant access savings account is, or, in case they do not have money stored on this type of account, what they think the nominal interest rate on an instant access savings account is. After that, participants are asked to estimate the current inflation rate (average increase in prices) in the Netherlands. These introductory questions are being asked to test whether the treatment and control group differ already before the intervention.

After the introductory questions, participants are randomly divided into two groups: a treatment group and a control group. The treatment group receives an elaborate explanation about the difference, importance and way of calculating the real interest rate. This explanation is supported by several graphs and examples.

The explanation starts with an illustration of how the account balance of a savings account develops over time and how the nominal interest rate affects this balance. It is then emphasized that what you can buy with your money (the real value) is more important than the level of the account balance. The real value is dependent of inflation, the rate at which the average price level in the economy increases.

Thereafter, participants are shown a formula on how to calculate the real interest rate based on the nominal interest rate and inflation. Some examples are being shown in which the inflation rate and nominal interest rate change, but the real interest rate stays (as a result) the same. It is emphasized that when estimating the development of the value of savings it is important to always consider both the nominal interest rate and the inflation.

The control group does not receive this elaborate introduction, but only receives a short explanation on how the account balance of a savings account develops over time and how the nominal interest rate affects this balance. This explanation is added to make sure that both groups (treatment and control) have the same definition of nominal interest in mind.

After the elaborate introduction for the treatment group and the short introduction for the control group, the main part of the survey starts. This part is exactly the same for both groups. Participants are presented two scenarios. In the first scenario, the average nominal interest rate increases from 0.1% to 2.0% per year and the inflation rate increases from 2.6% to 4.5% per year. Participants are

asked how they would adjust their savings decision a result of these changes. Options are: (a) I am going to spend more (and save less), (b) I am not going to change how much money I spend or (c) I am going to spend less (and save more). Participants are asked to explain their answer. After this question, participants are questioned whether they would keep their savings at a different location as a result of the changes in interest rate and inflation. Options are: (a) I am going to withdraw money from my savings account and store it at home, (b) I do not change where I keep my savings, (c) I am going to deposit cash that I previously stored at home into my bank account or (d) other: [...]. Participants are asked to explain their answer.

After these questions, the second scenario is presented. In this scenario, the nominal interest rate changes from 2.0% to -0.5% per year and the inflation rate changes from 4.5% to 2.0% per year. Participants receive the same questions as in scenario 1 about whether and how they would adjust their savings decisions and whether they would change the location of where they keep their savings. The questions about savings behaviour form the main part of the survey and are used to test my hypotheses.

The survey ends with a possibility to comment on the survey. The original survey (in Dutch) and a translated version of the survey can be found in the appendix.

4.2. Sample size

In order to properly analyse the survey results and to have enough statistical power of a test, the survey needs to be filled out by a minimum number of participants. This amount is called the sample size. In this chapter, I explain how I calculated the minimum sample size.

The minimum sample size that is needed for this experiment is determined with the formula from Wang & Chow (2004) that is especially designed to compare two different sample means:

$$n = \frac{\left(\frac{Z_{\alpha}}{2} + Z_{\beta}\right)^2 \cdot (p_1(1-p_1) + p_2(1-p_2))}{(p_1 - p_2)^2},$$

where $Z_{\frac{\alpha}{2}}$ is the critical value of the normal distribution at significance level 5% ($Z_{\frac{\alpha}{2}} = 1.95$). A desired significance level of 5% means that in 5% of the cases we state that our null hypothesis is false (we state that there is a treatment effect), while our null hypothesis is actually true. 5% is an arbitrary level, but it is the standard in economic literature.

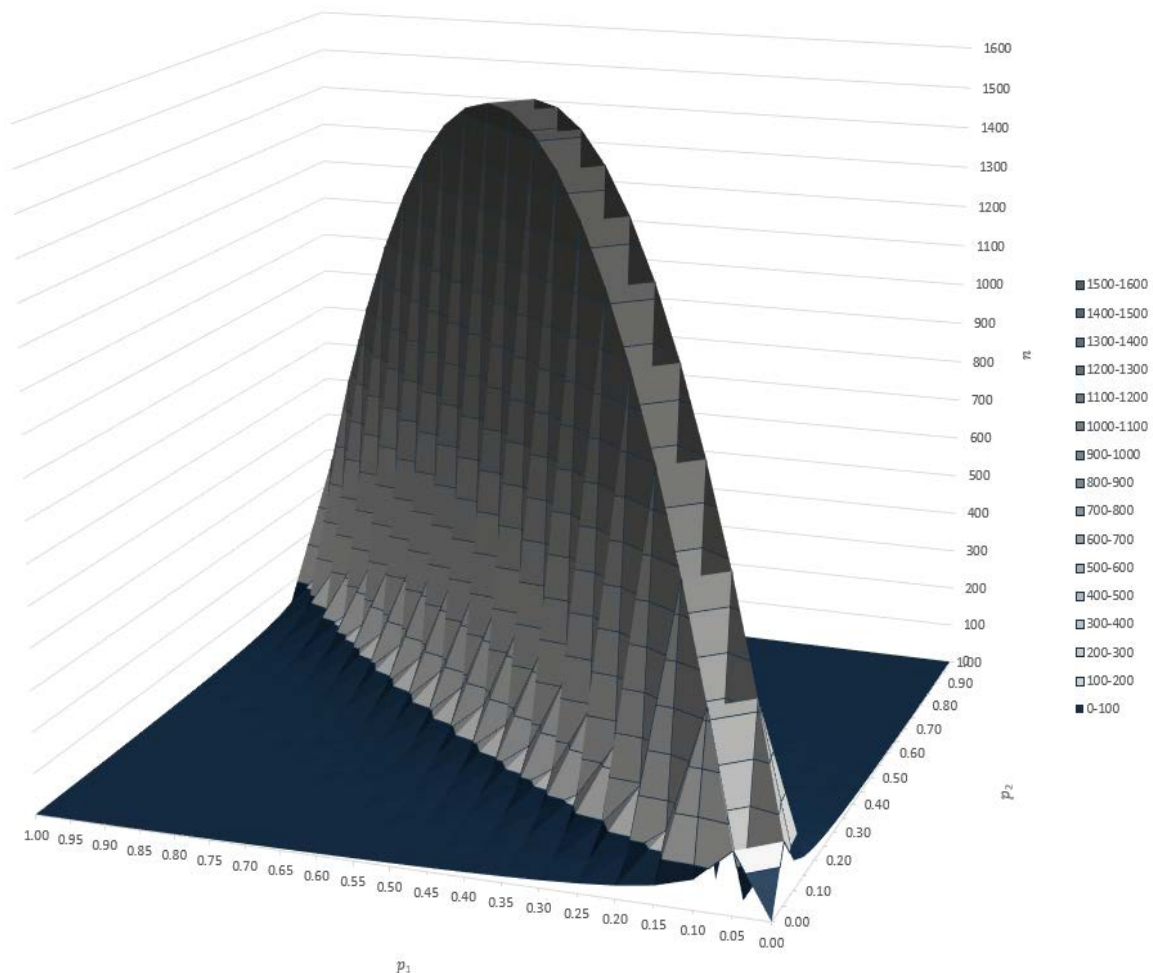
Z_{β} is the critical value that belongs to the power of the test in a normal distribution. The desired power of this test is set at 80%. (The corresponding value of $Z_{\beta} = 0.84$.) A power of 80% means that we

erroneously do not reject our null hypothesis in 20% of the time. A power of 80% is the standard in economic literature.

p_1 and p_2 are the estimated proportions in the control (p_1) and treatment (p_2) group that choose a specific multiple-choice alternative, for example the percentage of participants that withdraws money from their savings account in case of a negative interest rate. This percentage is hard to predict upfront, especially because I have multiple hypotheses and survey questions.

Because I determined the power of the test and the desired significance level upfront, the minimum sample size for this survey only depends on the estimated proportions p_1 and p_2 . To ease my decision about the level of p_1 and p_2 , I created a graph that shows the relationship between p_1 , p_2 and the sample size n .

Graph 1. Estimated proportions and corresponding sample size



The graph shows that the minimal sample size (n) increases when the difference between p_1 and p_2 decreases. Also, the minimal sample size (n) increases the closer p_1 and p_2 get to 0.5.

For this survey, I selected a value for $p_1 = 0.40$ and $p_2 = 0.60$. The dark blue area shows that this covers the majority of the possible combinations of p_1 and p_2 and that these values correspond to a minimum group size of $n = 93.4$. Graph 2 (to be found in the appendix) provides a top view of this graph.

A minimum group size of 93.4 means that each group of participants should contain at least 94 participants. Because I divided my participants into two groups (treatment and control), this means that I need at least 188 survey participants.

5. Results

In this chapter, I show the results of my experiment, together with the way these results are obtained.

5.1. Methodology

5.1.1. Difference between treatment and control

Before examining the effect of treatment on the survey participants, I test whether the treatment and control group differ already before the intervention. In other words, I test the treatment-control balance of the sample. This is done with the Chi-square test of independence. This test shows whether there is a significant relationship (and therefore: difference) between the treatment and control group. The outcome of the Chi-square test is the Chi-square test statistic (χ^2). In combination with the degrees of freedom of the Chi-square test (the amount of answer categories minus 1), this chi square test statistic leads to a p-value. This p-value shows the probability of, given that the null hypothesis of no relationship between treatment and control group is true, observing a sample statistic as extreme as the test statistic. If this probability is very low (below 5%), it is very unlikely that the null hypothesis of no relationship between treatment and control group is true. The lower bound of the p-value is set at $p = 0.05$. This means that I reject the null hypothesis if the probability of observing a sample statistic as extreme as the test statistic is lower than 5%. 5% is an arbitrary level, but it is the standard in economic literature. The Chi-square test of independence is an appropriate test in this case, because the assignment of treatment and control is random, and the observed variables are categorical.

5.1.2. Hypothesis testing

After I have tested for the differences between the treatment and control group, I test my hypotheses. For all three hypotheses, I perform a multinomial logit regression. In order to use this regression type, the following assumptions should hold (Tabachnick & Fidell, 2001 and Liao, 1999):

1. The outcome variable follows a categorical distribution and is unordered

The outcome variable is the answer on the multiple-choice questions. Participants can only choose one answer at a time and choose between three non-overlapping, unordered answer categories. Therefore, this assumption is met.

2. Independence of observations

Independence of observations means that every survey participant appears only once in the sample. The survey software allows participants to fill out the survey only once and a survey participant is either in the control or in the treatment group, not in both. As a result, this assumption is met.

3. Independence of irrelevant alternatives (IIA)

Another assumption that should hold is the independence of irrelevant alternatives axiom. This means that the probabilities of a participant preferring answer A over answer B should not change if an irrelevant alternative answer C is added. Tversky (1972) showed that this assumption is often violated in the case of human decision making in a multiple-choice setting. He found out that people do in fact change their decisions on a given choice set, once irrelevant alternatives are removed. To test whether the independence of irrelevant alternatives assumption holds, I performed a Hausman diagnostic test (Hausman & McFadden, 1984). The test showed that the IIA assumption is not violated.

I also did a multinomial probit regression. For this model, the IIA assumption does not need to hold. The results of this regression do not show a different pattern as seen in the multinomial logit model, while the coefficients are a lot harder to interpret. This supports my decision to continue my analysis with the multinomial logit model.

Other assumptions necessary to create a proper regression model are also met. For example, no important variables are omitted, the model is a good fit and there are no (non-random) measurement errors.

