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Pensions and Consumption Decisions

Evidence from the Lab

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Pensions and Consumption Decisions: Evidence From the Lab[*]

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Abstract

Pensioners have increasingly more control over their income streams as a result of pension reforms, which gives them more freedom to save for their old age. We devise an experiment where subjects face a life-cycle optimization task with lifetime uncertainty and a given lifetime income. The aims are to test whether subjects' saving and consumption behaviour is affected by: (i) the steepness of the income profile; and (ii) the freedom to choose the steepness of the income profile before the optimization task. We find that subjects' consumption decisions deviate systematically from the optimal ones in the sense that they are overly sensitive to current income and financial wealth. Subjects' behaviour is unaffected by the steepness of the income profile. When subjects are given such a flexibility their consumption decisions are relatively more sensitive to current income and financial wealth. Subject behavior is unaffected by the steepness of the income profile.

JEL codes: C91, G23, H55
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[§] The third author, Jenny Ligthart, passed away on November 21, 2012. We will always remember her as a very fine friend and an excellent scholar.

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1 Introduction

With the ongoing transition from mandatory pension arrangements to individual accounts and private pension plans that are based on voluntary participation, workers have access to a wider menu of alternatives to finance their old age consumption. This trend shifts the responsibilities from governments and pension funds to pensioners and gives them more control over their income profiles.[1] Typically, pension arrangements are considered to be a useful way to smooth income over ones lifetime, presumably under the assumption that this helps in realizing the optimal consumption path. Despite the fact that pension investments constitute a sizable portion of life-time resources, little is known about the actual behavioural impact of pension arrangements on economic decisions. Given the reforms of the pension systems and the resulting changes in income streams it becomes increasingly important to know how people react to these transforms. In the real world it is rather difficult to investigate these issues as pension arrangements are not easily comparable. For instance, it is hard to account for the risks involved in different pension plans and the expectations of participants regarding their future benefits and contributions are mostly unknown. Another complicating factor in reality is that there often is a lack of control, i.e. many variables may be subject to changes simultaneously, and therefore typically a proper counterfactual is missing. A laboratory experiment, on the other hand, offers the opportunity to control these elements to a large extent. It allows for controlled variation such that it is possible to examine and isolate the effect of a change in one of the relevant variables, while keeping other economic circumstances constant. That is why we investigate these issues in a laboratory experiment. Such a controlled setting allows us to examine the role of pensions in facilitating consumption-smoothing and the consequences of shifting responsibilities to pensioners.

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[1] According to OECD (2008), countries with large private pension markets relative to GDP include the Netherlands (149.1 %), Iceland (147.4 %), Denmark (140.6 %), the United States (124 %), Australia (119.5 %) and Canada (103.4 %).

In order to do so we have designed an experiment in which individuals face an optimization task under uncertain lifetimes. In this framework, we examine the interplay of individuals' consumption decisions and income streams. We examine whether pension schemes that bring the income profile closer to the optimal consumption path have an effect on subjects' decisions. The second aim of our paper is to investigate whether the freedom to choose the pension schedule affects subjects' behaviour compared to the case where pension parameters are exogenously given.

For these purposes, we devised two treatments. In the first treatment, subjects are randomly given one of four possible income profiles. The optimal consumption path is the same in all four cases. However, these income profiles differ from each other in terms of how close they are to the optimal consumption path. When an income profile is further away from the optimal consumption path, the subject could benefit more from consumption smoothing. In other words, he should rely more on his private savings to achieve the optimal consumption path. In contrast to the first treatment, where subjects are confronted with only one of the exogenously determined income profiles, in the second treatment subjects can choose their preferred income profile. Hence, in the second treatment subjects first choose one of four income profiles and then make their consumption and saving decisions given the chosen income stream.

A large part of the traditional economic literature relies on the assumption that people are rational and that optimization models can accurately explain various economic decisions. Behavioural economics, on the other hand, suggests that people may not always behave rationally and make optimal decisions. Moreover, individuals not only often behave irrationally but they also tend to do so in a systematic way. Consequently, people are likely to be predictably irrational (Ariely, 2011). A number of empirical studies indeed argue that the forward-looking optimization assumption might be invalid in the case of life cycle decisions. These studies suggest that when individuals make consumption and investment decisions they might use rules of thumb instead of optimal decision rules, especially when the cognitive cost of optimization is large compared to the utility benefits from optimization (Browning and Crossley, 2001).[2] Also experimental evidence suggests that in the case of life cycle optimization problems, consumption and saving decisions may be systematically biased, possibly due to the fact that rule-of-thumb behaviour is cognitively less costly than optimization. Biases that have been documented in the literature include agents' oversensitivity to current financial wealth (Ballinger et al., 2003) and oversensitivity to their current income (Carbone and Hey, 2004).

In our setup the income profile, and thus the pension size, has no effect on the optimal consumption path and expected welfare. Therefore, according to standard economic theory agents are expected to make the same consumption decisions, irrespective of the income profile. In other words, rational, pay-off maximizing individuals should be indifferent between receiving one income stream or the other and behave similarly in all situations. The flexibility of choosing the income stream beforehand should also not influence their decisions. However, if people are irrational and make systemic errors, as behavioural economics suggests, some streams may lead to better outcomes than others. By comparing decisions across exogenously given income profiles (within the first treatment), we can explore whether or not individuals behave the same given different income streams. Secondly, by comparing decisions across treatments, we can investigate whether the freedom of choosing the pension size has a significant impact on subject behaviour.

Subjects' behaviour in the experiment indicates evidence in favor of systemic deviations from the optimal consumption path. In particular, our results suggest that actual consumption decisions are on average overly sensitive to both current income and financial wealth, whereas the slope of the income profile has no statistically significant effect on

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[2] Several empirical studies find that in violation of the optimization assumption individual consumption decisions are oversensitive to changes in current income (Wilcox, 1989) and to predictable changes in income in the near future. (Shea, 1995; Parker, 1999; Souleles, 1999; Souleles, 2002).

subject behaviour. We also find that the freedom to choose the income profile, on average, reinforces this kind of rule-of-thumb behaviour, in the form of higher oversensitivity of consumption decisions to current income and financial wealth. When people have more flexibility, they do not seem to adopt sophisticated strategies that may prevent them from making systematic errors. On the contrary, on average individuals tend to perform worse when they have more flexibility. We argue that this finding may be due to the fact that when people have the possibility to opt for a specific income profile, they pay less attention to the optimization task, believing that the choice of the income profile already brings them close(r) to the optimal solution.

Several studies claim that after retirement average consumption drops suddenly in a way that is inconsistent with rational optimizing behaviour (Bernheim et al., 2001; Schwerdt, 2005; Haider and Stephens, 2007 and Blau, 2008). Various explanations have been proposed to account for this decline while maintaining the optimization assumption such as, household bargaining (Lundberg et al., 2003), hyperbolic discounting (Angeletos et al., 2001), household production (Hurd and Rohwedder, 2003 and Aguiar and Hurst, 2005) and non-separable preferences over consumption and leisure (Laitner and Silverman, 2005). Interestingly, although none of these explanations is relevant and valid in our experimental design, we do observe overconsumption prior to retirement, followed by an abrupt decline in consumption at the time of retirement. In our experiment, this pattern is primarily driven by the oversensitivity of consumption decisions to income coupled with the large gap between income and optimal consumption prior to retirement. Our results suggest that the oversensitivity explanation may potentially shed light on some of the puzzling consumption trends that take place around retirement.

Our paper is closely related to the branch of the literature which investigates subject behaviour in similar optimization tasks. Hey and Dardanoni (1988) conduct an experiment to examine whether the subjects are able to smooth consumption in the face of income uncertainty. Anderhub et al. (2000) is more closely related to our study, as they adopt an experimental setting with lifetime uncertainty and a deterministic income sequence. Both studies find that subjects often make important mistakes when they deal with an optimization problem. Johnson et al. (1988) gives the subjects different asset/labour earnings mixes with equal present values, and finds that the propensity to consume out of assets is higher than propensity to consume out of labour earnings. One of the few experimental studies that do look at pensions is Fatas et al. (2013). They investigate the effect of receiving lump-sum benefits as opposed to annuities and conclude that lump-sum benefits lead to more cautious behaviour. One difference between our paper and the papers by Johnson et al. (1988) and Fatas et al. (2013) is that our income profiles can be ranked in terms of their closeness to the optimal consumption path. This allows us to examine the causal relationship between the smoothness of the income profile and subject behaviour.

The remainder of the paper is organized as follows. Section 2 presents the basic life cycle model upon which the experiment is based and introduces the experimental design and procedures. Section 3 discusses basic descriptive statistics and the main results. Section 4 concludes.

2 The Experiment

This section sets out the basic life cycle model and discusses the experimental design.

2.1 The Model

In the experiment, subjects deal with a simple version of the life-cycle optimization problem, introduced by Hall (1978). Subjects maximize the following utility function:

$$\Lambda = \sum_{t=1}^{t=20} P_t U(C_t) \tag{1}$$

subject to their flow budget constraint:

$$A_{t+1} = A_t + Z_t - C_t, \qquad A_0 = 0, \qquad C_t \geq 0, \qquad t = 1, \ldots, 20, \tag{2}$$

where C_t is private consumption, $U(C_t)$ is instantaneous utility at period t, P_t is the probability of an agent surviving to period t, A_t is the financial wealth at the beginning of period t, and Z_t is labour related income received at period t. Subjects live for a maximum of 20 periods. Following Ballinger et al. (2003) we assume that the utility function is of the generalized constant relative risk aversion (CRRA) form:

$$U(C_t) = k + \theta \frac{(C_t + \varepsilon)^{1-\sigma}}{1-\sigma}, \tag{3}$$

where σ denotes the elasticity of marginal utility with respect to consumption and k, θ, and ε are adjustment parameters. This general specification of the CRRA function allows us to set σ sufficiently high so that decision errors are costly. If $\sigma > 1$, k should attain a positive value in order to ensure that $U(C_t) > 0$ for positive values of C_t. Whenever $k > 0$, in order to attain $U(0) = 0$ it is necessary to set a positive ε. Although it is possible to ensure that some of the typical properties of the utility function hold, it is not guaranteed that the solution to the problem would be non-negative in the absence of the $C_t \geq 0$ condition.

Subjects receive a constant wage income while they are working, namely until period 12. An individual invests a constant fraction of his wage (τ , $0 \leq \tau \leq 1$) in his pension account during his working life and in return he receives a benefit stream during retirement, that is, from period 13 to 20. Net income in a given period can be expressed as follows:

$$Z_t \equiv \begin{cases} W(1-\tau) & \text{for } 1 \leq t \leq 12 \\ B_t & \text{for } 13 \leq t \leq 20 \end{cases}, \tag{4}$$

where W is the gross wage and B_t is the benefit level in period t. Note that expression (4) fully specifies an income profile, such that differences in income can only be explained by differences in income profiles. All relevant parameters in (3) are set in such a way that the inequality constraints in (2) are non-binding.[3] To accommodate a broad range of income profiles, the benefit profile is assumed to be decreasing in time, such that:

$$B_t = Q - M(t - 13), \qquad M > 0, \qquad 13 \leq t \leq 20, \tag{5}$$

This equation suggests that in the first retirement period (i.e., in period 13) subjects receive a pension benefit Q and in each of the following periods the benefits decrease by M.[4]

The present-value budget constraint of the pension fund is given as follows:

$$\sum_{t=1}^{t=12} W\tau = \sum_{t=13}^{t=20} B_t. \tag{6}$$

It is assumed that a pension fund is able to offer a set of (τ, Q, M) combinations such that for each combination (6) is satisfied. In particular, we consider four scenarios, which are fully determined by the values of these parameters. Small values of τ and Q correspond to a steep income profile with high net wage income and low retirement benefits whereas higher values of τ and Q imply an income profile with a lower net wage income but higher benefits after retirement. The scenario with $\tau = B_t = 0$ corresponds to a situation without pension provision. It is also assumed that the individual cannot choose to opt out of the pension fund once she is in.

Equations (4)-(6) indicate that the return offered by the pension fund is equal to the unconditional market return which is zero. Hence, in this simple model, the pension fund aggregates the individual mortality risks and keeps the resulting profit. More specifically, if at least one individual dies before reaching the maximum age, the pension fund runs

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[3] This condition is deemed necessary, since it is conceivable that a problem with non-linear decision rules is cognitively more demanding than one with linear decision rules. If the inequality constraints are not binding in (2), equations (4)-(6) imply that the optimal consumption profiles are the same for any income schedule offered by the pension fund.

[4] An obvious alternative is to assume a flat benefit profile. However, this assumption is quite restrictive given the parameter values that we use in the experiment. Besides, many countries do not apply indexation such that the pension benefits in real terms actually decrease over time.

a surplus and otherwise it runs a balanced budget at the aggregate level.[5] Equations (4)-(6) ensure that the pension fund affects the steepness of the income profile, but not lifetime income. Therefore, the pension fund has no economic effect other than its possible behavioural effect on decision making. In the experiment, parameters are such that the constraint $0 \leq C_t \leq A_t$ is not binding for any t. Given equations (2)–(6), optimal consumption decision in period q can then be expressed as follows (see Appendix B for the derivation):

$$C_q^* = \frac{A_q + \sum_{t=q}^{t=20}(Z_t + \varepsilon)}{\sum_{t=q}^{t=20}\left(\frac{P_t}{P_q}\right)^{\frac{1}{\sigma}}} - \varepsilon, \qquad 1 \leq q \leq 20. \tag{7}$$

2.2 Experimental Design

In the experiment, subjects receive experimental tokens and are asked to make a series of conversion decisions. The decision problem in the experiment is the analogue of the optimization problem specified in Section 2.1, such that the amount of tokens that subjects receive in each period corresponds to their net period income and the converted amounts correspond to consumption decisions. With each conversion decision part of the token stock is converted to real money, whereas the remaining part of the token stock is saved and can be converted in a later period (see equation (2)).