5.2. Summary statistics

The survey is filled out by 318 respondents in the period between 23 November and 6 December 2019. This is well over the minimum required sample size of 188. Table 1 provides summary statistics on the total sample of survey respondents. This information is collected before intervention.

Table 1. Composition of respondent group

	Control	Treatment	χ^2
Household composition			
Single	51	53	
Single parent with child(ren)	3	0	
Couple	46	48	
Couple with child(ren)	50	40	
Other	13	14	
<i>Total</i>	<i>163</i>	<i>155</i>	P = 0.402
Education level			
Primary education (basisschool)	1	1	
Pre-vocational education (VMBO)	3	1	
Pre-university education (HAVO/VWO)	21	20	
Senior vocational training (MBO)	13	9	
Vocational colleges (HBO/WO)	125	124	
<i>Total</i>	<i>163</i>	<i>155</i>	P = 0.817
Total savings			
No savings	14	11	
Emergency fund	38	24	
More than emergency fund	111	120	
<i>Total</i>	<i>163</i>	<i>155</i>	P = 0.159
Saving flow			
Regularly	87	95	
Irregularly	62	49	
<i>Total</i>	<i>149</i>	<i>144</i>	P = 0.181

The table shows that around one third of the survey participants (33%) is single, another third (30%) is part of a couple (30%), and around a third (28%) of participants is part of a couple with children. This reflects the average household composition in the Netherlands (CBS, 2019). Also, 78% of the survey respondents has followed higher education (vocational colleges). In comparison, in the Netherlands, this percentage was 31% in 2018 (CBS, 2019).

The bigger share of highly educated people in the survey population could partly be the result of a self-selection bias. I received feedback from some people that the survey was quite complicated. This might cause some people to drop out, where the probability to drop out is higher for participants with a lower education level. In total, from the 387 people that started the survey, 69 people did not finish. Another cause of the higher average education level of my sample may have been the distribution of

the survey. I shared the survey via my own social media accounts. The fact that I am connected to a lot of friends from university could add to a bias towards more highly educated people.

Nevertheless, the higher average education level of my survey respondents is not a problem for my analysis. Because the average education levels in both treatment and control group are not significantly different, I can still measure the effect of treatment on the survey participants. However, because of the higher average education level in my sample, I should be careful applying my results to the Dutch population as a whole.

25 survey respondents (8%) state to have no savings at all. These respondents were excluded from the question about saving flow (whether the participant saved (ir)regularly). They also received slightly adjusted questions in the remainder of the survey. For example, instead of: 'What is the yearly nominal interest rate that you receive on your (instant access) savings account?', they answered the question: 'What do you think is the yearly nominal interest rate on an (instant access) savings account?'. The amount and characteristics of the survey respondents with no savings do not significantly differ between the treatment and control group. Therefore, answers of these participants are included in the analysis.

Out of the survey sample, 19% of participants has a minimum amount of savings (an emergency fund), while the majority of the survey participants (73%) has more savings than only an emergency fund. From the respondents with savings, 62% saves regularly, while 48% saves on an irregularly base.

The Chi-square test of independence shows that there is no significant difference in the characteristics of the treatment and control group. This means that both groups are not significantly different on the factors that the questions are about. factors that influence participants' answers to the main research questions.

Table 2 provides an overview of the mean estimates (before intervention) of nominal interest rates and inflation.

Table 2. Mean estimate of nominal interest rates and inflation

	Control	Treatment	χ^2
Mean estimate of nominal interest rate With instant access savings account N = 278	0.165	0.091	P = 0.565
Mean estimate of nominal interest rate No instant access savings account N = 15	1.304	1.629	P = 0.504
Mean estimate of nominal interest rate No savings N=25	0.847	0.117	P = 0.461
Mean estimated inflation rate N = 318	2.244	2.313	P = 0.644

The actual average nominal interest rate on an instant access savings account is 0.1% in November 2019 in the Netherlands (De Nederlandsche Bank, 2019). With a mean estimate of 0.165% (control) and 0.091% (treatment), survey participants with an instant access savings account deviate the least from the true percentage. Survey participants with savings on another account than an instant access savings account are more optimistic about the nominal interest rate: on average they estimate it at 1.5%. Participants without savings are somewhere in the middle: on average they think that the nominal interest rate is 0.847% (control) and 0.117% (treatment). There is no statistical difference between the mean estimates of these different types of savers.

The mean estimated inflation rate is close to the true inflation rate in 2019 in The Netherlands: 2.6% (CBS, 2019). Participants in the treatment group estimated the inflation on 2.3%, while participants in the control group estimated this around 2.2%. According to the Chi-square test of independence, there is no significant difference in the estimate of nominal interest rates and inflation rates between treatment and control group. In the next chapter, the results of the experiment are being discussed.

5.3. Results hypothesis 1: Nominal interest rate is most important

Hypothesis 1: Without information provision, consumer behaviour responds more strongly to the nominal interest rate compared to the real interest rate.

To test whether uninformed individuals respond more strongly to the nominal values instead of real monetary values in a situation of interest on savings, I analyse the survey results of the participants in

the control group. I only look at the results of participants in the control group, because I want to test whether my hypothesis is true for people who did not receive an intervention. If participants in the control group respond more strongly to the nominal values instead of real monetary values, then the participants should solidly decide to change their savings decision in scenario 1 and 2. In both scenarios, the nominal interest rate changes, while the real interest rate is kept constant. The two different scenarios presented in the survey are as follows:

Scenario 1:

The average nominal interest rate in the Netherlands is 0.1%. The average inflation rate is 2.6%. Consider a change in nominal interest rate to 2.0% per year on all bank accounts and a change in inflation rate to 4.5%. Assume that nothing else changes. What reaction would describe you best?

Scenario 2:

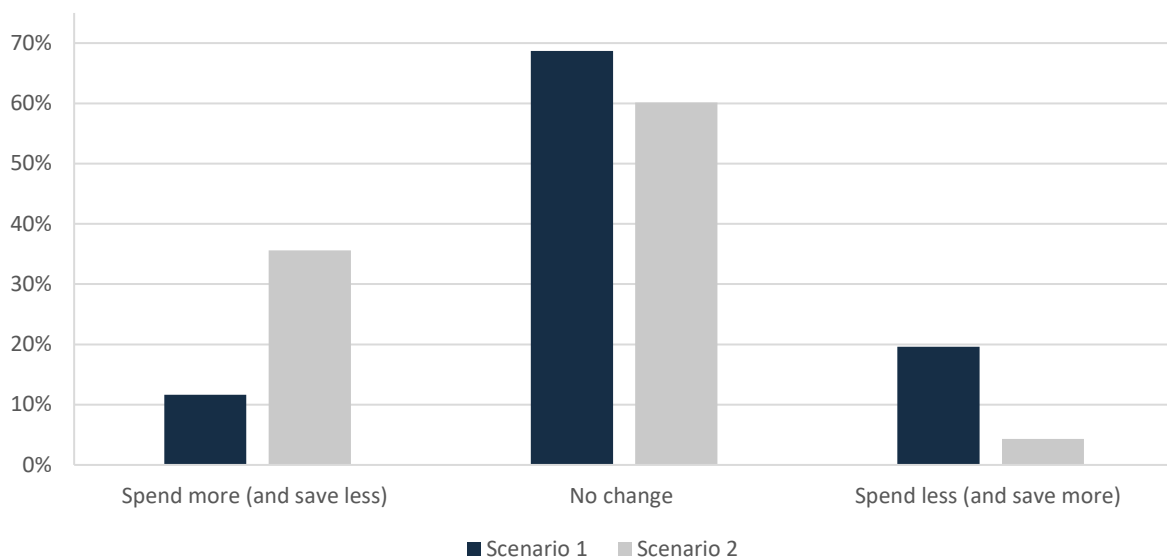
Now, consider a change in nominal interest rate to -0.5% per year (on all bank accounts) and a change in inflation rate to 2.0%. Assume that all other factors remain constant. What reaction would describe you best?

Participants can either choose to:

- A. Spend more (and save less)
- B. Not change how much money to spend
- C. Spend less (and save more)

Graph 3 shows the responses of the participants in the control group.

Graph 3. Responses control group



In the first scenario, 31% (51 out of 163) of participants decided to change their savings decision in case the interest rate increases from 0.1% to 2.0% and the inflation rate increases from 2.6% to 4.5%. This already shows that participants respond strongly to changes in the nominal interest rate.

More than 19% (32 out of 163) of participants decided to save more as a result of the changes in interest rate in inflation. This is possibly the result of money illusion, the phenomenon where participants think in terms of nominal values rather than real values. Since the nominal interest rate increases, saving becomes more interesting based only on the nominal account balance. If participants took the real values into account, their decision should not change, because the real interest rate is the same in both situations.

The decision to save more is inconsistent with the higher level of inflation, because inflation makes saving less attractive. If the average price level in the economy increases at a higher rate, the real value of savings decreases faster. This supports my hypothesis that participants do not take this inflation into account and that consumer behaviour responds more strongly to the nominal interest rate compared to the real interest rate.

The behaviour in the first scenario seems mainly the result of money illusion and not of loss aversion, because there is no new or additional loss involved when moving to the first scenario. The nominal interest rate and inflation both increase (at a level above 0). The real interest rate is negative, but this was already the case. As a result, loss aversion seems not to play a role in this decision.

In the second scenario, 40% (65 out of 163) of participants decided to change their savings decision in case the interest rate decreases from 2.0% to -0.5% and the inflation rate decreases from 4.5% to 2.0%. This already shows that participants respond strongly to changes in the nominal interest rate.

36% (58 out of 163) of participants in the control group decided to spend more (and save less) as a result of the changes in interest rate and inflation. This can point towards money illusion, because when merely looking at the nominal interest rate, saving becomes less attractive. Also, the change in behaviour can be the result of loss aversion. Participants may perceive the negative nominal interest rate as a loss and because they weigh losses more heavily than gains, they decide to withdraw money from their bank account and spend it. Also, inflation decreases so spending might be more attractive in general. What is certain is that also in scenario 2, people do react more strongly to the nominal interest rate compared to the real interest rate.

Table 3 shows results of the logistic regression of the change in scenario on the spending decision.

Table 3. Logistic regression results

<u>Variable</u>	<u>Odds ratio</u>	<u>Standard error</u>	<u>P-value</u>
Spend more versus no change			
Scenario 2	2.6909	1.0824**	0.014
Intercept	0.0379	0.0263***	0.000
Spend less versus no change			
Scenario 2	1.4750	0.5117	0.263
Intercept	0.1635	0.0895**	0.001

Asterisks indicate statistical significance using a two-tailed test. *** indicates significance at the 1% level, ** at the 5% level, and * at the 10% level.

The regression results show that the odds of a participant in the control group choosing to ‘spend more (and save less)’ instead of ‘no change’ significantly increase by 169% if the interest rate and inflation decrease from that in the first scenario to that in the second scenario. This means that there is a significant difference in the responses of participants between scenario 1 and scenario 2. The real interest rate is the same in both scenarios. This supports my hypothesis that participants in the control group respond more strongly to the nominal interest rate compared to the real interest rate.

5.4. Results hypothesis 2: Information provision induces more rational decisions

Hypothesis 2: Information provision about real interest rates induces consumers to make more rational decisions regarding their assessment of whether to spend versus save.

To assess whether information provision incites participants to make more rational saving decisions, I analyse the survey results of both the treatment and control group. If the information provision has a positive effect, the treatment group should be less responsive to trivial changes in the nominal interest rate compared to the control group.