The money subjects earn depends only on the amount of converted tokens. In other words, any remaining, unconverted tokens have no monetary value. The monetary amounts resulting from the conversion decisions are added up and paid to the subjects privately, in cash, at the end of the experiment. Subjects proceed at their own pace and make their decisions individually and sequentially throughout the experiment. It is not possible

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[5] If the pension fund shares its surplus with the participants, the optimal pension size may no longer be indeterminate but a positive amount. In that case the pension fund effectively issues annuities that provide insurance against longevity risk, and some pension schedules may lead to higher welfare than others. Since it is practically difficult to isolate the role of the pension fund in facilitating better decision making when the optimal pension size is positive, it is assumed that the pension fund does not offer any insurance to the participants.

to change previous decisions at any point in time. At the beginning, subjects know the number of tokens that they receive in each period. In other words, before making any decisions, they are fully informed about the complete income profile.

Subjects can observe the relationship between converted tokens and period earnings in a graph at all times (see instructions in Appendix C). This conversion function is based on (3). We set $\sigma = 1.20$, $\varepsilon = 20$, and $W = 2,000$, which leads to sizable monetary losses for reasonable decision errors. We set $\theta = 0.40$ so that expected average earnings are in line with the usual amounts paid in the lab. Finally, in order to have, $U(0) = 0$, k is set to 1.10. Hence, subjects deal with the following conversion function:

$$U(C) = 1.10 - 2(C + 20)^{-0.2}. \tag{8}$$

During the experiment subjects can use a calculator, built in the screen, which computes the monetary equivalent of a given number of tokens. In addition, each subject has a simple hand calculator at his disposal during the experiment.

In the experiment, subjects may live for a maximum of 20 periods. Therefore, each subject makes a maximum of 20 consecutive consumption decisions which cannot be modified once the decisions are confirmed. In line with equations (4) and (6), it is assumed that subjects receive an exogenous income (gross wage, W) in each period up to period 12. A fixed fraction of this income (τW) is saved as individual pension contributions, which is to be paid back as benefits during retirement, namely after period 12.[6] However, subjects only observe their net income which is equivalent to income net of contributions $(1 - \tau)W$ from period 1 to 12 and benefits $Q - M(t - 13)$ from period 13 to 20. In other words, subjects do not observe the function of the pension fund.[7]

The only type of uncertainty that the subjects face is lifetime uncertainty. Starting

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[6] Assuming that the individual is initially 20 years old and each period corresponds to 4 years, subjects retire at the age of 68 and may live up to age 100.

[7] By informing subjects only about the resulting (net) income in each period and not framing contributions as deductions or losses, we try to minimize the potential effects of loss aversion on our results.

from period 8, the experiment may be terminated depending on the result of a random draw. At the end of period 8, the termination probability, that is the probability that the experiment will not continue to the next period, is equal to 1/13. It is explained (and demonstrated) that this probability is equal to the probability of drawing a red ball out of a bag with 12 blue balls and one red ball.[8] From period 8 until the last period, the termination probabilities increase monotonically such that after period 9, the termination probability is 1/12, after period 10 it is 1/11 and so on. Subjects are told that if they survive to the next period one blue ball is removed from the bag before making a new draw at the end of the next period. We believe that the resulting survival pattern is a good approximation of the actual average mortality rates. Indeed, in the real world, mortality rates are rather low until a certain age, after which they sharply increase.[9] An additional advantage of this design is that it enables subjects to understand and remember the generated pattern easily.

Given these specifications the experimental lifetime can be naturally divided into three intervals. During the first stage, that is from period 1 to 8, subjects receive a constant net wage income and do not face any mortality risk. In the second stage, from period 9 to 12, they keep receiving the same net wage income, yet the probability of death is positive and increasing in each period. Finally in the third stage they do not receive wage income but receive declining benefits and deal with an increasing death probability.

In general, in order to obtain a non-trivial solution to a life cycle optimization problem it is necessary to impose a no-Ponzi game condition, which rules out infinite borrowing. In our case, a stronger restriction is needed since we do not want subjects to leave the experiment

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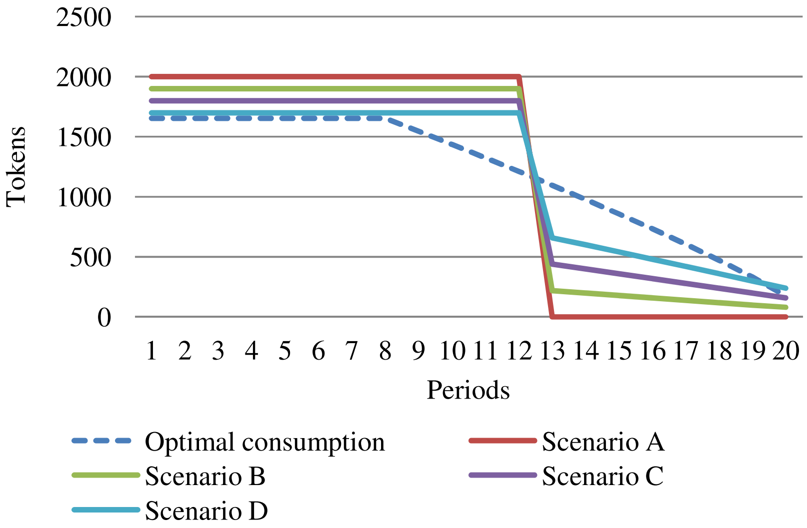
[8] Since subjects may be more sensitive to physical draws as opposed to the electronic ones, a demonstration was made at the beginning of each session using a bag and colored balls aimed at clarifying the notion of a random draw.

[9] Under the same assumptions stated in footnote 6, the correlation between the survival rates in the experiment and the actual average survival rates in the Netherlands is equal to 0.99 ($p = 0.01$). The actual survival rates are obtained from the *Human Mortality Database* of University of California, Berkeley and the Max Planck Institute for the years 2005–2009.

Figure 1: Optimal Consumption and Income Profiles



with negative earnings. To prevent negative earnings we do not allow borrowing against future income (tokens).[10] Hence, in every period, subjects cannot convert more than the sum of unconverted tokens from the previous period and the newly received tokens, *i.e.* $C_t \leq A_t + Z_t$.

Although imposing borrowing constraints solves the problem at hand, it may lead to other complexities, such as binding liquidity constraints. To avoid this, in all treatments parameters are set in such a way that liquidity constraints are not binding at the optimum. That is, along the optimal path the number of converted tokens (C_t^*) is strictly positive and lower than the sum of accumulated tokens and newly received tokens. *i.e.* $0 < C_t^* < A_t + Z_t$.

In the experiment we use four possible scenarios or income profiles, where each scenario is defined by a stream of tokens in each period. These four possible token profiles are shown in Figure 1 and the numerical values are given in Table A1 in Appendix A.[11] Figure 1 also

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[10] We could also have implemented another restriction in which total financial wealth should be bounded away from a negative finite number before period 8, and from period 8 on, it should be bounded away from 0. In order to avoid confusion on behalf of the subjects, borrowing against future tokens is disallowed altogether.

[11] The corresponding τ's are 0, 0.05, 0.10, 0.15, respectively. To keep the structure similar across income profiles the τ/M ratio is fixed. The corresponding M's are 0, 20, 40, and 60.

shows the the optimal consumption path. Scenario A corresponds to the case without a pension fund where, during their working lives (periods 1-12), subjects receive the highest possible income and when retired (periods 13-20), they do not receive any income. The motive for saving is the strongest in the case of scenario A and it weakens as the size of the pension provision increases. Scenario D corresponds to the case with the largest pension provision. In this scenario, the benefits are highest of all scenarios, yet in exchange the net income in the first 12 periods is lower than the pre-retirement income in all of the other scenarios. As can be seen from the figure, the optimal level of consumption is constant in the first 8 periods, when the survival probability is 1 and then it falls gradually over time. The figure illustrates that it is possible to rank the income profiles not only in terms of their steepness, but also in terms of their closeness to the optimal consumption path. Namely, as pension size increases, the income profile gets closer to the optimal consumption path.

We conducted two experimental treatments. In treatment 1, subjects receive one of the income profiles in Figure 1, whereas in treatment 2 subjects have to choose the profile that they would like to receive before they make their first conversion decision. As mentioned, given the parameters if subjects behave optimally throughout the experiment, consumption will be constant during the first 8 periods, it will start declining as of period 9 when mortality risk kicks in and it should continue declining during retirement. We investigate whether the decisions are consistent with these predictions. More importantly, standard economic theory predicts that subjects' behaviour does not depend on treatment or scenario, *i.e.* our null hypothesis is that the consumption decisions are the same across all scenarios and treatments. As indicated in the introduction, behavioural economics and experimental evidence suggest that people may not always behave rationally but may make systematic errors. Therefore, the first alternative hypothesis is that the presence of a pension provision, or equivalently, the steepness of the income profile does have an effect on subject behaviour. To test this hypothesis, we compare subject behaviour given different income profiles in treatment 1. The second alternative hypothesis is that subjects may behave differently when they have the ability to choose the size of the pension fund, or in other words, the slope of the income profile. We test this hypothesis by comparing decisions in treatments 1 and 2. Even if behavioural biases play a role, it is not so clear whether and how people may be affected by income profiles and treatments. Whether subjects make better decisions in one scenario or treatment than in another remains an empirical question and we do not want to speculate about the hypothesized direction of possible differences.

2.3 Experimental Procedure

Invitations were sent to Tilburg University students who have previously indicated that they would like to participate in economic experiments that take place on campus. 127 participants responded positively to the invitation and took part in one of the two treatments (65 in treatment 1 and 62 in treatment 2). Subjects participated in only one of the 10 experimental sessions and in each session only one treatment was run. All sessions were run in CentERlab at Tilburg University. Following their arrival at the lab, subjects were randomly seated behind computer terminals, instructions were distributed and read aloud by the experimenter. In order to familiarize subjects with the experiment, they were presented a quiz form before the experiment. The questions on the form are based on the design of the actual experiment and are specifically aimed at improving the subject's understanding of conditional probabilities. In treatment 1, subjects were confronted with one of the four possible scenarios; all subjects in a session faced the same scenario. In treatment 2, subjects were confronted with all four scenarios and had to select one. Each session lasted on average about an hour, but since survival probabilities were individually and randomly drawn some subjects finished much earlier than others.[12] In the experiment, subjects converted their tokens to money which they received at the end of the session. Earnings range from €2.16 to €12.32 with an average of €10.16 and a standard deviation of €2.53.

3 Results

This section discusses descriptive statistics and analyzes the results. Subsection 3.1 includes an aggregate level analysis whereas individual behaviour is examined in more detail in subsection 3.2.

3.1 Descriptive Statistics

This section reports and discusses aggregate statistics concerning scenario selection, consumption decisions and earnings. Absent any decision errors all scenarios would lead to the same expected payoff. Even if subjects make decision errors, expected payoff will be the same across scenarios as long as the decisions errors are random. Different scenarios would only lead to different expected payoffs if subjects make systematic decision errors rather than random ones. Therefore, a rational payoff-maximizing subject is expected to be indifferent between scenarios in treatment 2. She may have a strict preference for a particular income profile, only if she makes systemic decision errors and is sophisticated enough to realize that some scenarios lead to higher payoffs than others given these errors. An example of such a systematic error is a bias to consume the entire period income in each period. A subject who converts tokens according to this rule will in expectation earn the highest possible amount if she chooses scenario D. She would indeed choose this scenario if she knows that she will consume her period income in each period. Apart from that,

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[12] We believe that subjects understood the survival rates and believed that they were truly randomly determined. We have not received any questions on this aspect of the experiment.

Table 1: Average Consumption and Average Earnings (Euros)

		Consumption				
Treatment	Scenario	A	B	C	D	All
1	Mean	1456.63	1433.78	1536.57	1349.98	1437.87
	Std dev.	926.48	767.94	875.37	551.28	825.11
	Number of obs.	462	167	99	202	930
2	Mean	1427.93	1543.25	1417.74	1447.34	1459.70
	Std dev.	830.14	859.92	1092.02	545.56	814.40
	Number of obs.	318	205	104	215	842
Both	Mean	1444.93	1494.11	1475.69	1443.10	1448.24
	Std dev.	888.03	820.64	991.64	549.84	819.88
	Number of obs.	780	372	203	417	1772
		Earnings				
Treatment	Scenario	A	B	C	D	All
1	Mean	8.54	8.32	7.39	9.50	8.55
	Std dev.	2.00	1.79	2.05	2.41	2.10
	Number of obs.	32	12	8	13	65
2	Mean	8.35	7.26	8.79	8.36	8.10
	Std dev.	1.86	2.34	2.20	2.24	2.15
	Number of obs.	22	17	7	16	62
Both	Mean	8.46	7.70	8.04	8.87	8.33
	Std dev.	1.93	2.16	2.16	2.35	2.13
	Number of obs.	54	29	15	29	127

people may have preferences that are not in line with standard economic assumptions. For instance, if people value flexibility, they may choose scenario A in treatment 2, as it offers the highest incomes before retirement and is most flexible.

Table A.2 in Appendix A shows the number of subjects across treatments and scenarios. First, we ran several sessions of treatment 2, in which subjects could choose their preferred scenario. Scenario A was by far the most popular choice, followed by scenarios B and D, which were almost equally likely to be chosen. Although all income profiles have a positive and reasonable chance of being chosen, not all scenarios are equally popular; the hypothesis that scenarios are selected randomly by the subjects can be rejected at the 1 percent level ($p = 0.01$).[13] In treatment 1, the numbers of subjects per scenario are exogenously determined. Here we allocated subjects to scenarios such that the numbers correspond reasonably well to the endogenous allocation in treatment 2.

Table 1 presents the average consumption (top panel) and average earnings (bottom panel) in each scenario for both treatments. The average consumption is the average number of tokens that is converted in each period in the given scenario/treatment. At a first glance, differences between treatments and differences between scenarios are relatively small. For example, average earnings in treatment 1 are €0.45 higher than in treatment 2. Note, however, that it is hard to draw any conclusions based on these averages because they depend on the realized lifetimes. A subject who has a lifetime of 8 periods is likely to have relatively high average consumption and relatively low earnings. Since lifetimes were truly randomly determined and the number of subjects in some scenarios is low, the realized lifetimes may not be evenly distributed across scenarios and treatments. In addition, these averages do not show the development of decisions across periods. To that end, the next section will present a more elaborate analysis.

3.2 Analysis of the Results

The analysis begins with the comparison of actual consumption decisions with the optimal consumption profile. The latter variable can be defined in two different ways and both definitions are considered below. According to the first definition it is simply the *ex-ante* optimal lifetime consumption profile at the beginning of the experiment. The second definition involves re-calculation of the optimal consumption path in each period based on

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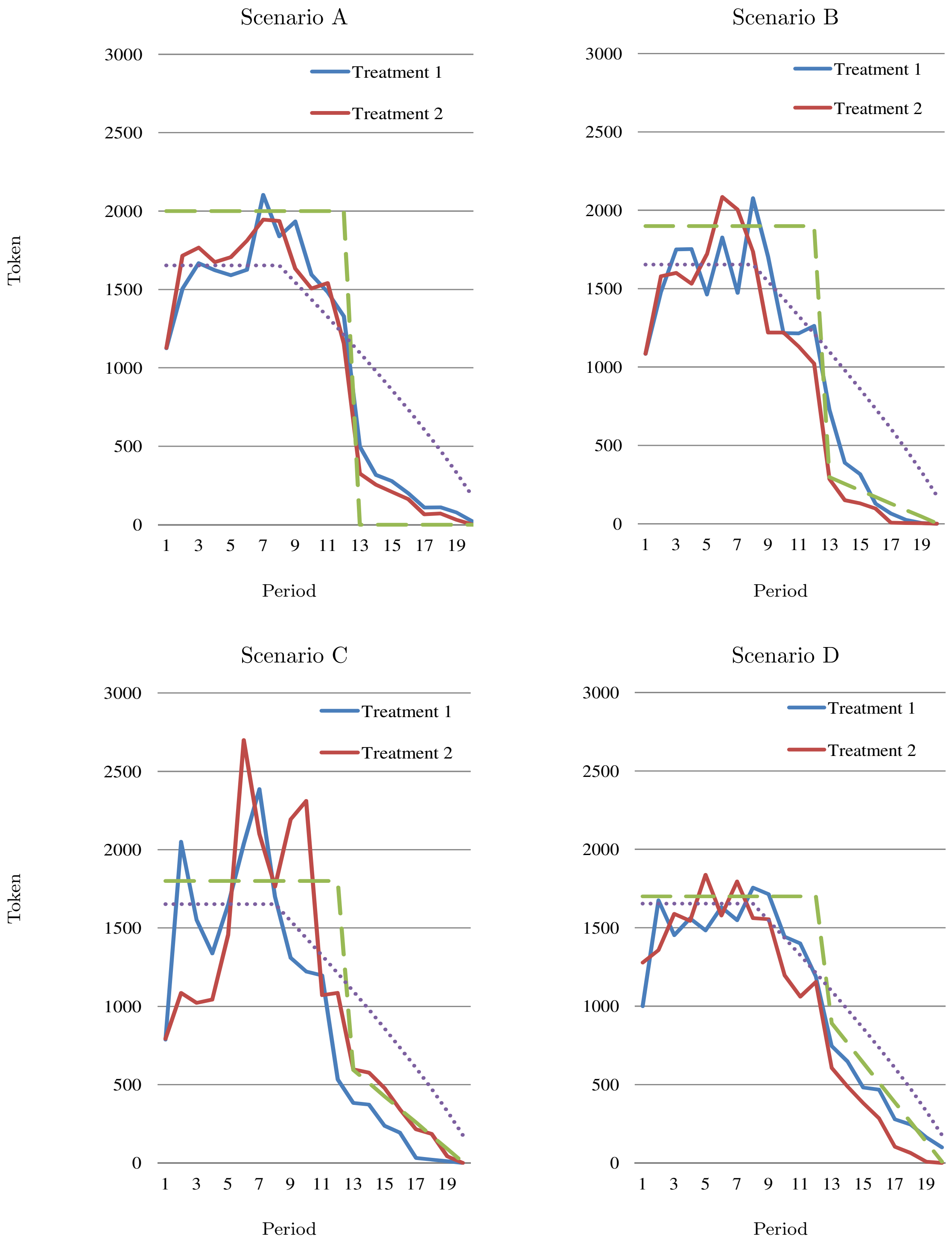
[13] Selection of scenarios is characterized by a multinomial distribution where the probability of a subject selecting into each scenario is equal to 0.25.

(7). The two versions of the optimal consumption profile are referred to as *ex-ante* optimal consumption profile and *ex-post* optimal consumption profile, respectively. They differ only if subjects deviate from the ex-ante optimal path. For instance, if a subject consumes 500 less than the optimal amount in period 2, this would not affect the optimal consumption in period 3 according to the ex-ante measure whereas according to the ex-post definition the optimal consumption in period 3 and in all later periods would be higher than what they would be if the period 2 consumption were optimal. Note that in any given period ex-ante optimal consumption is the same for all subjects whereas ex-post optimal consumption can be different for each subject.

3.2.1 Graphical Analysis

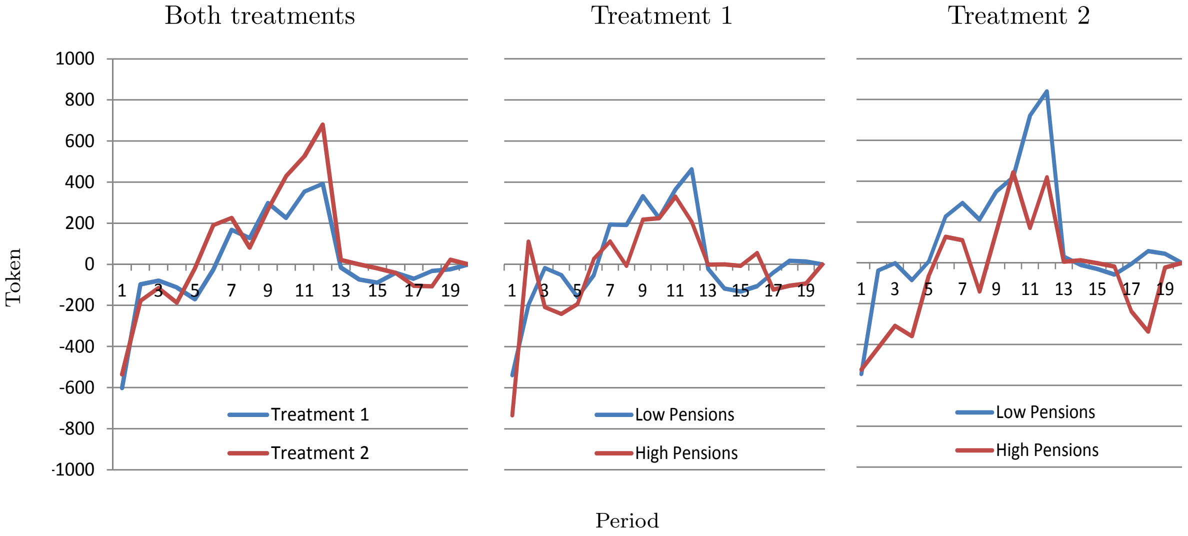
Figure 2 shows the income profile, the ex-ante optimal consumption path and the average consumption for both treatments. Each panel refers to one specific scenario. Although the relationship between income profile and average consumption levels is not immediately clear from the graphs, they allow for some general observations. First, while actual consumption is roughly in between the income and the ex-ante optimal consumption, it typically follows the (exogenously given) income pattern quite closely. Second, there seem to be quite substantial differences across panels, suggesting that although the optimal consumption path does not depend on the scenario, actual consumption decisions are affected by the income profiles. Third, within the panels, the difference between average consumption in treatments 1 and 2 seems to be rather small. The last general observation is that regardless of the scenario and treatment, subjects convert on average rather low amounts in the very first period and then increase their consumption in the next period. It should be noted that the closeness of average consumption decisions to optimal consumption decisions does not necessarily reveal average subject performance, since one subject's overconsumption may be offset by another subject's under-consumption. Nevertheless, the figure depicts

Figure 2: Actual and Ex-ante Optimal Consumption per Income Profile



Note: The dotted and dashed lines represent the ex-ante optimal consumption profile and the income profile respectively.

Figure 3: Actual Consumption Minus Optimal Consumption


Both treatments

Treatment 1

Treatment 2

average overconsumption and under-consumption trends throughout the life-cycle. Note, however, that these findings are based on the ex-ante definition of optimal consumption.

Alternatively, by considering the ex-post measure, one can account for the changes in the optimal profile as the subject progresses in the experiment. For this purpose Figure 3 depicts the evolution of the gap between the ex-post optimal consumption and actual consumption in a given period, averaged across the subjects. Because the number of observations in each scenario is limited, in the analyses that follow, observations that fall under scenarios A and B are pooled together and together they are referred to as the low-pensions category. Similarly, scenarios C and D constitute the high-pensions category. The left panel displays the gap measure at the treatment level aggregated over all scenarios. The middle (right) panel presents the gap for the low and high pension scenarios separately for treatment 1 (2). According to the left panel of the figure, on average the evolution of the gap is quite similar in both treatments: the difference being negative in the first periods, positive in the middle periods and close to zero in the last periods. Furthermore, the figure shows that subject averages move together for high and low-pension profiles especially in treatment 1. In treatment 2, subjects who choose low-pensions on average consume

Table 2: Consumption patterns

		Treatment 1		Treatment 2	
		Low pensions	High Pensions	Low pensions	High Pensions
(a)	Average decline in optimal consumption at retirement	9.50%	9.50%	9.50%	9.50%
	Average decline in actual consumption at retirement	37.25%	21.42%	60.67%	36.21%
	Number of observations	28	12	22	14
(b)	Share of subjects whose consumption drop after period 12	64.29%	66.67%	31.82%	35.71%
(c)	Share of subjects that consume a constant amount during the first 8 periods	79.55%	65.00%	69.23%	65.22%
	Share of subjects whose consumption drop after period 8	22.73%	11.77%	9.68%	4.34%
(d)	Average decline in actual consumption after period 8	26.61%	0.44%	3.40%	19.35%
	Average change in optimal consumption after period 8	-6.53%	-6.53%	-6.53%	-6.53%
	Number of observations	43	18	31	22

consistently more than subjects who choose high pensions.

Taken together, Figures 2 and 3 suggest that there is a substantial change in consumption levels around retirement age. In addition, in the second stage (periods 9-12) overconsumption is evident, and more so in treatment 2 and for the low pension scenarios. Finally, in the third stage (periods 13-20), the subjects tend to under-consume on average, although this trend is not as pronounced.

3.2.2 Numerical Analysis

The observed drop in consumption at the time of retirement is of particular interest. Several empirical studies have found a strong decrease in consumption immediately after retirement, which is not in line with the predictions of standard life-cycle models. Possible explanations for this consumption pattern include household production, hyperbolic discounting, within household bargaining, and non-separable preferences over consumption and leisure (see Laitner and Silverman, 2005). Even though all these alternative explanations can be ruled out in our case we nevertheless observe a sizable drop in consumption. The optimal decline in consumption from period 12 to period 13 is 9.50% and it does not depend on the scenario or treatment (see first row of Table 2). As can be seen from the second row of the table, the average actual decays range from about 21% to 60%. The actual declines are much larger than the optimal one and the differences between the drops in actual and optimal consumption are statistically significant in all cases except for the high pensions scenario in treatment 1 ($p = 0.15$, all other $p < 0.05$, Wilcoxon signed ranks tests). Furthermore, the average decline is significantly larger when subjects choose the income profile (treatment 1 versus 2 gives $p = 0.014$ for low pensions and $p = 0.067$ for high pensions) and also larger for low pensions than for high pensions, but only significantly so in treatment 2 ($p = 0.034$ in treatment 2 and $p = 0.337$ in treatment 1)[14]. In Table 2, row labeled (b) shows the share of subjects that reduce their consumption when retired, so after period 12. Remarkably, the percentages in treatment 1 are about twice as high as in treatment 2. However, this difference between the treatments is not statistically significant ($p=0.25$). Hence, even in such a stylized environment as ours we observe an abrupt decline in consumption after retirement for a considerable number of people. Perhaps more importantly, the magnitude of the drop and the fraction of people experiencing this depend on the income profile and even more strongly on whether or not the scenario is exogenously determined. We think that this is a novel and interesting observation, which would be hard to detect outside the controlled environment of an experiment and which could have important consequences for real-world situations.