As described in the previous chapter, the survey participants are presented two scenarios:

Scenario 1: Nominal interest rate changes from 0.1% to 2.0%. The inflation rate changes from 2.6% to 4.5%.

Scenario 2: Nominal interest rate changes from 2.0% to -0.5%. The inflation rate changes from 4.5% to 2.0%.

Participants are asked to describe their reaction on these changes by choosing between:

- A. Spend more (and save less)
- B. Not change how much money to spend
- C. Spend less (and save more)

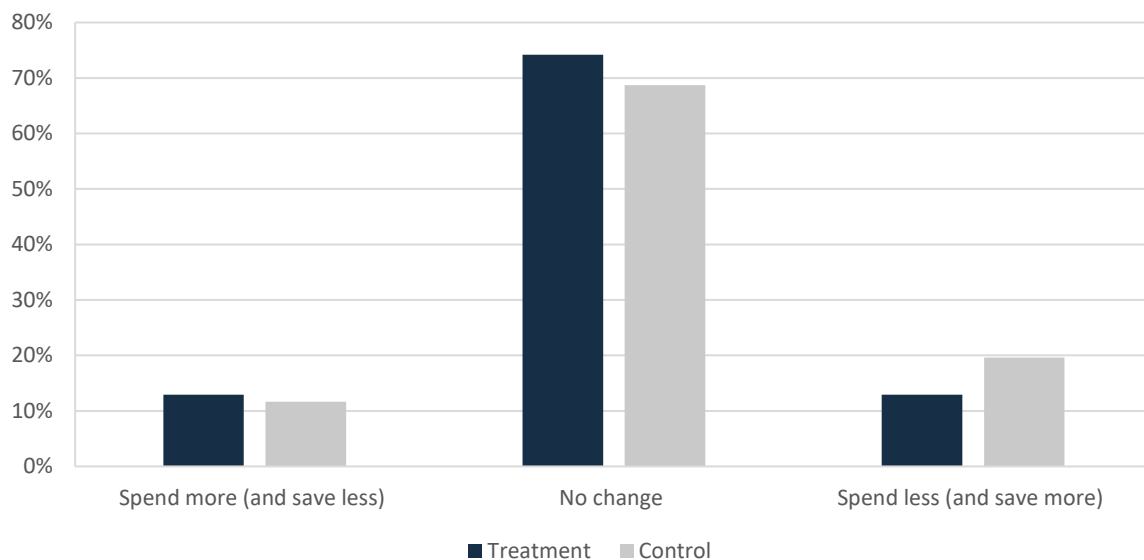
Table 4 shows the result of the regression of whether a participant is in the treatment group on savings decisions in the first scenario. Graph 4 gives an overview of the responses in the first scenario.

Table 4. Multinomial logit model of decisions in scenario 1.

<u>Variable</u>	<u>Odds ratio</u>	<u>Standard error</u>	<u>P-value</u>
Spend more versus no change			
Treatment	1.0252	0.3555	0.943
Intercept	0.1655	0.0914	0.001
Spend less versus no change			
Treatment	0.6087	0.1914	0.114
Intercept	0.4694	0.2199	0.106

Asterisks indicate statistical significance using a two-tailed test. *** indicates significance at the 1% level, ** at the 5% level, and * at the 10% level.

Graph 4. Survey results scenario 1



In order to state that the treatment has a significant effect, there should be a significant difference in the survey responses of the participants in the treatment group versus the control group. However, the multinomial regression results show that this is not the case. None of the odds ratios are statistically significant. Next to that, according to the Chi-square test of independence, there is no significant difference between the responses in the treatment and control group.

The regression results still provide interesting information. The odds of a participant choosing to 'spend more' instead of 'no change' increase by 2% if a participant is in the treatment group. The odds of a participant choosing to 'spend less' instead of 'no change' decrease by 40% if a participant is in the treatment group. These findings are, even though they are not significant, in line with my hypothesis. As a result of the information provision, participants in the treatment group learned that they should also take the inflation rate into account by making a saving decision. Therefore, they do not only look at the increase in nominal interest rate (from 0.1 to 2.0%), but also account for the inflation rate. Because the inflation rate increases in scenario 1 with an equal amount as the nominal interest rate, saving does not become more rewarding. Participants in the treatment group seem to have understood this, because a participant in the treatment group is less likely to decide to 'spend less' instead of 'no change' and more likely to 'spend more' instead of 'no change' in scenario 1 compared to participants in the treatment group.

This shows that participants in the treatment group are likely to respond more rational to trivial changes in the nominal interest rate compared to the control group. This points towards a decrease in money illusion and loss aversion for participants in the treatment group.

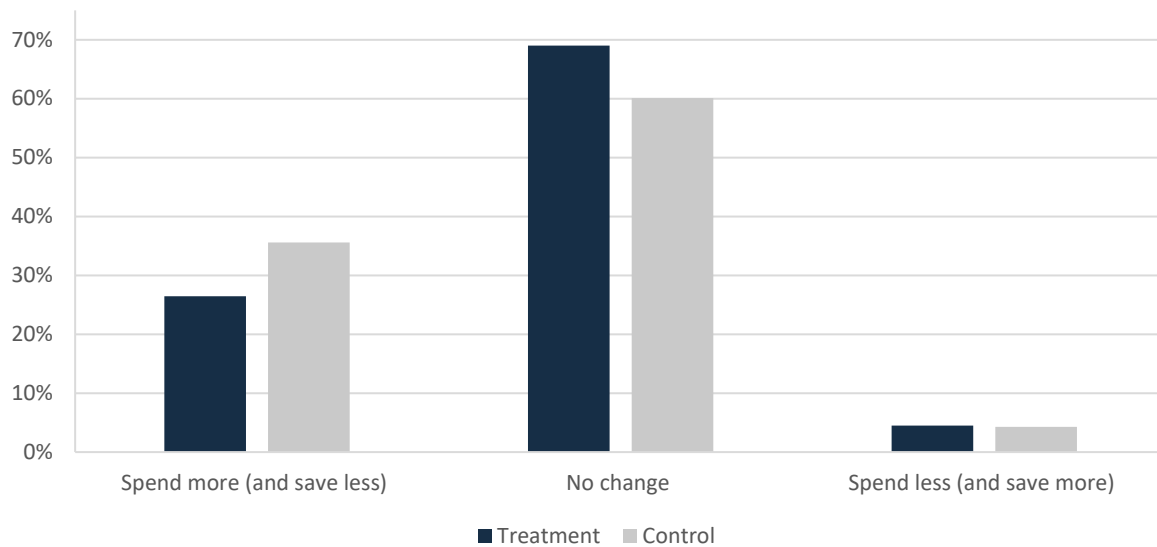
Table 5 shows the result of the regression of whether a participant is in the treatment group on savings decisions in the first scenario. Graph 5 shows the outcome of the survey for the second scenario.

Table 5. Multinomial logit model of decisions in scenario 2

<u>Variable</u>	<u>Odds ratio</u>	<u>Standard error</u>	<u>P-value</u>
Spend more versus no change			
Treatment	0.6474	0.1601*	0.079
Intercept	0.9141	0.3463	0.813
Spend less versus no change			
Treatment	0.9159	0.5060	0.874
Intercept	0.0780	0.0682	0.004

Asterisks indicate statistical significance using a two-tailed test. *** indicates significance at the 1% level, ** at the 5% level, and * at the 10% level.

Graph 5. Survey results scenario 2



In order to state that the information provision has a significant effect, there should be a significant difference in the survey responses of the participants in the treatment group versus the control group. The multinomial regression results show that there is.

In the second scenario, the odds of a participant choosing to 'spend more' instead of 'no change' decreases by 36% if the participant is in the treatment group. This effect is significant. This implies that participants in the treatment group are less likely to change their savings decision as a result of the decrease in interest rate and inflation in scenario 2. This supports the hypothesis that information provision survey induces participants to make more rational decisions.

The (non-significant) result of the odds of a participant choosing to 'spend less' instead of 'no change' supports my hypothesis as well. A participant in the treatment group is less likely to 'spend more' instead of 'no change' as a result of the decrease in nominal interest rate. This means that the participants in the treatment group are more rigid in their decision about whether to spend or save compared to participants that are in the control group. Because the real interest rate did not change while the nominal interest rate decreased, this finding points towards a reduction of money illusion and loss aversion in the treatment group.

5.5. Results hypothesis 3: Strong reaction to interest rates below zero

Hypothesis 3: If the nominal interest rate falls only slightly below zero, consumers react strongly by solidly willing to withdraw money from their savings account and store it at home.

The interest rate does not only influence the savings decision of consumers, but also the decision about where to keep these savings. When banks charge a negative interest rate, this question becomes particularly interesting.

I test what the reaction of the survey respondents is to a negative interest rate regarding the place of where they store their savings. In order to perform this test, I analyse the results of specific survey questions about where survey participants keep their savings in two different scenarios. The two different scenarios are the same as the ones used for the first and second hypothesis and are as follows:

Scenario 1: Nominal interest rate changes from 0.1% to 2.0%. Inflation rate changes from 2.6% to 4.5%.

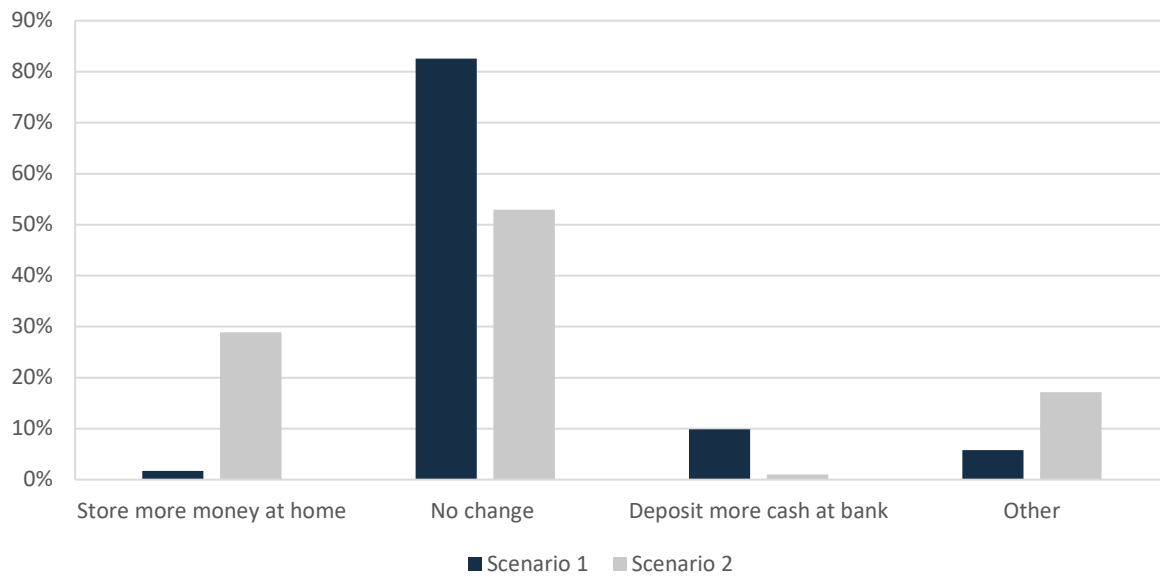
Scenario 2: Nominal interest rate changes from 2.0% to -0.5%. Inflation rate changes from 4.5% to 2.0%.