The bottom half of Table 2 gives some insights about subjects behaviour before retire-

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[14] Note that the number of observations is lower than the number of subjects in each treatment/scenario as not all subjects reach the retirement age.

ment. As indicated in the first row of the part labeled (c), a majority of subjects consume a constant amount during the first 8 periods, which is in line with standard economic theory. In contrast to the standard predictions, however, very few subjects turn out to react to the uncertainty in lifetime introduced after period 8 by reducing their consumption. Again, the share of people responding in the right direction is higher in treatment 1 compared to treatment 2, although the difference is not statistically significant (p=0.31). A similar difference can be seen when comparing the low and high pension scenarios, and this difference is independent of the treatment. Finally, the last three rows of the table, labeled (d), show that the average change in actual consumption after period 8 is positive in all scenario and treatments, although the theory predicts a decline of 6.53%. The actual change in consumption exceeds the optimal change significantly in the case of Treatment 1 - High pensions (p=0.018), Treatment 2 - Low pensions (p=0.093), Treatment 2 - Low pensions (p=0.0663) but not in the case of Treatment 1 - Low pensions (p=0.158). The next sections try to shed some more light on these observations.

Although Table 1 suggests that average consumption and average earnings are similar both across treatments and pension profiles, differences in individual behaviour could still exist. Indeed, the results of the previous subsection indicate that there may be reasons to suspect that subjects behave differently in different settings. Therefore, we look more closely into individual behaviour. In particular, we investigate if subjects employ simple suboptimal decision rules and if the prevalence of these decision rules differ across settings.

Given the relative complexity of the task it is not reasonable to expect subjects to be able to follow the optimal decision rule precisely. Instead, as also suggested by previous experimental findings, subjects may rely on simple, suboptimal decision rules. There are virtually an unlimited number of decision rules that subjects could use when making consumption decisions. In the following analysis, three natural candidates are considered: (1) consuming a constant amount; (2) consuming a constant fraction of income; and (3) consuming a constant fraction of financial wealth in each period. In addition to these strategies, a subject may employ any combination of these pure strategies. For example, one subject's responses may be best explained by a linear combination of (1) and (3), whereas another subject may only follow decision rule (2). It is also possible that subjects follow the optimal consumption profile closely and do not employ any of the three decision rules systematically. We test empirically whether linear combinations of these rules are employed. If optimal consumption is not controlled for its effect on the actual consumption decision will be picked up by other variables since optimal consumption is a function of current income and financial wealth. For this reason, based on equation (7) an ex-post optimal consumption variable is created and added to the set of explanatory variables.

As a precursor to a more detailed analysis, the explanatory power of these decision rules is tested on an aggregate level without any individual-specific effects. In these estimations, actual consumption is explained by optimal consumption, current income, current financial wealth and a constant, which are possible determinants of actual consumption decisions. If the subjects decided optimally or made random decision errors, the coefficient of the optimal consumption variable would be the only statistically significant determinant of actual consumption decisions and it would be equal to or very close to 1. If any of the explanatory variables other than optimal consumption turn out to be significant, this indicates that on average subjects employ sub-optimal decision rules systematically and therefore exhibit behavioural biases.

Table 3 presents the regression results for all secenarios together. Columns 2 and 3 (5 and 6) show the results for both treatments separately when a constant term is included (not included). To explore differences between the two treatments columns 4 and 7 show the estimates when both treatments are taken together and interaction terms are included for treatment 2, with and without a constant term respectively. Despite substantial variation in subject performance, actual consumption loosely tracks optimal consumption in both

Table 3: OLS Regressions

	With constant term			Without constant term		
	Treatment 1	Treatment 2	Both	Treatment 1	Treatment 2	Both
Optimal consumption	0.255***	0.036	0.255***	0.424***	0.147**	0.424***
	(0.078)	(0.077)	(0.076)	(0.070)	(0.073)	(0.068)
Income	0.442***	0.667***	0.442***	0.471***	0.724***	0.471***
	(0.053)	(0.058)	(0.052)	(0.053)	(0.057)	(0.052)
Financial wealth	0.036**	0.058***	0.036***	0.034**	0.058***	0.034**
	(0.014)	(0.016)	(0.014)	(0.014)	(0.016)	(0.014)
Treatment 2 dummy			-40.727			
			(96.027)			
Treatment 2 dummy x Optimal consumption			-0.219**			-0.277***
			(0.110)			(0.102)
Treatment 2 dummy x Income			0.225***			0.253***
			(0.079)			(0.078)
Treatment 2 dummy x Financial wealth			0.022			0.024
			(0.022)			(0.022)
Constant	318.026***	277.299***	318.026***			
	(69.296)	(66.218)	(67.436)			
N	930	842	1772	930	842	1772
R-squared	0.26	0.33	0.30	0.81	0.84	0.83

Note: The dependent variable is the actual consumption decision. Standard errors are presented in parenthesis. ***,** and * denote significance at 1 percent, 5 percent and 10 percent levels.

treatments. In the regressions where the constant term is excluded, the coefficient of the optimal consumption variable is substantially lower than 1, which indicates that decisions are on average far from optimal. In theory, the marginal propensity to consume out of current income should be the same as marginal propensity to consume out of financial assets excluding current income. However, both variables should be irrelevant once optimal consumption is accounted for. In all specifications the coefficients of current income and financial wealth are statistically significant. The magnitude of the coefficients indicates that in both treatments subjects are rather sensitive to current income and to a smaller extent to financial wealth. This means that when income is higher (lower) subjects tend to consume more (less), even when other factors are controlled for.

As optimal consumption starts declining after period 8, the wedge between income and optimal consumption steadily increases until period 12. Given this pattern, oversensitivity of consumption to current income leads to considerable overconsumption before retirement, which corroborates the picture arising from Figures 2 and 3. After retirement, income declines substantially which may cause consumption to get closer to optimal consumption and even fall below it, as we also observed in the graphs.

The estimation results in columns 4 and 7 can be used to test whether the coefficients are significantly different across treatments. Column 4 shows that in treatment 2, the consumption decisions are significantly less sensitive to optimal consumption and significantly more sensitive to current income than in treatment 1. When the constant term is excluded the results remain qualitatively similar, as exhibited in column 7. Therefore, our findings suggest that when people can chose their pension provision (in treatment 2), they base their consumption decisions on current income more than people who are assigned to a specific pension provision (as in treatment 1). It is possible that this pattern arises because subjects in treatment 2 are consuming exactly their income more frequently than subjects in treatment 1. In the experiment, subjects are found to frequently choose a consumption level that is equal to their current income. The frequency of such observations is higher in treatment 2 (25.77%) than in treatment 1 (17.87%), and the difference is significant according to a χ-squared test ($p = 0.01$). Therefore, the higher coefficient of the current income variable in treatment 2 is at least partly driven by observations where consumption is equal to current income.

3.2.3 Individual Effects

The analysis based on ordinary least squares regressions (OLS) regressions gives a general idea about average decision patterns across treatments and pension profiles. However, some of the assumptions behind these specifications may be considered to be restrictive and could be replaced by more realistic ones. For example, although it is plausible that each subject follows a different decision rule and therefore explanatory variables may have different weights for each subject, the OLS regressions do not allow for individual specific effects. To capture this type of unobserved heterogeneity, we incorporate individual effects to both the constant term and the other coefficients. One way to introduce individual effects is to use fixed effects, which is equivalent to the pooled OLS analysis with individual dummies and interaction terms that involve individual dummies and other regressors. Since the number of variables to be estimated becomes very large, it is often assumed that each individual effect is drawn from a population with a certain statistical distribution and then the unknown parameters of this distribution are estimated. This specification is known as the random effects or random coefficients specification (Greene, 2003). The empirical model is defined as follows:

$$C_{it} = (\beta^0 + \alpha_i^0) + (\beta^1 + \alpha_i^1)C_{it}^* + (\beta^2 + \alpha_i^2)Z_{it} + (\beta^3 + \alpha_i^3)A_{it} + \epsilon_{it}, \tag{9}$$

where α_i^k's are the individual effects, β^ks are the coefficients and ϵ_{it} is the error term. With treatment effects this linear model can be expressed as:

$$\begin{aligned} C_{it} \; = \; & (\beta^0 + \alpha_i^0) + (\beta^1 + \alpha_i^1)C_{it}^* + (\beta^2 + \alpha_i^2)Z_{it} + (\beta^3 + \alpha_i^3)A_{it} + (\beta^4 + \alpha_i^4)D_i + \\ & (\beta^5 + \alpha_i^5)D_iC_{it}^* + (\beta^6 + \alpha_i^6)D_iZ_{it} + (\beta^7 + \alpha_i^7)D_iA_{it} + \epsilon_{it}, \end{aligned} \tag{10}$$

where D_i is a treatment dummy, which is equal to 1 if subject i is in treatment 2.

In both random coefficients specifications, it is assumed that each one of the α_i^k terms is drawn from different normal distributions with zero mean and unknown variance such that:[15]

$$\alpha_i^k \backsim N(0, {\sigma^k}^2) \text{ for } \forall \text{ k} \tag{11}$$

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[15] The random effects specification is also referred to as mixed effects specification as the random individual effects are broken into two parts, namely the fixed part, β^k terms, and the random, individual specific part, α_i^k terms.

The residual term is also drawn from a normal distribution:

$$\epsilon_{it} \backsim N(0, \eta^2)$$

Finally, we have to make assumptions about the covariances between different random coefficients. We will consider two possibilities. According to the first specification, which corresponds to columns 2-4 in Table 4, it is assumed that different types of individual fixed effects have zero covariance:

$$\mathrm{Cov}(\alpha_i^k, \alpha_i^l) = 0 \text{ for k} \neq \text{l} \tag{12}$$

Note that this assumption may be restrictive, since in practice subjects may substitute one decision strategy with another decision strategy, which means that individual fixed effects that correspond to different variables do not have zero covariance. According to the second specification, the results of which are shown in columns 5-7 in Table 4, the covariance structure between the individual effects is more flexible, such that:

$$\mathrm{Var}\begin{bmatrix} \alpha_i^0 & \dots & \alpha_i^7 \end{bmatrix} = \begin{bmatrix} M & 0 \\ 0 & N \end{bmatrix} \tag{13}$$

where M and N are 4×4 matrices. According to this assumption individual random effects can be correlated with each other in a given treatment, whereas they are uncorrelated across treatments. If these assumptions are correct, random effects estimates obtained by maximum likelihood estimation will be consistent and efficient (Greene, 2003).

The regression results are presented in Table 4, which is organized in a similar way as Table 3. The random coefficients specifications lead to similar results as the pooled OLS results. As in the case of OLS regressions, according to the null hypothesis of no systemic decision errors, only the coefficient of optimal consumption should be statistically significant and close to 1. In all specifications, however, the coefficient of optimal consumption is

Table 4: Random Coefficients Regressions

	Without covariance			With covariance		
	Treatment 1	Treatment 2	Both	Treatment 1	Treatment 2	Both
Optimal consumption	0.330***	0.023	0.330***	0.248***	-0.019	0.264***
	(0.082)	(0.084)	(0.079)	(0.099)	(0.092)	(0.092)
Income	0.370***	0.664***	0.365***	0.434***	0.669***	0.419***
	(0.060)	(0.065)	(0.057)	(0.074)	(0.071)	(0.068)
Financial wealth	0.139***	0.208***	0.145***	0.143***	0.215***	0.148***
	(0.024)	(0.031)	(0.024)	(0.029)	(0.035)	(0.028)
Treatment 2 dummy			-72.439			-20.082
			(105.571)			(111.690)
Treatment 2 dummy x Optimal consumption			-0.333***			-0.287**
			(0.123)			(0.147)
Treatment 2 dummy x Income			0.310***			0.257**
			(0.092)			(0.111)
Treatment 2 dummy x Financial wealth			0.098**			0.083*
			(0.045)			(0.049)
Constant	178.721**	137.018**	182.193***	164.740**	188.284***	172.167**
	(71.161)	(66.369)	(69.377)	(72.747)	(67.563)	(71.741)
N	930	842	1772	930	842	1772
BIC	14817.516	13313.700	28169.169	14780.018	13297.762	28113.025

Note: The dependent variable is the actual consumption decision. Standard errors are presented in parenthesis. ***,** and * denote significance at 1 percent, 5 percent and 10 percent levels.

considerably and significantly below one and in treatment 2 it is not significantly different from zero. As before, the coefficients of income and financial wealth variables are positive and statistically significant.[16] Also, as in the pooled OLS case, the coefficients differ considerably across treatments but most patterns are qualitatively similar to the previous ones. Given either covariance structure, subjects in treatment 2 tend to base their decisions significantly more on current income and financial wealth while at the same time they put significantly less weight on the optimal consumption profile compared to subjects in treatment 1.

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[16] When the constant term is excluded the results are quite similar. These regression results are not reported for the sake of brevity, but are available upon request.

In all specifications the estimated coefficient of the income variable is considerably higher than that of the financial wealth variable whereas sample averages of these variables are close, 1,566.98 and 1,625.57, respectively. It can be concluded that, on average, oversensitivity to current income may lead to a much larger deviation from the optimal solution than oversensitivity to financial wealth. The coefficient of the constant term does not differ significantly across treatments, although it is arguably similar to the other two strategies in terms of both simplicity and effectiveness.[17]

Figure 4 shows the average predictions of the model for each treatment. The figure suggests that our model captures some of the pronounced features in the data. According to the figure, the average predicted consumption is higher than optimal consumption between periods 10 and 12 and lower than optimal consumption after period 12. This pattern is roughly in line with the pattern of actual consumption shown in the left panel of Figure 3. The model also predicts higher consumption in treatment 1 than in treatment 2 between periods 10 and 12 which is also observed in the left panel of Figure 3. Nevertheless, this predicted difference between treatment 1 and treatment 2 is smaller than the actual difference. Therefore, there could be other factors affecting consumption decisions which are not accounted for in our model.

Our results imply that the decision rules that the subjects seem to employ to make their consumption decisions depend on the freedom to choose the pension fund. The signs and statistical significance of the interaction terms in Tables 3 and 4 indicate that, in treatment 2, where subjects have freedom to pick their income streams, their consumption decisions are on average more likely to be based on simpler, sub-optimal decision rules and less likely to follow the optimal consumption path. Standard economic theory would suggest that, if anything, the decision problem in treatment 2 is easier because subjects have more

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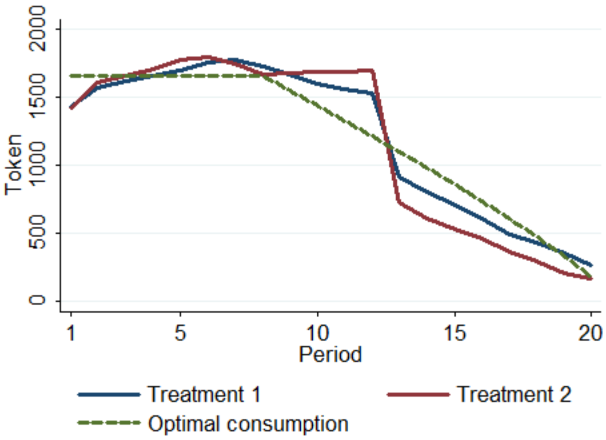
[17] In Table A.4 in the Appendix, we do not control for optimal consumption. According to our results, in the "without covariance" specification consumption decisions are more sensitive to current income in treatment 2. In the "without covariance" specification, we do not find a statistically significant difference between the two treatments.

Figure 4: Predicted values (columns 1 and 2 in Table 4)



information, i.e. about four possible income profiles, than in treatment 1. Nevertheless, subjects' behaviour in treatment 2 seems to be worse than in treatment 1.[18]

Although it is difficult to identify the exact reasons for these findings we would like to speculate about some possible explanations. The way the problem is presented in both treatments is not the same. In treatment 2, subjects may be possibly led to think that one of the scenarios provides the best answer to the given problem. As a result, they may believe that once the right stream is chosen, consumption decisions should follow the income stream very closely. This reasoning could explain why the coefficient of current income is higher in treatment 2, but it fails to explain the larger coefficient of the current financial wealth variable in treatment 2. The findings in this section also suggest that basing decisions on current income or financial wealth may be regarded as a substitute for basing decisions on the optimal consumption profile, since, when the explanatory power of optimal consumption is lower (higher), the explanatory power of both current income and

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[18] A more direct measure of subject performance may be the realized efficiency in each scenario. For each subject, the realized efficiency of all consumption decisions is computed by dividing the realized payoffs by the maximum possible payoffs given the realized lifetime. For each scenario, the average efficiency can be calculated by taking the average of all subjects in that particular scenario and treatment. As it is shown in Table A.3 in Appendix A, the realized levels of efficiency are rather high in all scenarios and treatments. This suggests that the decision errors made by the subjects do not translate into significant monetary losses. In both treatments the efficiency is highest in the scenario with the flattest income profile, scenario D.

financial wealth is higher (lower). In a similar vein, following the optimal consumption profile could be considered to be more challenging than employing simpler, suboptimal decision rules. Since subjects tend to follow simple suboptimal decision rules especially in treatment 2, it may be argued that subjects pay relatively less attention after they have chosen the income stream. This argument would be in line with the two system approach of Kahneman (2011). Kahneman argues that there are two types of reasoning which affect behaviour. System 1 type reasoning is a thought process which is fast, automatic and habitual, wheras system 2 type reasoning corresponds to a slower and conscious type of thinking. In treatment 1 subjects are exposed to one, complex, problem which may trigger deep, system 2 type, reasoning. In contrast, in treatment 2, subjects first have to choose the scenario which may also be considered a cognitively demanding, non-trivial decision. This choice may also evoke system 2 type thinking. After subjects have chosen the scenario they may rely on relatively simple, intuitive and effortless rules such as rule-of-thumb rules that are considered above. This type of thinking corresponds to the system 1 thinking in Kahneman's terminology.

We also examine the differences across income profiles (see Table 5). Although subjects behave differently across treatments, differences in behaviour across scenarios are statistically insignificant. Within each treatment, consumption decisions are equally sensitive to optimal consumption, income and financial wealth in the case of low and high pension profile, as it is depicted in Table 5. This pattern is observed both when income stream is given and when it is chosen.

Table 5: Random Coefficients Regressions

	Treatment 1			Treatment 2			Both treatments	
	Low pension	High pension	Both	Low pension	High pension	Both	Low pension	High pension
Optimal consumption	0.256**	-0.069	0.270**	-0.021	-0.108	-0.013	0.274**	0.023
	(0.126)	(0.175)	(0.118)	(0.115)	(0.178)	(0.111)	(0.116)	(0.183)
Income	0.399***	0.725***	0.394***	0.662***	0.759***	0.666***	0.387***	0.660***
	(0.084)	(0.165)	(0.081)	(0.079)	(0.161)	(0.080)	(0.076)	(0.159)
Financial wealth	0.128***	0.316***	0.142***	0.240***	0.223***	0.214***	0.142***	0.239***
	(0.034)	(0.091)	(0.033)	(0.050)	(0.052)	(0.044)	(0.034)	(0.071)
High pension dummy			118.665			133.453		
			(208.350)			(174.146)		
High pension dummy x Optimal consumption			-0.356			-0.190		
			(0.279)			(0.238)		
High pension dummy x Income			0.328			0.133		
			(0.226)			(0.200)		
High pension dummy x Financial wealth			0.161			0.073		
			(0.104)			(0.090)		
Treatment 2 dummy							-53.972	27.692
							(138.308)	(194.936)
Treatment 2 dummy x Optimal consumption							-0.251	-0.217
							(0.189)	(0.266)
Treatment 2 dummy x Income							0.259**	0.146
							(0.129)	(0.239)
Treatment 2 dummy x Financial wealth							0.085	0.053
							(0.062)	(0.103)
Constant	-76.732	247.128*	-42.502	127.019*	258.517*	137.424*	131.974	240.806*
	(90.171)	(120.106)	(85.224)	(76.396)	(134.713)	(80.199)	(87.591)	(128.499)
N	629	301	930	523	319	842	1152	620
BIC	10092.815	4654.016	14813.448	8240.227	5066.173	13334.312	18372.479	9750.868

Note: The dependent variable is the actual consumption decision. Standard errors are presented in parenthesis. ***,** and * denote significance at 1 percent, 5 percent and 10 percent levels. The structure of the empirical model is the same as the random coefficients specification with covariance which is outlined above.

3.2.4 Risk Aversion

Heterogeneity in risk aversion may potentially explain several patterns, including the variance in subject performance in general and the choice of the pension profile in treatment 2. We test whether risk aversion affects these choices in a significant way. After the experiment, a standard Holt and Laury (2002) type of risk aversion test is conducted where subjects make 10 binary choices between simple lotteries and receive a payment based on one of the choices that they make (see Part 2 of the Instructions in Appendix C). It is possible that risk averse subjects view mortality as a risk and consume more than other subjects before the mortality risk becomes relevant. If this is the case, we would observe that in early periods, the average consumption of risk averse subjects would be higher than ex-ante optimal consumption (dashed line in Figure 1), whereas it would be lower than ex-ante optimal consumption in later periods. According to the results displayed in Table A.6, in treatment 1 relatively risk averse subjects do not consume more than relatively risk-loving subjects in earlier periods.

It is also possible that some scenarios are regarded safer than others and these scenarios are more likely to be chosen by risk averse subjects. In particular, risk averse subjects may be expected to choose one of the scenarios with high income and low pensions. However, as indicated in Table A.5 in Appendix A, subjects whose risk aversion score is relatively low are not more or less likely to choose one of the scenarios that belong to the low-pension category. Therefore, risk aversion does not affect scenario selection, and also not strongly consumption decisions.

4 Conclusions

We examine the data from a laboratory experiment, where subjects deal with a simple version the life-cycle consumption optimization problem, and find that on average consumption decisions are more sensitive to current income and financial wealth and less sensitive to optimal consumption when subjects choose the pension size themselves before the optimization task. According to our findings the slope of the income profile by itself does not have a significant effect on consumption decisions. In all settings the decline in consumption at retirement is far greater than the optimal decline. The magnitude of this sub-optimal drop is significantly higher when the subjects choose their income path. The results suggest that subjects exert less cognitive effort when they are given more freedom.

In our experiment, the shift from optimal behaviour to rule of thumb behaviour does not translate into a significant decline in earnings. However, in reality such a change may have important welfare and policy consequences. Given the observed patterns, it can be concluded that shifting the responsibilities from pension funds to pensioners may not always produce desirable outcomes. Policy makers and pension designers may potentially influence the welfare of pensioners by restricting the number of alternative pension arrangements that are offered.

For economists, it is often difficult to observe how much their optimizing models can explain the decisions of individuals who face fairly complex problems. Previous studies suggest that consumption decisions are possibly affected by the cognitive cost of optimization and framing of the optimization problem. Although pension funds to a large extent determine the allocation of income across life it is difficult to isolate the affect of pension parameters on subject behaviour. We believe that controlled experiments are suited for this purpose and they may play an important role in future analysis.

In this paper, we present the subjects a typical problem which has the same structure as a life-cycle optimization problem. We choose this particular type of problem because it is often used by the economists to describe household behaviour. Future research could clarify whether our conclusions remain valid in other contexts.

A Appendix

Table A.1: Income Profiles Used in the Experiment

Period	Scenario A	Scenario B	Scenario C	Scenario D
1	2000	1900	1800	1700
2	2000	1900	1800	1700
3	2000	1900	1800	1700
4	2000	1900	1800	1700
5	2000	1900	1800	1700
6	2000	1900	1800	1700
7	2000	1900	1800	1700
8	2000	1900	1800	1700
9	2000	1900	1800	1700
10	2000	1900	1800	1700
11	2000	1900	1800	1700
12	2000	1900	1800	1700
13	0	297	594	891
14	0	255	510	765
15	0	213	426	639
16	0	171	342	513
17	0	129	258	387
18	0	87	174	261
19	0	45	90	135
20	0	3	6	9
	24000	24000	24000	24000

Note: The amounts listed under scenarios are denominated in tokens. The sum of tokens in each profile is given in the last row. The scenarios are ordered by the size of the pension fund such that as one moves to the right in the table pension size increases and income profiles get flatter. Scenario A corresponds to the case without a pension fund where, during their working lives (periods 1-12), subjects receive the highest possible income and when retired (periods 13-20), they do not receive any income. The motive for saving is the strongest in the case of scenario A and it weakens as the size of the pension fund increases. Scenario D corresponds to the case with the largest pension fund. In this scenario, the benefits are highest of all scenarios, yet in exchange the net income in the first 12 periods is lower than the pre-retirement income in all of the other scenarios.

Table A.2: Observations

Scenario	Low pension		High pension		
Treatment	A	B	C	D	Total
1	32	12	8	13	65
2	22	17	7	16	62

Table A.3: Efficiency

	Scenario A	Scenario B	Scenario C	Scenario D
Treatment 1	.989	.966	.938	.995
	.052	.146	.093	.030
Treatment 2	.980	.964	.979	.988
	.108	.074	.070	.035

Note: Standard deviations are reported in the bottom row.

Table A.4: Random Coefficients Regressions

	Without covariance			With covariance		
	Treatment 1	Treatment 2	Both	Treatment 1	Treatment 2	Both
Income	0.375***	0.662***	0.445***	0.416***	0.671***	0.476***
	(0.060)	(0.066)	(0.050)	(0.063)	(0.068)	(0.053)
Financial wealth	0.129***	0.197***	0.143***	0.124***	0.196***	0.139***
	(0.022)	(0.030)	(0.022)	(0.024)	(0.031)	(0.023)
Treatment 2			-178.594*			-148.325
			(97.721)			(109.438)
Treatment 2 x Income			0.111*			0.099
			(0.060)			(0.067)
Treatment 2 x Financial wealth			0.059			0.049
			(0.040)			(0.040)
Constant	178.919**	130.139*	235.132***	247.476***	195.320***	296.506***
	(71.022)	(66.751)	(66.771)	(79.982)	(69.580)	(73.387)
N	930	842	1772	930	842	1772
BIC	14814.297	13312.479	28152.220	14802.102	13307.619	28135.779

Note: The dependent variable is the actual consumption decision. Standard errors are presented in parenthesis. ***,** and * denote significance at 1 percent, 5 percent and 10 percent levels.