Participants can describe their reaction to the changes by choosing between the following alternatives:

- A. I am going to withdraw money from my savings account and store it at home
- B. I do not change where I keep my savings
- C. I am going to deposit cash that I previously stored at home into my bank account
- D. Other: ... [open question]

If my hypothesis is true, then participants will solidly choose to withdraw money from their savings account and store it at home once the nominal interest rate drops only slightly below 0%. In scenario 2, the interest rate drops slightly below 0 (-0.5%). Graph 6 shows an overview of the survey responses per scenario.

Graph 6. Overview of the survey responses about the location of savings



There is a clear difference between the responses in scenario 1 and 2. In scenario 1, only 5 out of 293 (2%) survey participants with savings choose to store money at home as a result of the changes of nominal interest rate and inflation. In scenario 2, this increased to 84 participants, almost 17 times as much compared to scenario 1.

I converted the survey data to panel data and performed a multinomial logit regression to investigate whether the increase in the number of participants that want to store money at home is significant. The results of this analysis can be found in table 6.

Table 6. Multinomial logit model of panel data on the location of savings

<u>Variable</u>	<u>Odds ratio</u>	<u>Standard error</u>	<u>P-value</u>
Deposit more cash versus no change	0.1626	0.1000***	0.003
Scenario 2	0.7372	0.5183	0.664
Intercept			
Store at home versus no change			
Scenario 2	26.4000	12.4537***	0.000
Intercept	0.0008	0.0007***	0.000
Other versus no change			
Scenario 2	4.6218	1.3823***	0.000
Intercept	0.0152	0.0080***	0.000

Asterisks indicate statistical significance using a two-tailed test. *** indicates significance at the 1% level, ** at the 5% level, and * at the 10% level.

The regression results show that the increase in the number of participants that want to store money at home is significant. In scenario 2, participants are 26.4 times more likely to decide to withdraw money from their bank account and store it at home compared to scenario 1. This supports my hypothesis about consumers reacting strongly to negative nominal interest rates.

I also investigated whether there is a significant difference between the reactions of participants in the treatment and control group to the negative nominal interest rate. Performing a Chi-square test of independence on the results of scenario 1 did not reveal a significant difference between the answers of participants in the treatment group and control group, but in scenario 2, it did. The odds of a participant choosing to 'store money at home' instead of 'no change' significantly decreases by 60% in scenario 2 if this participant is in the treatment group. Also, the odds of a participant choosing to 'store money elsewhere' instead of 'no change' decreases by 45% if this participant is in the treatment group. This implies that information provision about the importance of real interest rate make participants more rigid in their decision about where to keep their savings. The regression results that lead to these statements can be found in table 7 in the appendix.

17 (scenario 1) and 50 (scenario 2) participants indicated to store their money 'elsewhere' as a result of the changes in interest rate and inflation. If participants answered this, I always asked for a specification. 36 out of these 67 participants specified to invest in stocks and shares as a result of the changes in interest rate and inflation. This aligns with the theory of loss aversion that people elicit risk-seeking behaviour if they face losses with high probabilities, for example a negative interest rate. Other frequently occurring answers were: 'redeem my mortgage' and 'invest in real estate'.

The survey results show that consumers are sensitive to negative nominal interest rate: a negative nominal interest rate of -0.5% incentivizes 30% of survey participants to withdraw money from their bank account and store it at home. This is a lot, considering the possible risk of money getting stolen and the costs of storing the money and securing the money (for example with a safe) at home. This indicates that consumers suffer from loss aversion in the case of a negative interest rate. Information provision about the importance of real interest rates significantly relieves the phenomenon of loss aversion.

6. Conclusion

6.1. Main findings

In this thesis, I investigated the effect of the savings interest rate on the savings behaviour of consumers. I found that, when consumers are confronted with different interest rate and inflation scenarios, consumer behaviour responds more strongly to the nominal interest rate compared to the real interest rate. This collides with the standard economic assumption of rationality. The phenomenon of thinking of money in nominal instead of real terms is called 'money illusion'. The results of the experiment support my hypothesis that money illusion is present in the savings decision of consumers.

Secondly, the results of my experiment showed that information provision about real interest rates induces consumers to make more rational decisions regarding their assessment of whether to spend versus save. Participants in the treatment group reacted less strongly to trivial changes in the nominal interest rate and inflation compared to participants in the control group. This shows that information provision can help to diminish money illusion.

The savings interest rate does not only influence the savings behaviour of consumers, but also impacts the location of where people keep their savings. The survey results showed that if the nominal interest rate falls only slightly below zero (-0.5%), almost 30% of the survey participants solidly decides to withdraw money from their bank accounts and keep it at home. This high willingness to store money at home might have to do with loss aversion, the tendency of people to weigh losses more heavily than gains. Based on the results of my survey, participants in the treatment group suffer significantly less from loss aversion. The odds of a participant choosing to 'store money at home' instead of 'no change' significantly decreases by 60% in scenario 2 if the participant is in the treatment group. This shows that providing information about the importance, meaning and computation of real interest rates can help to decrease loss aversion and diminish the possible negative effects of a low interest rate.

6.2. Discussion

My experiment shows that information provision induces consumers to make more rational decisions regarding their assessment of whether to spend or save. At this moment, the real interest rate on savings is below 0% in the Netherlands. As a result, the real value of savings decreases over time and excessive saving (i.e. saving more than the minimum buffer for emergency situations) is costly. Information provision could be a low-cost and accessible way of diminishing this problem of 'oversaving'.

I also found that consumers act loss averse when they are confronted with a negative interest rate. Once the interest rate drops slightly below zero, consumers solidly decide to withdraw money from their bank accounts and keep it at home. This is an unfavourable situation, not only for the economy, but also regarding the huge personal financial risks attached to storing money at home.

Information provision has shown to diminish participants' inclination to keep money at home in case of a small negative nominal interest rate. If people do not only look at the small but certain losses of receiving a negative interest rate, but also take the uncertain but huge losses (for example, in case the money kept at home gets stolen) into account, more rational decisions regarding this topic can be made.

6.3. Limitations and further research

In this chapter, I discuss the limitations of my analysis and I provide suggestions for future research.

One limitation of my analysis is that it is based on a survey experiment. Surveys can be a good indication of expected economic behaviour, but they are not perfect. Participants can rush through the survey questions or do not give honest answers.

Also, my survey sample is not randomly selected. The survey is carried out online and the link to the survey is shared via my own social media accounts on WhatsApp, LinkedIn and Facebook. As a result, people in my own network are more likely to fill out the survey compared to other people in the survey population. One consequence of this non-random sampling is visible in the survey results: the average education level of participants in my sample is significantly higher than average in the Netherlands. This causes no structural problems for my analysis because the average education level in treatment and control group is not significantly different, but it might limit the external validity of my results.

In the explanation for the treatment group, I describe the difference between real and nominal interest rates and the effect of inflation. In both examples, the real interest rate is negative. This might put saving in quite a bad light and possibly influences participants view on saving in general and via that way, their survey responses.

This analysis could be used as a starting point for further research. Next to the interest and inflation rate, it is likely that other factors also influence people's savings behaviour in case of a negative interest rate. These are not discussed in this thesis. Mapping out these facts could help to better predict consumer savings behaviour in case of a negative interest rate.

In the comment section of my survey results, I found out that a lot of people choose to invest money in stocks and shares if the interest rate on their savings account becomes negative. Investing in stocks and shares entails financial risks. Investments are for example not covered under any guarantee scheme by the government. A lot of financial companies are now advertising with special investment funds that have almost the same look and feel as normal savings accounts, but the companies invest the money in stocks and shares. Based on my survey results, I expect that the interest in this type of financial products increases even more. Further research can be done on whether consumers need more protection or advice on these types of products.

Also, quite a lot of people (69) started the survey but did not finish. Further research could be done on why participants did not finish the survey and what type of questions make that survey participants drop out and how to avoid this in the future.

Next to that, this survey experiment could be carried out in other European countries, to investigate the possible effects of interest rates on consumer behaviour there. In some European countries, for example Sweden and Denmark, the interest rates are already negative for a longer time. Because these countries are in some ways similar to the Netherlands, and at least closely connected via treaties and the European Union, investigating the effects in these countries could yield interesting insights and policy advices.

7. Bibliography

- Bell, D., Raiffa, H., & Tversky, A. (1988). *Decision Making: Descriptive, Normative, and Prescriptive Interactions*. New York: Cambridge University Press.
- Bhalerao, S., & Kadam, P. (2010). Sample size calculation. *International journal of Ayurveda research*, 1(1): 55-57.
- Brunnermeier, M. & Koby, Y. (2016). The reversal interest rate: An effective lower bound on monetary policy. Working Paper. Princeton University.
- Buera, F., & Nicolini, J. P. (2017). Liquidity Traps and Monetary Policy: Managing a Credit Crunch. Federal Reserve Bank of Chicago Working Paper, 14.
- Burda, M., & Wyplosz, C. (2013). *Macroeconomics: a European text*. Oxford university press.
- Centraal Bureau voor de Statistiek (2019). *Bevolking; hoogstbehaald onderwijsniveau en onderwijsrichting*. Retrieved from:
<https://opendata.cbs.nl/statline/#/CBS/nl/dataset/82816NED/table?dl=B013>
- Centraal Bureau voor de Statistiek (2019). *Particuliere huishoudens naar samenstelling en grootte*. Retrieved from: <https://opendata.cbs.nl/statline/#/CBS/nl/dataset/37975/table?dl=249D8>
- Centraal Bureau voor de Statistiek (2019). *Consumentenprijzen; prijsindex 2015=100*. Retrieved from: <https://opendata.cbs.nl/#/CBS/nl/dataset/83131NED/table?ts=1573032224611>
- Cohn, A., Fehr, E., & Maréchal, M. A. (2014). Business culture and dishonesty in the banking industry. *Nature*, 516(7529), 86.
- Coibion, O., Gorodnichenko, Y., & Ropele, T. (2018). Inflation expectations and firm decisions: New causal evidence. *National Bureau of Economic Research*.
- Cornille, O., D'Hondt, C., De Winne, R., Efendic, E., & Todorovic, A. (2020). What leads people to tolerate negative interest rates on their savings?. Available at SSRN 3522966.
- Diamond, P., Shafir, E., & Tversky, A. (1997). Money illusion. *The Quarterly Journal of Economics*, 112(2), 341-374.
- Dur, R., Fleming, D., van Garderen, M., & van Lent, M. (2019). A Social Norm Nudge to Save More: A Field Experiment at a Retail Bank. Tinbergen Institute.
- European Central Bank (2019). *Key ECB interest rates*. Retrieved from: https://www.ecb.europa.eu/stats/policy_and_exchange_rates/key_ecb_interest_rates/html/index.en.html
- Fisher, I. (1928). *The Money Illusion*. New York: Adelphi Company
- Fisher, I. (1930). *The theory of interest*. London: Mac Millan.
- Hausman, J. & McFadden, D. (1984). Specification tests for the multinomial logit model. *Econometrica*, 52(5), 1219–1240.
- Li, X. (2007). The effects of appetitive stimuli on out-of-domain consumption impatience. *Journal of Consumer Research*, 34(5), 649-656.
- Liao, T. (1999). *Interpreting probability models: Logit, probit, and other generalized linear models*. Thousand Oaks, CA: Sage Publications.
- Kahneman, D. & Tversky, A. (1979). Prospect theory: An analysis of decision under risk. *Econometrica*, 47, 263-291
- Kahneman, D. & Tversky, A (1991). Loss aversion in riskless choice: A reference-dependent model. *The quarterly journal of economics*, 106(4), 1039-1061.
- Keynes, J. M. (1936). *The General Theory of Employment, Interest, and Money*. New York: Harcourt, Brace.