Figure 5: Predicted values (columns 1 and 2 in Table A.4)

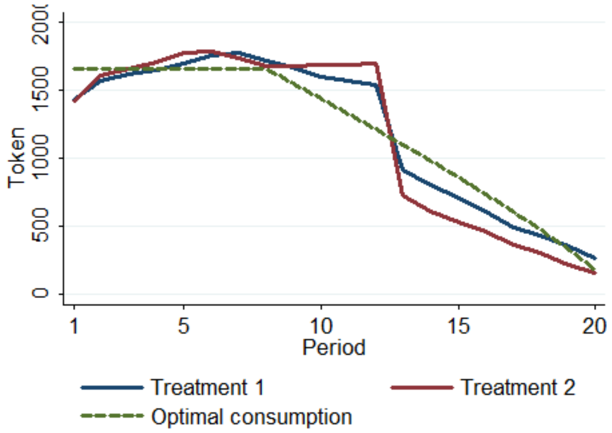


Table A.5: Scenario Selection and Risk Aversion. Logistic Regression

Risk aversion dummy	-0.886 (0.553)
Constant	-0.182 (0.428)
N	65
BIC	87.568

Note: The dependent variable is the high-pension dummy. Standard errors are presented in parenthesis. ***,** and * denote significance at 1 percent, 5 percent and 10 percent levels.

Table A.6: Random Coefficients Regressions

Optimal consumption	-0.213
	(0.563)
Income	-0.273
	(0.497)
Financial wealth	0.170***
	(0.062)
Risk aversion	588.916
	(2807.266)
Risk aversion x Optimal consumption	-0.586
	(0.853)
Risk aversion x Income	0.053
	(1.209)
Risk aversion x Financial wealth	0.371***
	(0.143)
Interval 2	452.043
	(2057.710)
Interval 2 x Optimal consumption	0.771
	(0.606)
Interval 2 x Income	-0.776
	(0.878)
Interval 2 x Financial wealth	-0.115
	(0.072)
Interval 2 x Risk aversion	348.651
	(6978.891)
Interval 2 x Risk aversion x Optimal consumption	1.178
	(0.961)
Interval 2 x Risk aversion x Income	-1.462
	(3.574)
Interval 2 x Risk aversion x Financial wealth	0.248
	(0.195)
Interval 3	-2278.385
	(1494.437)
Interval 3 x Optimal consumption	1.357*
	(0.716)
Interval 3 x Income	0.321
	(0.671)
Interval 3 x Financial wealth	-0.164
	(0.109)
Interval 3 x Risk aversion	-915.889
	(2851.852)
Interval 3 x Risk aversion x Optimal consumption	-0.273
	(1.520)
Interval 3 x Risk aversion x Income	0.063
	(1.939)
Interval 3 x Risk aversion x Financial wealth	0.177
	(0.363)
N	707
Log-likelihood	-5469.932
AIC	10987.863

Note: The dependent variable is the actual consumption decision. Standard errors are presented in parenthesis. ***,** and * denote significance at 1 percent, 5 percent and 10 percent levels. Observations are drawn from treatment 1. The structure of the empirical model is the same as the random coefficients specification with covariance which is outlined above. That is, individual effects that correspond to the constant term, income, current income and financial wealth are allowed to have covariance, yet covariance is not allowed for across different groups of subjects. Risk aversion dummy takes the value 1 when the subjects risk aversion score is greater than the median.

Table A.7: Demographics

	Baseline	Age	Female	Dutch	Chinese	Econ. major	Master	Risk averse
Optimal consumption	0.226**	0.207	0.243	0.281*	0.087	0.155	0.116	0.263**
	(0.114)	(0.151)	(0.160)	(0.144)	(0.147)	(0.242)	(0.133)	(0.119)
Income	0.462***	0.459***	0.309***	0.519***	0.417***	0.514***	0.516***	0.432***
	(0.085)	(0.109)	(0.101)	(0.109)	(0.099)	(0.187)	(0.099)	(0.088)
Financial wealth	0.151***	0.177***	0.089**	0.188***	0.139***	0.098**	0.196***	0.097***
	(0.030)	(0.044)	(0.037)	(0.040)	(0.038)	(0.060)	(0.038)	(0.038)
Age dummy		-115.797						
		(200.359)						
Age dummy x Optimal consumption		0.026						
		(0.249)						
Age dummy x Income		0.018						
		(0.184)						
Age dummy x Financial wealth		-0.001						
		(0.070)						
Female dummy			-367.068*					
			(206.967)					
Female dummy x Optimal consumption			-0.112					
			(0.252)					
Female dummy x Income			0.306*					
			(0.178)					
Female dummy x Financial wealth			0.188**					
			(0.074)					
Dutch dummy				405.004				
				(257.679)				
Dutch dummy x Optimal consumption				-0.210				
				(0.267)				
Dutch dummy x Income				-0.153				
				(0.186)				
Dutch dummy x Financial wealth				-0.045				
				(0.070)				
Chinese dummy					-385.850*			
					(205.435)			
Chinese dummy x Optimal consumption					0.242			
					(0.260)			

Chinese dummy x Income					0.128			
					(0.193)			
Chinese dummy x Financial wealth					0.125			
					(0.085)			
Econ. major dummy						38.831		
						(243.024)		
Econ. major dummy x Optimal consumption						0.091		
						(0.279)		
Econ. major dummy x Income						-0.063		
						(0.213)		
Econ. major dummy x Financial wealth						-0.032		
						(0.071)		
Master dummy							-275.730	
							(271.208)	
Master dummy x Optimal consumption							0.325	
							(0.290)	
Master dummy x Income							-0.125	
							(0.206)	
Master dummy x Financial wealth							-0.007	
							(0.078)	
Risk aversion dummy								-213.498*
								(127.468)
Risk aversion dummy x Optimal consumption								-0.084
								(0.163)
Risk aversion dummy x Income								0.108
								(0.126)
Risk aversion dummy x Financial wealth								0.140**
								(0.056)
Constant	156.179*	191.568	387.857**	32.720	348.495***	104.136	209.249**	263.412***
	(86.053)	(127.080)	(153.827)	(98.889)	(132.178)	(216.810)	(100.663)	(90.288)
N	757	757	757	757	757	757	757	1327
BIC	12080.674	12115.642	12103.673	12110.107	12104.899	12115.901	12109.695	20882.788

Note: The dependent variable is the actual consumption decision. Standard errors are presented in parenthesis. ***,** and * denote significance at 1 percent, 5 percent and 10 percent levels. The structure of the empirical model is the same as the random coefficients specification with covariance which is outlined above.

B Appendix

In period q subject solves the following problem:

$$\max_{C_k} \qquad \omega_q = \sum_{t=q}^{t=20} P_t U(C_t) \tag{14}$$

$$\text{subject to} \qquad A_{t+1} = A_t + Z_t - C_t, \qquad t = q, \ldots, 20, \tag{15}$$

where A_q is given. $A_{t+1} \geq C_t \geq 0$ constraint is dropped out since it is not binding in the optimum. The first order conditions for the optimization problem are given as follows:

$$C_t + \epsilon = \left(\frac{P_{t+1}}{P_t} \right)^{\frac{1}{\sigma}} (C_{t+1} + \epsilon), \qquad t = q, \ldots, 20, \tag{16}$$

Given that in the last period the subject optimally consumes all of his financial wealth and period income (i.e. $A_{21} = 0$), rearranging (15) leads to:

$$\sum_{t=q}^{t=20} C_t = \sum_{t=q}^{t=20} Z_t + A_q \tag{17}$$

Combining (17) with (16) optimal consumption in period q can be written as:

$$C_q^* = \frac{A_q + \sum_{t=q}^{t=20} (Z_t + \epsilon)}{\sum_{t=q}^{t=20} \left(\frac{P_t}{P_q} \right)^{\frac{1}{\sigma}}} - \epsilon \tag{18}$$

C Appendix

Instructions - Treatment 2

Welcome! You are now taking part in an individual decision making experiment financed by the CentER research institute. If you read the following instructions carefully, you can earn a considerable amount of money, depending on your decisions and chance.

The experiment consists of two parts. The choices that you make in the first part do not affect your payoff in the second part. Similarly, your choices in the second part have no effect on your payoff in the first part. Your payoff from the first part and the second part will be added up and paid to you in cash privately at the end of the session. After the first part is over, you will receive a new set of instructions for the second part. The following summarizes the experiment:

- Part1
    - The experimenter reads the instructions for part 1 aloud.
    - You answer the questions at the end of this document.
    - When you are ready, begin part 1 (on the computer).
    - After part 1 is finished, wait for the instructions for part 2.
- Part 2
    - The experimenter reads the instructions for part 2 aloud.
    - When you are ready, begin part 2 (on the computer).
    - Fill out the questionnaire (on the computer).
    - You receive your payment.

After both parts are over, please remain seated and wait for the announcement of the experimenter. Once all participants complete the experiment, the experimenter will read the computer-terminal numbers of the participants aloud one by one. When your computer-terminal number is announced, please walk up to the experimenter and receive your payment. Your personal payment information will only be revealed to you. Please leave the instructions and seat number on your desk when you leave.

Every participant receives the same information and is reading the same instructions. If you have a question during any stage of the experiment please raise your hand. We will answer your question privately. Neither your question nor the answer will be announced aloud to the other participants in this room.

Please do not communicate with the other participants during the experiment! If this rule is violated, we shall have to exclude you from the experiment and from all payments.

Part 1

The task in part 1 consists of a maximum of 20 periods. Depending on chance, your experiment may last for less than 20 periods. At the beginning of each period you may receive some tokens, which are added to your token stock. In each period you can convert a part of your token stock to money (Euros). At the end of the experiment, these Euros will be added up and paid to you in cash.

The number of tokens that you may receive in each period depends on the scenario you choose. In Figure 1, you see the four possible scenarios for the first part of the experiment. For example, if you choose scenario C, you will receive 1800 tokens from periods 1 to 12, 594 tokens in period 13 etc. However, as will be explained below, whether you actually receive these tokens depends on whether you will survive until that period.

Figure 1

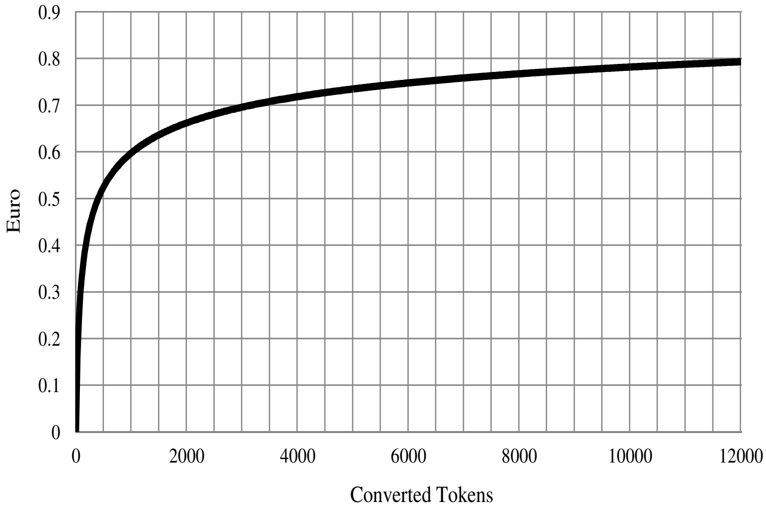
Period	Scenario A	Scenario B	Scenario C	Scenario D
1	2000	1900	1800	1700
2	2000	1900	1800	1700
3	2000	1900	1800	1700
4	2000	1900	1800	1700
5	2000	1900	1800	1700
6	2000	1900	1800	1700
7	2000	1900	1800	1700
8	2000	1900	1800	1700
9	2000	1900	1800	1700
10	2000	1900	1800	1700
11	2000	1900	1800	1700
12	2000	1900	1800	1700
13	0	297	594	891
14	0	255	510	765
15	0	213	426	639
16	0	171	342	513
17	0	129	258	387
18	0	87	174	261
19	0	45	90	135
20	0	3	6	9

First you have to decide on the scenario, by clicking on the corresponding radio button. If you would like to choose scenario A, you should click on the corresponding radio button and then click Next. Once you click Next, this decision cannot be undone later on, so think carefully before you decide. After this, you will proceed to period 1 and make your first conversion decision.

Before you make your first conversion decision, you will observe the number of tokens that you will receive at the beginning of each period. This information will be available to you throughout the experiment.

The part of your token stock which you do not convert can be converted in a later period. The following graph (Figure 2) demonstrates the relationship between Converted Tokens and Euros:

Figure 2



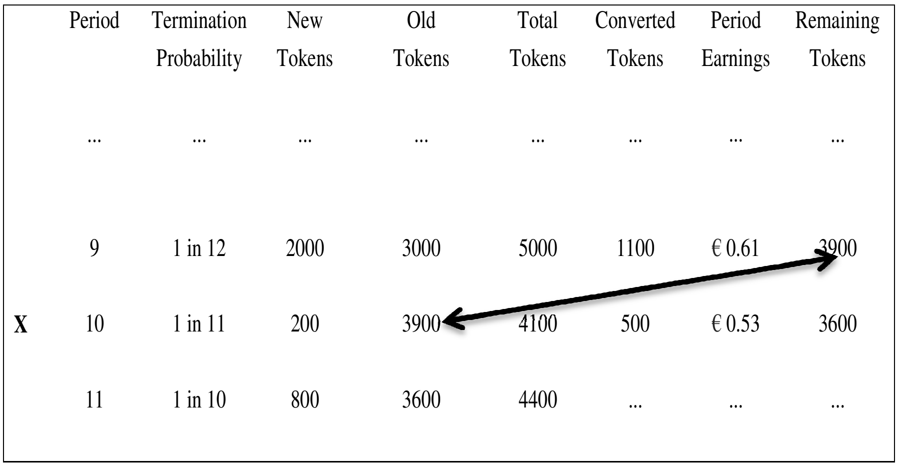
For example, if you convert 500 tokens this will yield 0.53. This graph will be available to you throughout the experiment. In each period you have to decide how many tokens you want to convert. Only converted tokens count towards earnings at the end of the experiment. The following examples demonstrate some of the basic rules of the experiment.

Conversion Screen

- Example 1 :

Suppose a participant has reached period 10, as indicated by the X to the left of period number 10. At the end of period 9, she had 3,900 remaining tokens. At the beginning of period 10, she receives 200 new tokens. So in total she has 3,900 + 200 = 4,100 tokens. Out of these 4,100 tokens, she may choose to convert any amount between 0 and 4,100 (0 and 4,100 are included). Let us say that she chooses to convert 500 tokens, which, as can be seen from Figure 2, yields 0.53. This amount is listed under the Period Earnings column in Figure 3. She will have 4,100 - 500 = 3,600 remaining tokens at the end of period 10. This amount will be added to the new tokens that she will receive at the beginning of the

Figure 3

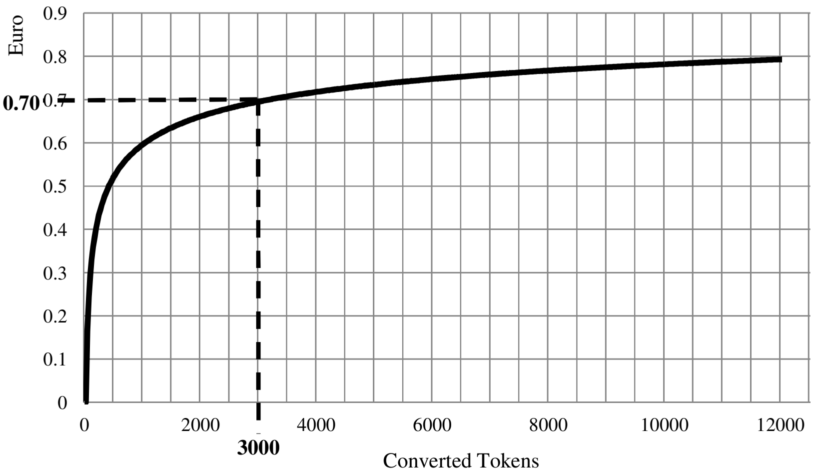


	Period	Termination Probability	New Tokens	Old Tokens	Total Tokens	Converted Tokens	Period Earnings	Remaining Tokens
	...	...	...	...	...	...	...	...
	9	1 in 12	2000	3000	5000	1100	€ 0.61	3900
X	10	1 in 11	200	3900	4100	500	€ 0.53	3600
	11	1 in 10	800	3600	4400	...	...	...

next period, so that she will have a total of 3,600 + 800 = 4,400 tokens at the beginning of period 11.

- Example 2:

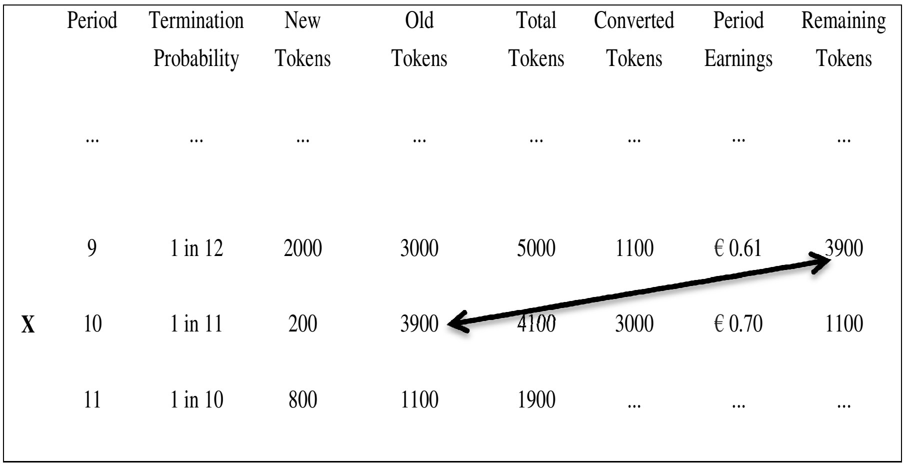
Figure 4



Consider the case described in example 1. If, in period 10, the participant chooses to convert 3,000 tokens instead of 500 tokens, this will yield 0.70 (see Figure 4).

Figure 5 depicts the details if the participant converts 3,000 tokens. In this case, she will have 4,100 3,000 = 1,100 remaining tokens at the end of period 10. At the beginning

Figure 5



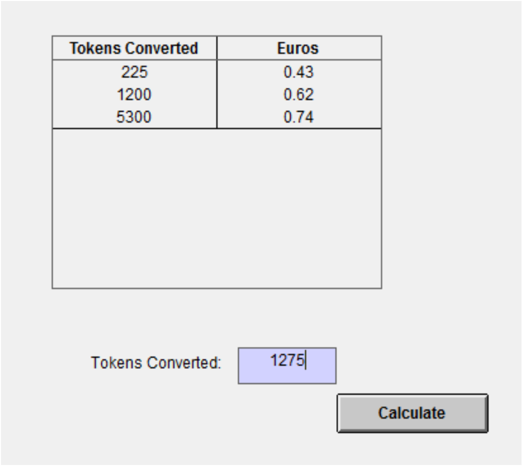
	Period	Termination Probability	New Tokens	Old Tokens	Total Tokens	Converted Tokens	Period Earnings	Remaining Tokens
	...	...	...	...	...	...	...	...
	9	1 in 12	2000	3000	5000	1100	€ 0.61	3900
X	10	1 in 11	200	3900	4100	3000	€ 0.70	1100
	11	1 in 10	800	1100	1900	...	...	...

of period 11, she will have a total of 1,100 + 800 = 1,900 tokens, which can be converted to money later on.

Calculator

Before you decide how many tokens you want to convert in a period, you can use the graph (Figure 2). You can also use the calculator which will be situated at the right-hand section of the decision screen: You can enter any non-negative number and click Calculate to find out the payment that corresponds to the given number of tokens. For example, if you enter

Figure 6



Tokens Converted	Euros
225	0.43
1200	0.62
5300	0.74

Tokens Converted: 1275

1200 and click Calculate, the calculator will return 0.62 under the Euros column. If you enter 5300 and click Calculate the calculator will return 0.74 under the Euros column.

Once you make your final decision, you can enter the number of tokens that you want to convert in the current period. After you click the Confirm button, your decision cannot be undone. You will proceed to the next screen.

Next Screen : Survival Screen

Part 1 of the experiment will go on for at least 8 and at most 20 periods. When the experiment ends, it is said to be Terminated. If the experiment is not terminated in a given period, you proceed to the next period. This is referred to as Survival.

You will proceed to the survival screen after you have made your conversion decision. Up until period 8, you certainly survive to the next period. From period 8 onwards, there is a possibility that you do not proceed to the next period. For example, in period 8, your chance to survive to the next period (period 9) is 12 in 13. In other words, in period 8, there is a 1 in 13 chance that the experiment will be terminated after you make the conversion decision. In order to visualize this probability better, consider the following case:

Let us say that there is an urn with 13 balls: 12 blue balls and 1 red ball. We have such an urn here in the room. (See the demonstration) Each ball in the urn is equally likely to be drawn.

Suppose that you are in period 8, where your survival chance is 12 in 13. This means that, at the end of period 8, you draw a ball from this urn and if it turns out to be a red one, this part of the experiment is over for you. In this case, you will not make any more decisions, until the end of the experiment. However, if it turns out to be a blue one you will survive to the next period. In this case the chance to survive to the next period is equal to 12 in 13. The chance of termination is 1 in 13.

Figure 7

Period	Survival Chance to the Next Period	Termination Chance
Period 1	Certainly survive	
Period 2	Certainly survive	
Period 3	Certainly survive	
Period 4	Certainly survive	
Period 5	Certainly survive	
Period 6	Certainly survive	
Period 7	Certainly survive	
Period 8	12 in 13	1 in 13
Period 9	11 in 12	1 in 12
Period 10	10 in 11	1 in 11
Period 11	9 in 10	1 in 10
Period 12	8 in 9	1 in 9
Period 13	7 in 8	1 in 8
Period 14	6 in 7	1 in 7
Period 15	5 in 6	1 in 6
Period 16	4 in 5	1 in 5
Period 17	3 in 4	1 in 4
Period 18	2 in 3	1 in 3
Period 19	1 in 2	1 in 2
Period 20		Certainly terminate

Let us say that you picked the blue ball and survived to period 9. After you have made a decision in period 9, you will once again proceed to the survival screen. Because you have already drawn a blue ball from the urn, it now contains 12 balls: 11 blue balls and 1 red ball. Therefore, the survival chance is 11 in 12 and the termination chance is 1 in 12. If you draw again a blue ball in period 9, you will survive to period 10. In this period the urn contains 11 balls: 10 blue balls and 1 red ball. The survival and termination chances are given in Figure 7.

As you can see the experiment lasts at least 8 periods. At the end of period 19, the survival chance is 1 in 2. At the end of period 20, your experiment is terminated with certainty. Note that the choice of the scenario has no effect on the survival and termination chances. That is, the survival and termination chances that are listed on Figure 7 are independent of the scenario chosen.

Instead of the experimenter drawing a ball from the urn at the end of each period, the computer will perform this task. After you click Draw you will be directed to a screen where you can see the result of the random draw. If the randomly drawn ball turns out to be red, this part of your experiment will be terminated. If it turns out to be blue, you will proceed to the next period. After everyone is finished with this part of the experiment, you will proceed to part 2.

You may have some unconverted tokens at the time of termination. These unconverted tokens will be lost. These tokens do not carry on to part 2. You will only earn money for the tokens that you have converted before termination. Finally, in the following table you can observe the survival chances, termination chances and scenarios side by side.

Before you begin

Before you begin, please take your time and think carefully about the decisions that you will make in the first part. Remember that once you confirm a decision you cannot go back and change it.

Also remember that tokens yield a monetary payment only when they are converted. In other words, tokens which have not been converted before the termination of the experiment do not yield monetary payment.

Before you make any decisions you will be asked to fill in a form on the next page. Please, do not proceed to the experiment, unless you can easily answer the questions on this page. Also, on this page, you can write about your thoughts and plans before you begin. Once you finish the first part of the experiment, please remain seated and wait for the new set of instructions.

Figure 8

Period	New Tokens (Scenario A)	New Tokens (Scenario B)	New Tokens (Scenario C)	New Tokens (Scenario D)	Survival Chance to the Next Period	Termination Chance
1	2000	1900	1800	1700	Certainly survive	
2	2000	1900	1800	1700	Certainly survive	
3	2000	1900	1800	1700	Certainly survive	
4	2000	1900	1800	1700	Certainly survive	
5	2000	1900	1800	1700	Certainly survive	
6	2000	1900	1800	1700	Certainly survive	
7	2000	1900	1800	1700	Certainly survive	
8	2000	1900	1800	1700	12 in 13	1 in 13
9	2000	1900	1800	1700	11 in 12	1 in 12
10	2000	1900	1800	1700	10 in 11	1 in 11
11	2000	1900	1800	1700	9 in 10	1 in 10
12	2000	1900	1800	1700	8 in 9	1 in 9
13	0	297	594	891	7 in 8	1 in 8
14	0	255	510	765	6 in 7	1 in 7
15	0	213	426	639	5 in 6	1 in 6
16	0	171	342	513	4 in 5	1 in 5
17	0	129	258	387	3 in 4	1 in 4
18	0	87	174	261	2 in 3	1 in 3
19	0	45	90	135	1 in 2	1 in 2
20	0	3	6	9		Certainly terminate

- Part1
  - The experimenter reads the instructions for part 1 aloud.
  - **You answer the questions at the end of this document.**
  - When you are ready, begin part 1 (on the computer).
  - After part 1 is finished, wait for the instructions for part 2.

Questions

1. x= chance of reaching period 12, given that you have already reached period 11. y= chance of reaching period 13, given that you have already reached period 12. What are x and y? Which one is greater, x or y?

   Answer:

2. x= chance of reaching period 14, given that you have already reached period 13. y= chance of reaching period 19, given that you have already reached period 18. What are x and y? Which one is greater, x or y?

   Answer:

3. Fill in the empty slots , [   ]

	Period	Termination Probability	New Tokens	Old Tokens	Total Tokens	Converted Tokens	Period Earnings	Remaining Tokens
	...	...	...	...	...	...	...	...
	11	1 in 10	1000	3000	[ ]	500	[ ]	[ ]
X	12	1 in 9	1000	[ ]	[ ]	[ ]	€ 0.70	[ ]
	13	1 in 8	800	[ ]	[ ]	...	...	...

Before you begin, please state your thoughts and plans (Part 1):

If you have answered these three questions please raise your hand. We will check your answers. If they are all correct you can start with part 1 of the experiment.

Please also raise your hand if you have any questions later.