- McNeil, B. J., Pauker, S. G. & Tversky, A. (1988). On the Framing of Medical Decisions. In Bell, D., Raiffa, H., & Tversky, A. (1988). *Decision Making: Descriptive, Normative, and Prescriptive Interactions*. New York: Cambridge University Press.
- De Nederlandsche Bank (2019). *Rente*. Retrieved from:
<https://statistiek.dnb.nl/dashboards/rente/index.aspx>.
- Roth, C. & Wohlfart, J. (2018). How do expectations about the macroeconomy affect personal expectations and behavior? Working Paper.
- Smith, A. (1846). *An Inquiry into the Nature and Causes of the Wealth of Nations*. Volume 2, Clarendon press.
- Tabachnick, B. G. & Fidell, L. S. (2001). *Using multivariate statistics (4th ed.)*. Needham Heights, MA: Allyn and Bacon.
- Thaler, R. H., & Benartzi, S. (2004). Save more tomorrow™: Using behavioral economics to increase employee saving. *Journal of political Economy*, 112(S1), S164-S187.
- Tversky, A. (1972). Elimination by aspects. *Psychological Review*, 79(4), 281–299.
- Wang, H. & Chow, S. C. (2004). Sample Size Calculation for Comparing Proportions. *Encyclopedia of Statistical Sciences*. John Wiley & Sons Inc.
- Wilcox, J. A. (1990). Nominal interest rate effects on real consumer expenditure. *Business Economics*, 31-37.

8. Appendices

8.1. Survey in Dutch

The translated version of the survey can be found in the next chapter. The online version of the survey can be viewed on the following website: [link to online survey](#).

I. Introduction

Bedankt voor uw deelname aan deze enquête over de economische effecten van de spaarrente en inflatie. Dit onderzoek duurt ongeveer 3-5 minuten. Uw antwoorden worden anoniem en strikt vertrouwelijk behandeld.

II. Introductory questions about household composition and savings behaviour

1. Hoe ziet uw huishouden eruit?
 - A. Alleenstaand
 - B. Alleenstaande ouder met kind(eren)
 - C. Echtpaar/samenwonend
 - D. Echtpaar/samenwonend met kind(eren)
 - E. Anders, namelijk:
2. Wat is uw hoogst behaalde opleidingsniveau?
 - A. Basisschool
 - B. VMBO
 - C. HAVO/VWO
 - D. MBO
 - E. HBO/WO
3. Welke zin beschrijft het beste uw situatie?
 - A. Ik heb geen spaargeld >> naar vraag 5 en vraag 11 overslaan
 - B. Ik heb wat spaargeld achter de hand voor noodgevallen
 - C. Ik heb meer spaargeld dan alleen voor noodgevallen (bijvoorbeeld: u heeft daarnaast ook spaargeld voor een vakantie of een grote aankoop)
4. Wat voor type spaarder bent u?
 - A. Ik spaar periodiek een vast bedrag (bijvoorbeeld maandelijks)
 - B. Ik spaar onregelmatig (bijvoorbeeld bij financiële meevallers)
5. U geeft aan geen spaargeld te hebben. Wat is het meest van toepassing op u?
 - A. Ik zou wel willen sparen, maar ik heb nooit geld over >> naar vraag 7
 - B. Ik zou wel kunnen sparen, maar ik wil het niet >> naar vraag 7
6. Wat is de hoogte van de rente die u nu ontvangt op uw vrij opneembare spaargeld?

Open vraag, met optie: 'Mijn spaargeld is niet vrij opneembaar' >> dan naar vraag 8, anders naar vraag 9
7. U geeft aan geen spaargeld te hebben. Hoe hoog is volgens u de gemiddelde spaarrente op een vrij opneembare spaarrekening?

Hierna naar vraag 9

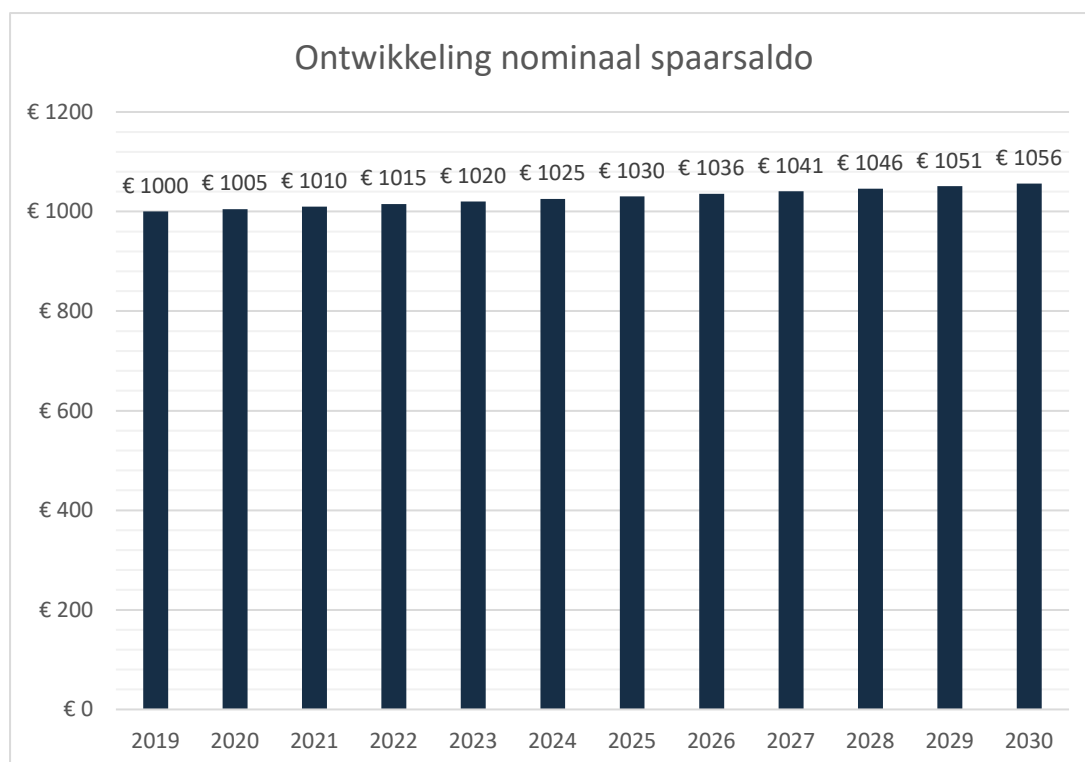
8. U geeft aan geen vrij opneembaar spaargeld te hebben.
Hoe hoog is volgens u de gemiddelde spaarrente op een vrij opneembare spaarrekening?

9. Hoeveel bedraagt volgens u de inflatie (gemiddelde prijsstijging) in Nederland?

III. Information provision (treatment group)

Er volgt nu belangrijke informatie die u helpt bij het verder invullen van de vragenlijst. Lees deze informatie alstublieft goed door.

Wanneer u geld op een spaarrekening heeft staan, ontvangt u rente. Stel u voor dat u 1000 euro heeft staan op een bankrekening met een jaarlijkse rente van 0.5%. Wanneer u in de tussentijd geen geld opneemt van uw spaarrekening, dan ontwikkelt uw spaarsaldo zich als volgt:



Het saldo dat u op uw bankrekening ziet staan, noemen we het nominale spaarsaldo. Belangrijker dan de hoogte van uw spaarsaldo, is wat u werkelijk met dit geld kunt kopen. Dit is de **reële waarde** van uw spaargeld.

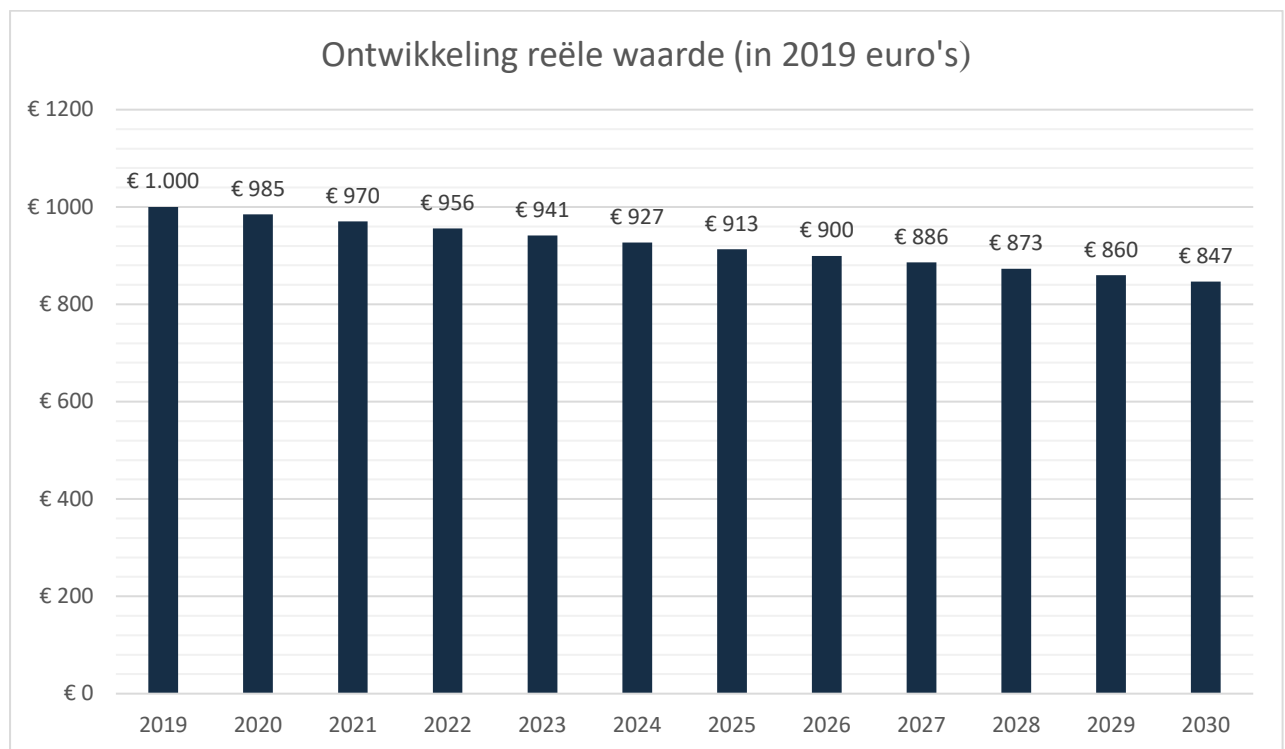
De reële waarde van uw spaargeld is afhankelijk van de inflatie, de snelheid waarmee het gemiddelde prijsniveau stijgt. Als de inflatie 2.0% bedraagt, stijgen de prijzen van alle goederen en diensten gemiddeld met 2.0% per jaar. Dit betekent dat u elk jaar 2.0% minder kunt kopen van uw spaargeld.

U kunt de ontwikkeling van de reële waarde van uw spaargeld bepalen door het nominale rentepercentage te verminderen met de inflatie. Het percentage waarmee de reële waarde van uw spaargeld jaarlijks verandert noemen we de reële rente.

$$\text{reële rente} = \text{nominale rente} - \text{inflatie}$$

Bij een positieve reële rente kunt u steeds meer kopen van uw geld, bij een negatieve reële rente steeds minder.

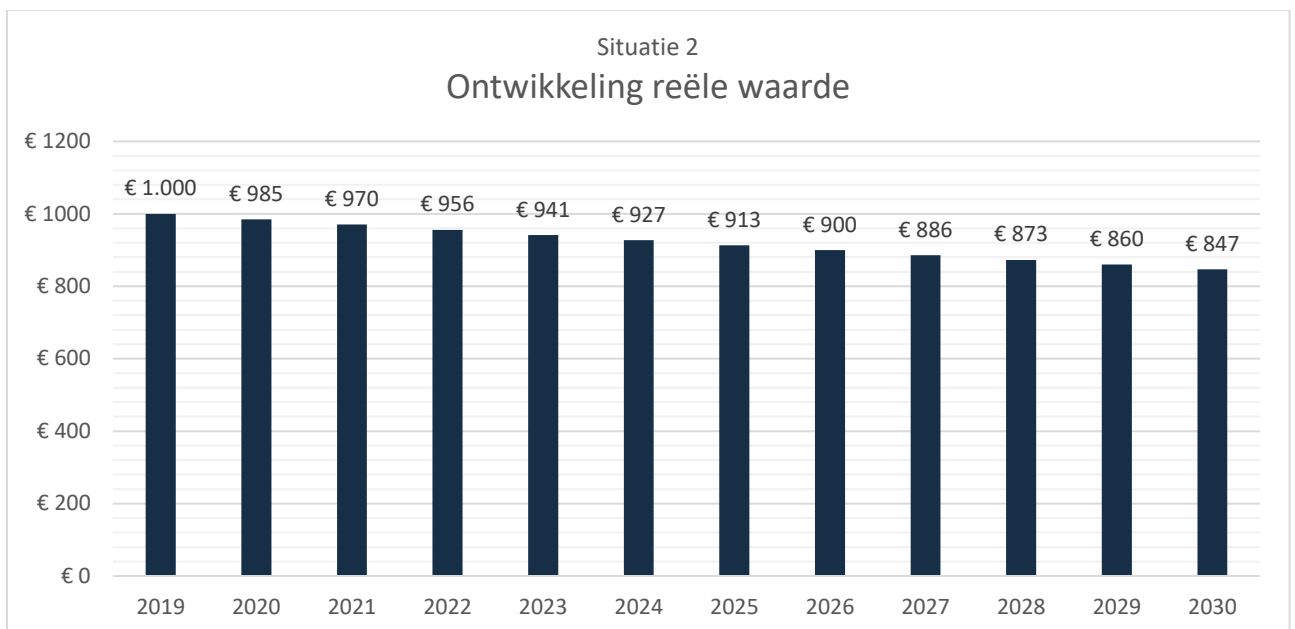
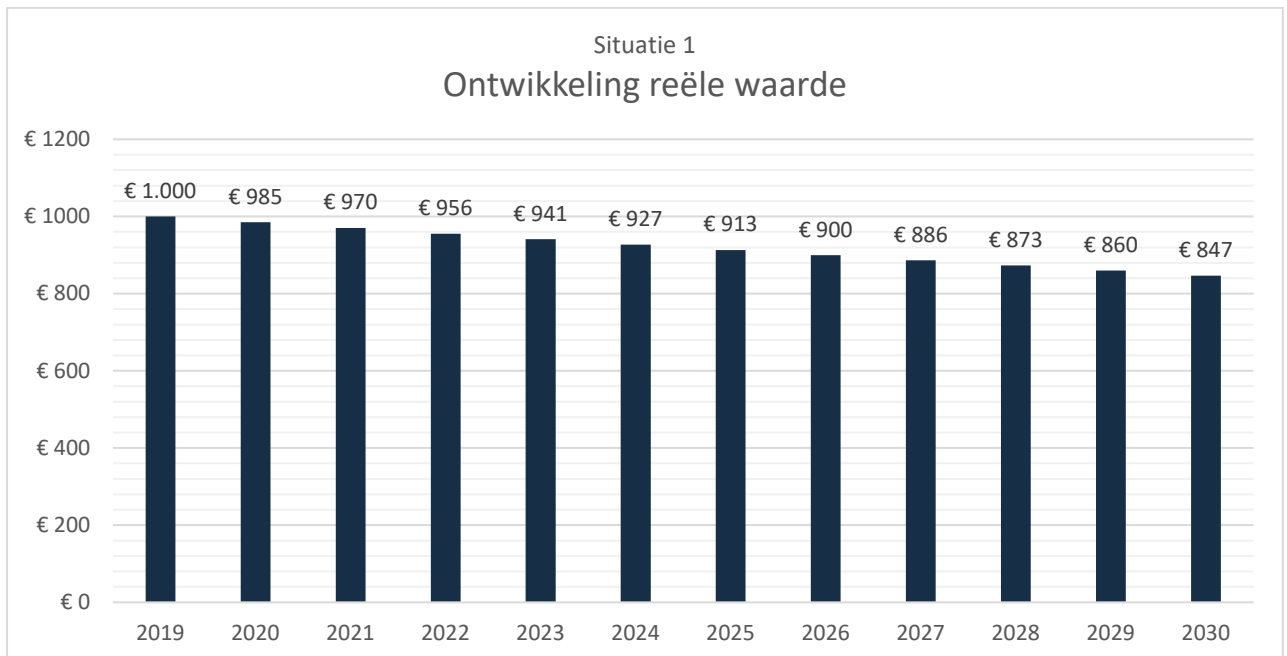
Stelt u zich de situatie voor waarin de inflatie 2% is en de nominale rente 0.5%. De reële rente bedraagt dan: $0.5\% - 2\% = -1.5\%$. Deze negatieve reële rente (-1.5%) betekent dat de reële waarde van uw 1000 euro spaargeld zich als volgt ontwikkelt:



Tot slot, hieronder staan twee combinaties van rente en inflatie:

- | | | | |
|--------------------|------|--------------------|-------|
| 1. Nominale rente: | 0,5% | 2. Nominale rente: | -0,5% |
| Inflatie: | 2,0% | Inflatie: | 1,0% |

In beide situaties bedraagt de reële rente – 1.5%. De werkelijke waarde van uw spaargeld ontwikkelt zich dus in beide gevallen hetzelfde. Zo zien we dat het bij het inschatten van de ontwikkeling van de waarde van uw spaargeld belangrijk is om altijd rekening te houden met zowel de nominale rente als de inflatie.

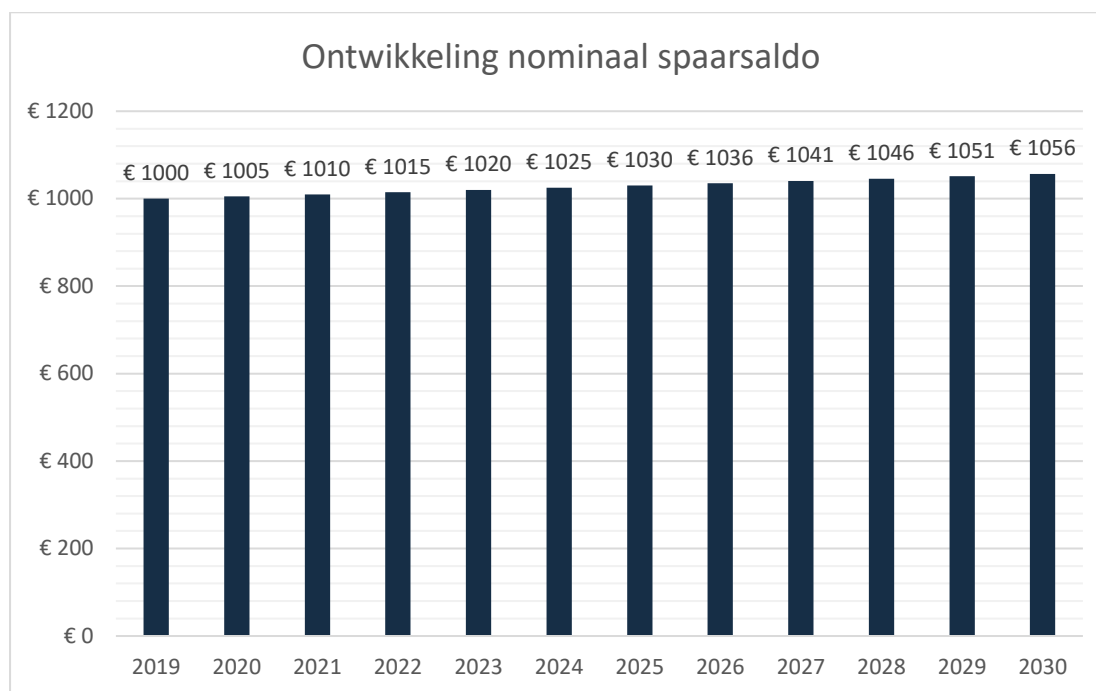


De volgende vragen gaan over spaarrente en inflatie. We zijn benieuwd naar uw mening, er zijn geen goede of foute antwoorden.

IV. Introduction to main survey questions (control group)

Er volgt nu belangrijke informatie die u helpt bij het verder invullen van de vragenlijst. Lees deze informatie alstublieft goed door.

Wanneer u geld op een spaarrekening heeft staan, ontvangt u rente. Stel u voor dat u 1000 euro heeft staan op een bankrekening met een jaarlijkse rente van 0.5%. Wanneer u in de tussentijd geen geld opneemt van uw spaarrekening, dan ontwikkelt uw spaarsaldo zich als volgt:



De volgende vragen gaan over spaarrente en inflatie. We zijn benieuwd naar uw mening, er zijn geen goede of foute antwoorden.

V. Main survey questions

De gemiddelde nominale spaarrente in Nederland is 0.1%. De gemiddelde inflatie is 2.6%. (bron: CBS, DNB).

Stel dat de nominale spaarrente overall in Nederland stijgt naar 2.0% per jaar en dat de inflatie stijgt naar 4.5% per jaar. Veronderstel dat er verder niks verandert. Wat beschrijft dan het beste uw reactie?

10. Als gevolg hiervan ga ik...
- A. Meer uitgeven (en dus minder sparen)
 - B. Evenveel geld uitgeven
 - C. Minder uitgeven (en dus meer sparen)

11. Waarom kiest u voor: [antwoord van vraag 10]?

Open vraag met de mogelijkheid om de vraag over te slaan.

Verder willen we graag meer weten over de plek waar u uw spaargeld bewaart.

12. Als gevolg van verhoging van de rente (0.1% → 2.0% per jaar) en inflatie (2.6% → 4.5% per jaar)...
- A. Haal ik geld van mijn spaarrekening af en bewaar ik het thuis
 - B. Verander ik niets aan waar ik mijn spaargeld bewaar
 - C. Zet ik geld dat ik eerst thuis bewaarde op mijn bankrekening
 - D. Anders, namelijk:

Stel dat de nominale spaarrente overal in Nederland daalt naar -0.5% per jaar en dat de inflatie daalt naar 2.0% per jaar. Veronderstel dat er verder niks verandert. Wat beschrijft dan het beste uw reactie?

13. Als gevolg hiervan ga ik...
- A. Meer uitgeven (en dus minder sparen)
 - B. Evenveel geld uitgeven
 - C. Minder uitgeven (en dus meer sparen)

14. Waarom kiest u voor: [antwoord van vraag 13]?

Open vraag met de mogelijkheid om de vraag over te slaan.

Verder willen we graag meer weten over de plek waar u uw spaargeld bewaart.

15. Als gevolg van de verlaging van de rente (2.0% → -0.5% per jaar) en inflatie (4.5% → 2.0% per jaar)...
- A. Haal ik geld van mijn spaarrekening af en bewaar ik het thuis
 - B. Verander ik niets aan waar ik mijn spaargeld bewaar
 - C. Zet ik geld dat ik eerst thuis bewaarde op mijn bankrekening
 - D. Anders, namelijk:

16. Heeft u vragen of opmerkingen naar aanleiding van deze vragenlijst?
- A. Nee
 - B. Ja >> naar vraag 17

17. Vul hieronder uw vraag/opmerking/verbetervoorstel in:

Wanneer u een reactie op prijs stelt, vul dan hier uw e-mailadres in:

VI. End of survey

Dit is het einde van de vragenlijst. Bedankt voor uw deelname!

8.2. Survey translated to English

The survey is set up as follows:

I. Introduction

Thank you for agreeing to take part in this survey measuring the economic effects of consumer interest rates and inflation. This survey should only take 3-5 minutes to complete. Be assured that all answers you provide will be kept in the strictest confidentiality.

II. Introductory questions about household composition and savings behaviour

1. Which description matches your household composition best?
 - A. Single
 - B. Single parent with child(ren)
 - C. Couple
 - D. Couple with child(ren)
 - E. Other, please specify:

2. What is the highest level of education that you completed?
 - A. Primary education (basisschool)
 - B. Pre-vocational education (Voorbereidend middelbaar beroepsonderwijs (VMBO))
 - C. Pre-university education (HAVO/VWO)
 - D. Senior vocational training or training through apprentice system (MBO)
 - E. Vocational colleges (HBO/WO)

3. What situation fits you best?
 - A. I do not have savings >> continue to question 5 and skip question 11
 - B. I have saved a minimal amount to use in case of emergency
 - C. I have more savings than needed in case of emergency (for example: you also have savings for a holiday or a large purchase)

4. What type of saver are you?
 - A. I save a fixed amount on a regularly base (for example every month)
 - B. I save irregularly (for example, only in case of a financial windfall)

5. You indicated that you do not have savings. What is most applicable to you?
 - A. I would like to save, but I never have money left >> continue to question 7
 - B. I would be able to save, but I do not want to >> continue to question 7

6. What is the yearly nominal interest rate that you receive on your instant access savings account?

Open question with option: 'my savings are not instantly accessible' >> if so, then continue to question 8, otherwise to question 9

7. You indicated that you do not have savings. What do you think is the average nominal interest rate on an instant access savings account?

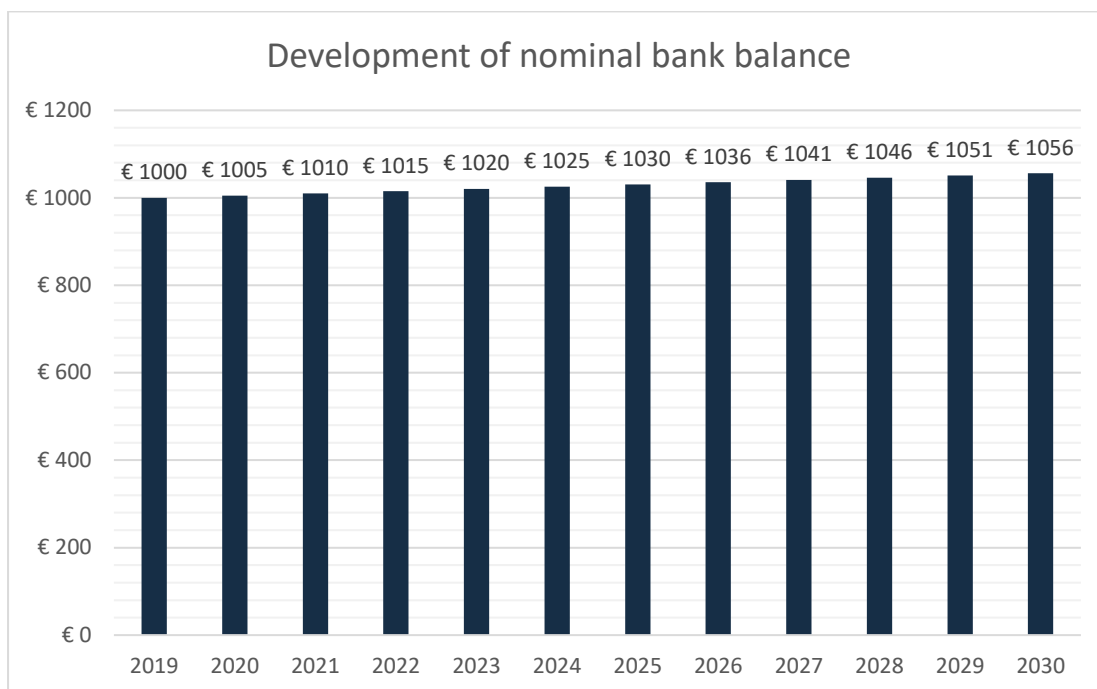
Continue to question 9

8. You indicated that you do not have instantly accessible savings. What do you think is the average nominal interest rate on an instant access savings account?
9. What do you think is the current inflation rate (average increase in prices) in the Netherlands?

III. Information provision (treatment group)

The next pages show important information to help you complete the questionnaire. Please read this information carefully.

If you deposit money in a savings account, you receive interest. Imagine that you deposit 1000 euros in a bank account against a 0.5% yearly interest rate. Over time, supposing you do not withdraw any money from this savings account, your bank balance develops in the following way:



The balance on your bank account is called the nominal bank balance. More important than the level of your savings balance, is what you can buy with this money. This is the real value of your savings.

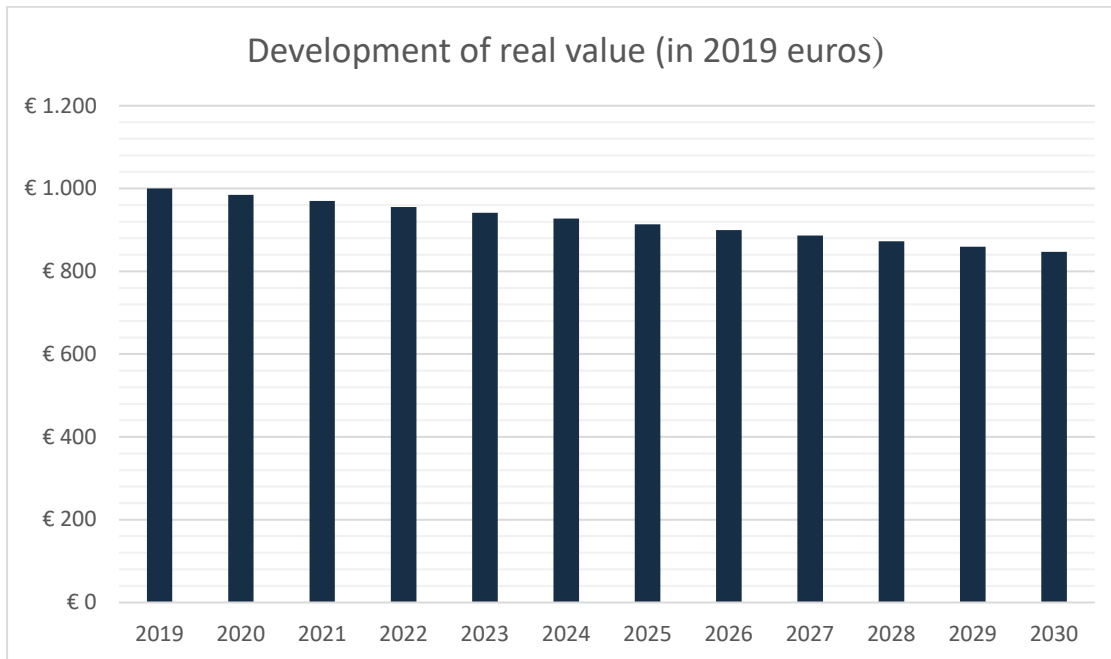
The real value of your savings is dependent of inflation, the rate at which the average price level in the economy increases. If the inflation level is 2.0%, the prices of all goods and services increase on average at a rate of 2.0% per year. This means that every year, your savings will buy a 2.0% lower quantity of goods.

You can determine the development of the real value of your savings by diminishing the nominal interest rate with the inflation. The rate at which the real value of your savings yearly changes is called the real interest rate.

$$\text{real interest rate} = \text{nominal interest rate} - \text{inflation rate}$$

In case of a positive real interest rate, you can buy increasingly more goods of your savings, in case of a negative real interest rate increasingly less.

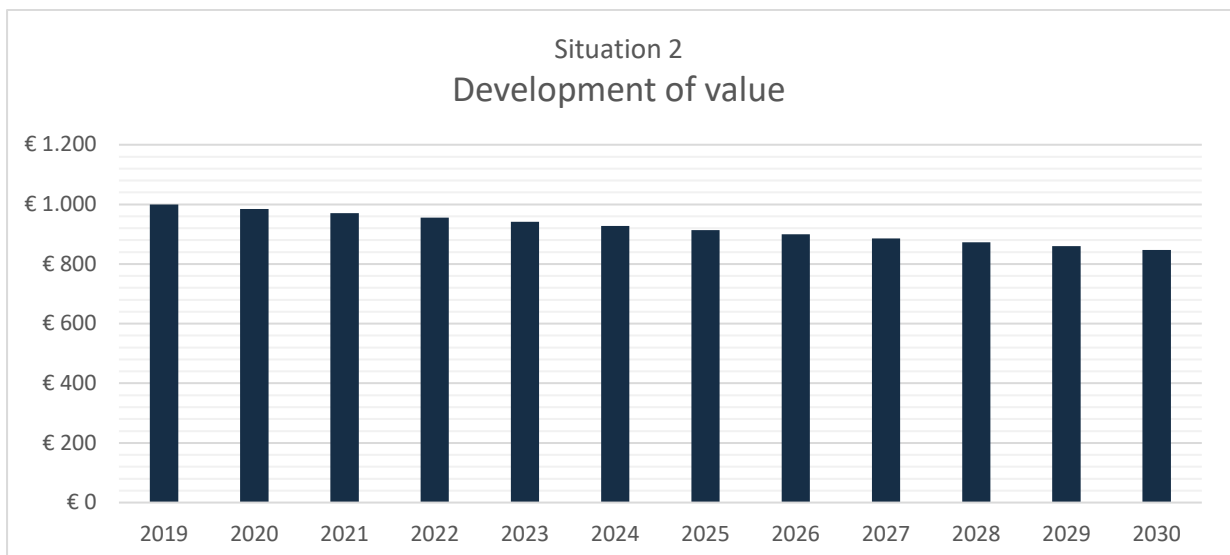
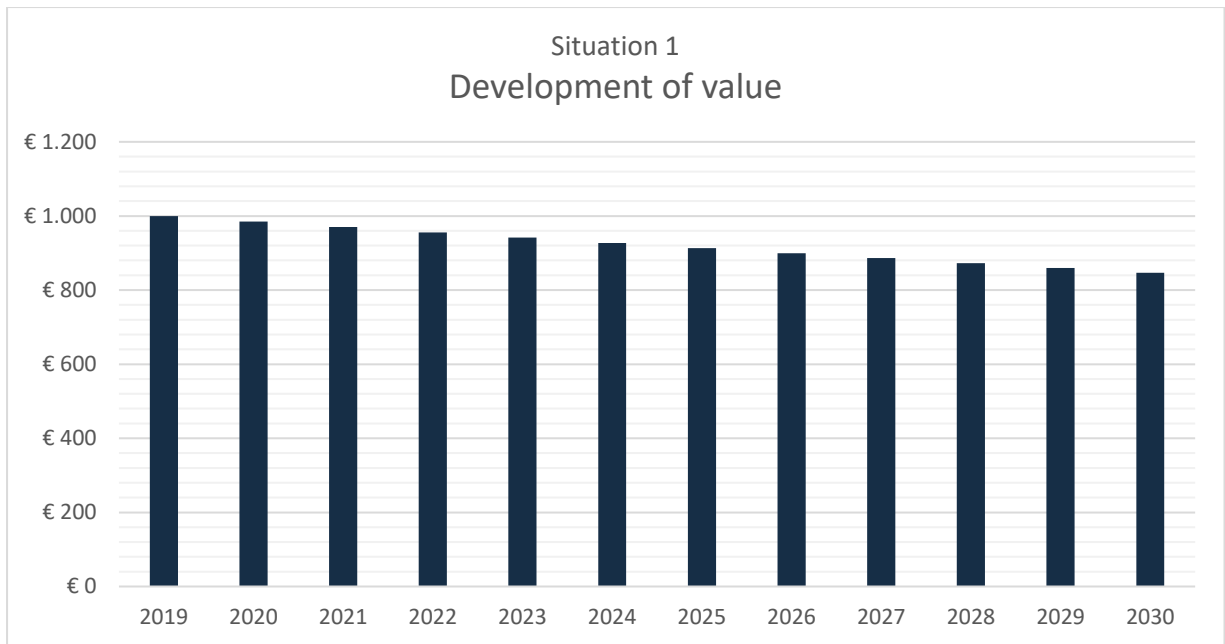
Consider a situation in which the inflation rate is 2.0% and the nominal interest rate is 0.5%. The real interest rate is then as follows: $0.5\% - 2.0\% = -1.5\%$. This negative real interest rate (-1.5%) means that the real value of your 1000 euro savings develops as follows:



Finally, below you find two combinations of interest and inflation:

- | | |
|--------------------------------|------------------------------------|
| 1. Nominal interest rate: 0.5% | 2. Nominal interest rate: -0.5% |
| Inflation rate: 2.0% | Inflation rate: 1.0% |

In both situations, the real interest rate is -1.5% . The real value of your savings develops the same in both cases. This teaches us that when estimating the development of the value of your savings it is important to always consider both the nominal interest rate and the inflation.

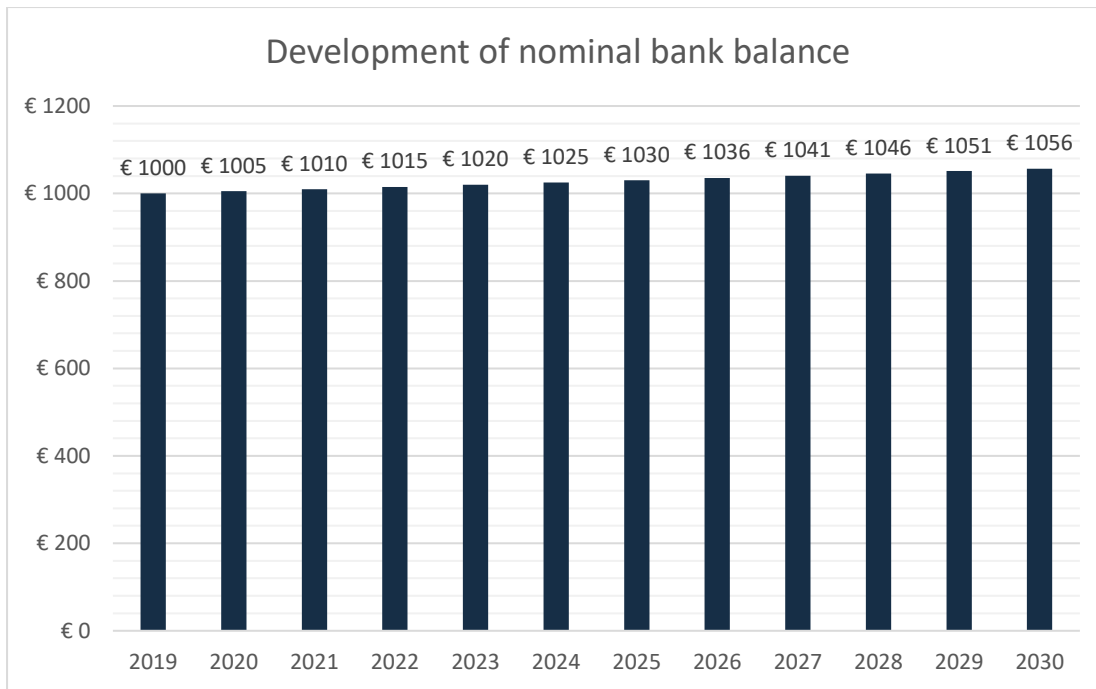


The next questions are about interest rates and inflation. There are no right or wrong answers.

IV. Introduction to main survey questions (control group)

The next page shows important information to help you complete the questionnaire. Please read this information carefully.

If you deposit money in a savings account, you receive interest. Imagine that you deposit 1000 euros in a bank account against a 0.5% yearly interest rate. Over time, supposing you do not withdraw any money from this savings account, your bank balance develops in the following way:



The next questions are about interest rates and inflation. There are no right or wrong answers.

V. Main survey questions

The average nominal interest rate in the Netherlands is 0.1%. The average inflation rate is 2.6% (source: CBS, DNB).

Consider an increase in nominal interest rate to 2.0% per year on all bank accounts and an increase in inflation rate to 4.5%. Assume that nothing else changes. Which statement would describe your reaction best?

10. As a result of these changes...
- A. I am going to spend more (and save less)
 - B. I am not going to change how much money I spend
 - C. I am going to spend less (and save more)

11. Why did you choose for: [answer from question 10]?

[Open question with the possibility to skip the question.]

In addition, we would like to know more about the location where you keep your savings.

12. As a result of the changes in interest rate (0.1% → 2.0% per year) and inflation (2.6% → 4.5% per year)...
- A. I am going to withdraw money from my savings account and store it at home
 - B. I do not change where I keep my savings
 - C. I am going to deposit cash that I previously stored at home into my bank account
 - D. Other: ... [open question]

Now, consider a change in nominal interest rate to -0.5% per year on all bank accounts and a change in inflation rate to 2.0% per year. Assume that all nothing else changes. Which statement would describe your reaction best?

13. As a result of these changes...
- A. I am going to spend more
 - B. I am not going to change how much money I spend
 - C. I am going to spend less

14. Why did you choose for: [answer from question 13]?

[Open question with the possibility to skip the question.]

In addition, we would like to know more about the location where you keep your savings.

15. As a result of the changes in interest rate ($2.0\% \rightarrow -0.5\%$ per year) and inflation ($4.5\% \rightarrow 2.0\%$ per year)...
- A. I am going to withdraw money from my bank account and store it at home
 - B. I am not going to change the location of my savings
 - C. I am going to deposit cash that I stored at home into my bank account
 - D. Else: ... [open question]

16. Do you have any questions or comments as a result of this questionnaire?
- A. No
 - B. Yes >> Continue to question 17

17. Please fill in your comment/question below:

If you would like to receive a response, please fill in your email address:

VI. End of survey

This is the end of the survey. Thank you very much for participating!

8.3. Tables and graphs

Graph 2. Estimated proportions and corresponding sample size (top view)

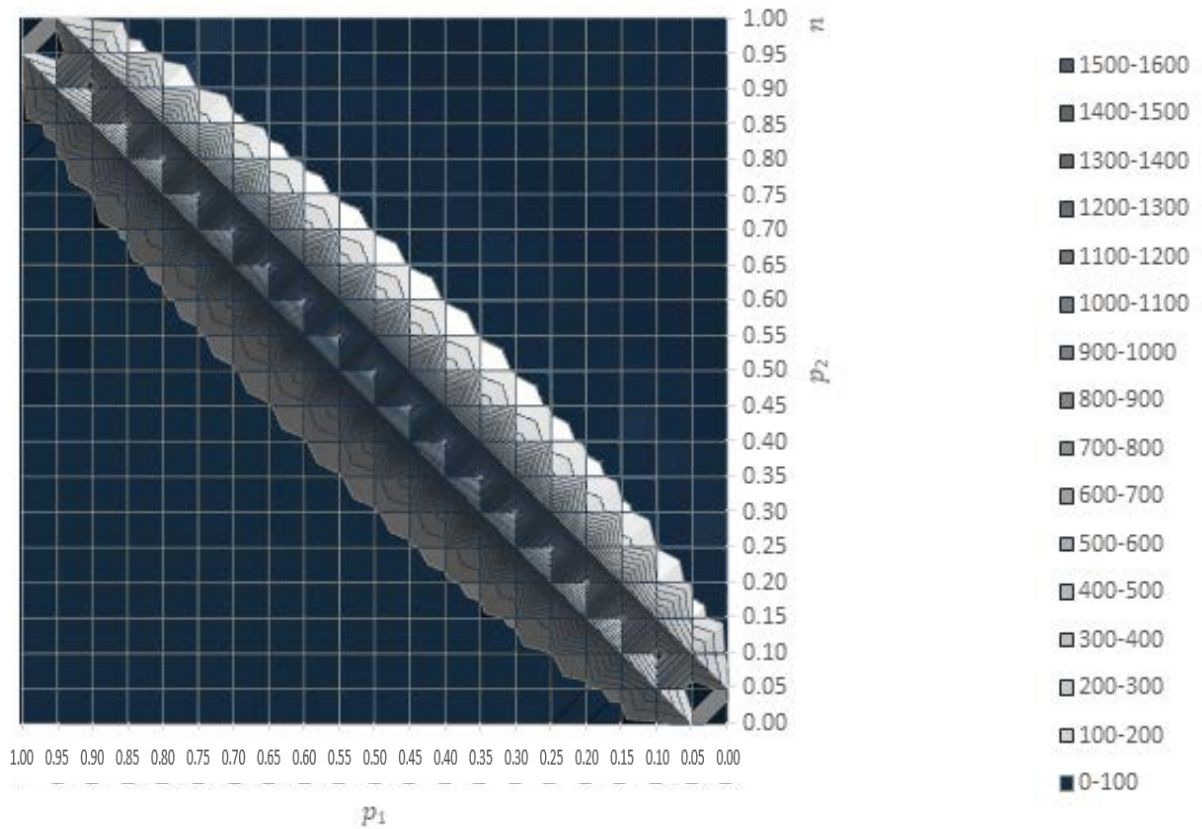


Table 7. Multinomial logit model of decisions about savings location in scenario 2.

<u>Variable</u>	<u>Odds ratio</u>	<u>Standard error</u>	<u>P-value</u>
Deposit more cash versus no change	0.3556	0.4393	0.403
Treatment	0.0879	0.1541	0.165
Intercept			
Store at home versus no change			
Treatment	0.3951	0.1107***	0.001
Intercept	2.1357	0.9087*	0.075
Other versus no change			
Treatment	0.5587	0.1835*	0.076
Intercept	0.7830	0.4007	0.633

Asterisks indicate statistical significance using a two-tailed test. *** indicates significance at the 1% level, ** at the 5% level, and * at the 10% level.