Part 2

After termination of the first experiment, you will proceed to the lottery screen. Here you will be asked to choose between two lotteries. For each row in the lottery table, you will be asked to choose between option A and option B. There are 10 rows in the table so in this part you will make a total of 10 decisions (1 decision for each row):

Figure 9

	Option A	Option B
1	1/10 chance for €2.00 , 9/10 chance for €1.60	1/10 chance for €3.85 , 9/10 chance for €0.10
2	2/10 chance for €2.00 , 8/10 chance for €1.60	2/10 chance for €3.85 , 8/10 chance for €0.10
3	3/10 chance for €2.00 , 7/10 chance for €1.60	3/10 chance for €3.85 , 7/10 chance for €0.10
4	4/10 chance for €2.00 , 6/10 chance for €1.60	4/10 chance for €3.85 , 6/10 chance for €0.10
5	5/10 chance for €2.00 , 5/10 chance for €1.60	5/10 chance for €3.85 , 5/10 chance for €0.10
6	6/10 chance for €2.00 , 4/10 chance for €1.60	6/10 chance for €3.85 , 4/10 chance for €0.10
7	7/10 chance for €2.00 , 3/10 chance for €1.60	7/10 chance for €3.85 , 3/10 chance for €0.10
8	8/10 chance for €2.00 , 2/10 chance for €1.60	8/10 chance for €3.85 , 2/10 chance for €0.10
9	9/10 chance for €2.00 , 1/10 chance for €1.60	9/10 chance for €3.85 , 1/10 chance for €0.10
10	10/10 chance for €2.00 , 0/10 chance for €1.60	10/10 chance for €3.85 , 0/10 chance for €0.10

For example, consider the first row of the table. Assume that there are 10 balls in an urn: 9 white balls and 1 black ball. You make a random draw from the urn. In the case of option A, if you pick a white ball you will earn 1.60 and if you pick the black ball you will earn 2. In the case of option B, if you pick a white ball you will earn 0.10 and if you pick the black ball you will earn 3.85. If you are to have either option A or option B, which one will you choose? After you make your choice, move on to another row and make the same comparison between option A and option B of that row. As in part 1, in this part draws will be carried out by the computer.

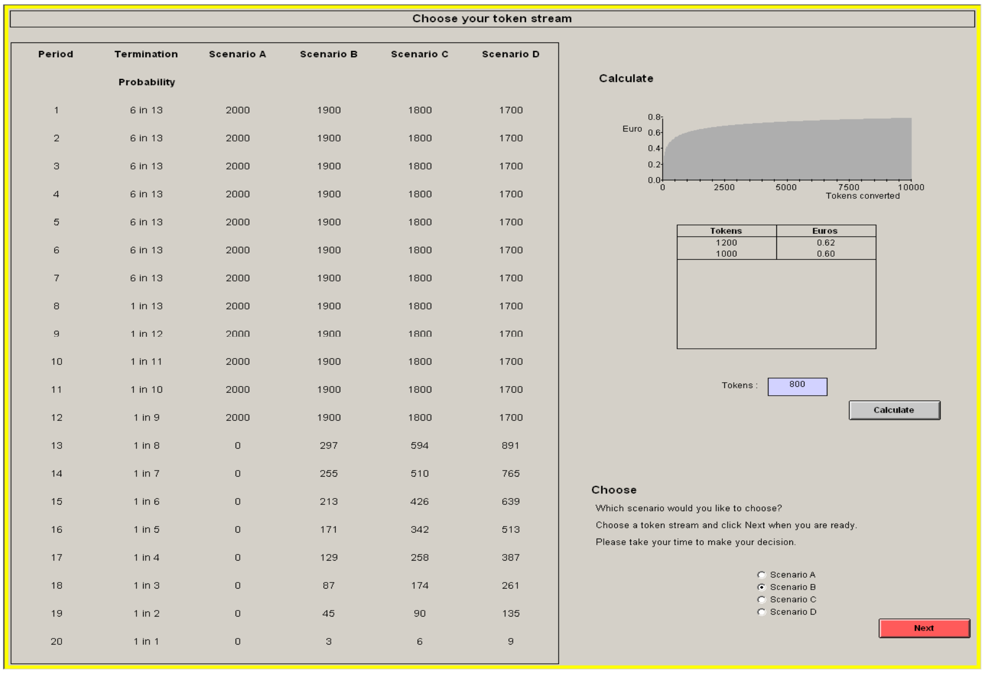
Once you confirm all your decisions, the computer will pick one of the rows randomly and play the chosen lottery. The computer is equally likely to choose each row in the table.

Lets say that it randomly chooses the first row and for the first row you chose option B rather than option A. The computer will play out option B. That is to say, the computer will draw a ball randomly from an urn in which there are 9 white balls and 1 black ball. If it draws a white ball you will earn 0.10 and if it draws the black ball you will earn 3.85. The monetary payoff that you will earn from this lottery will be added to your payoff from the first part. This will be your total payoff.

After you finish this part, you will be asked to provide some basic information about yourself, such as your gender and education. This information will only be used for academic purposes.

D Appendix

Screenshots



Period	Termination Probability	Scenario A	Scenario B	Scenario C	Scenario D
1	6 in 13	2000	1900	1800	1700
2	6 in 13	2000	1900	1800	1700
3	6 in 13	2000	1900	1800	1700
4	6 in 13	2000	1900	1800	1700
5	6 in 13	2000	1900	1800	1700
6	6 in 13	2000	1900	1800	1700
7	6 in 13	2000	1900	1800	1700
8	1 in 13	2000	1900	1800	1700
9	1 in 12	2000	1900	1800	1700
10	1 in 11	2000	1900	1800	1700
11	1 in 10	2000	1900	1800	1700
12	1 in 9	2000	1900	1800	1700
13	1 in 8	0	297	594	891
14	1 in 7	0	255	510	765
15	1 in 6	0	213	426	639
16	1 in 5	0	171	342	513
17	1 in 4	0	129	258	387
18	1 in 3	0	87	174	261
19	1 in 2	0	45	90	135
20	1 in 1	0	3	6	9

Tokens	Euros
1200	0.62
1000	0.60

Tokens : 800

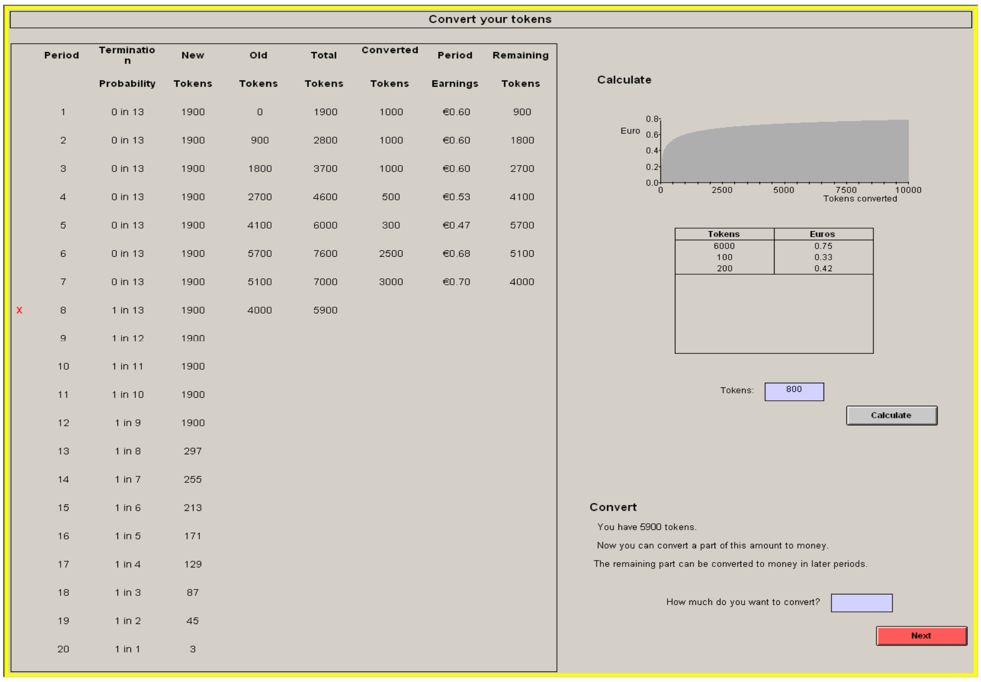
Choose

Which scenario would you like to choose?

Choose a token stream and click Next when you are ready.

Please take your time to make your decision.

○ Scenario A
● Scenario B
○ Scenario C
○ Scenario D



	Period	Termination Probability	New Tokens	Old Tokens	Total Tokens	Converted Tokens	Period Earnings	Remaining Tokens
	1	0 in 13	1900	0	1900	1000	€0.60	900
	2	0 in 13	1900	900	2800	1000	€0.60	1800
	3	0 in 13	1900	1800	3700	1000	€0.60	2700
	4	0 in 13	1900	2700	4600	500	€0.53	4100
	5	0 in 13	1900	4100	6000	300	€0.47	5700
	6	0 in 13	1900	5700	7600	2500	€0.68	5100
	7	0 in 13	1900	5100	7000	3000	€0.70	4000
x	8	1 in 13	1900	4000	5900			
	9	1 in 12	1900					
	10	1 in 11	1900					
	11	1 in 10	1900					
	12	1 in 9	1900					
	13	1 in 8	297					
	14	1 in 7	255					
	15	1 in 6	213					
	16	1 in 5	171					
	17	1 in 4	129					
	18	1 in 3	87					
	19	1 in 2	45					
	20	1 in 1	3					

Tokens	Euros
6000	0.75
100	0.33
200	0.42

Tokens: 800

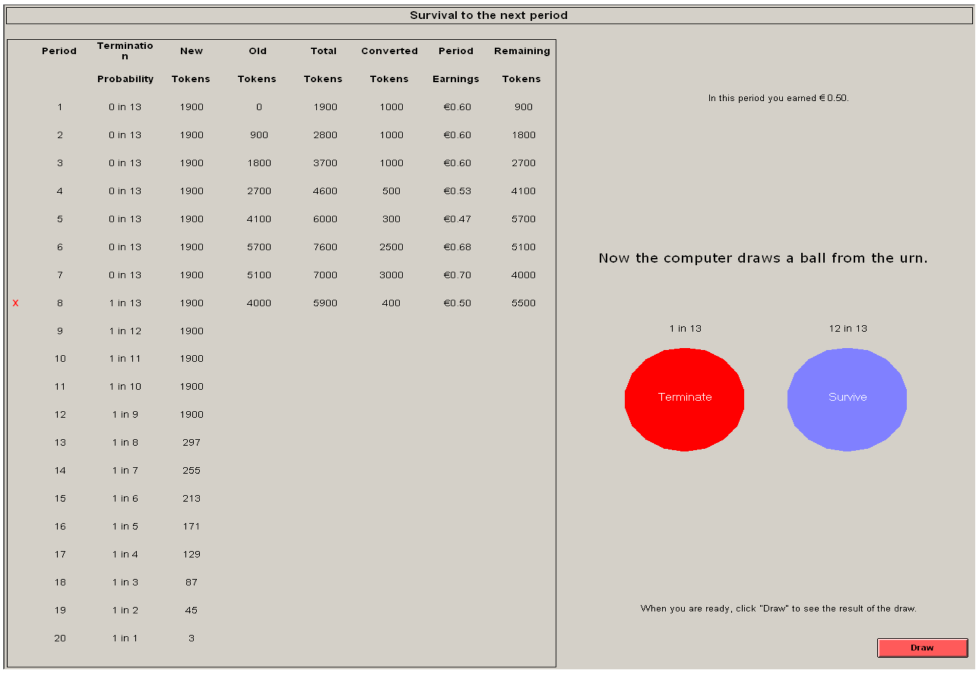
Convert

You have 5900 tokens.

Now you can convert a part of this amount to money.

The remaining part can be converted to money in later periods.

How much do you want to convert?



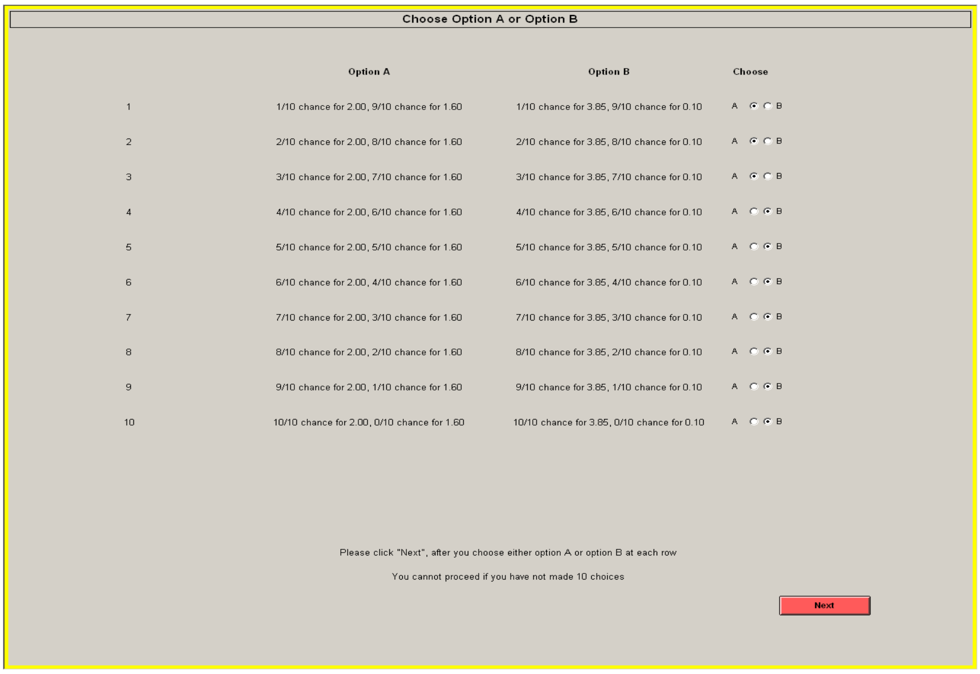
Survival to the next period

	Period	Termination Probability	New Tokens	Old Tokens	Total Tokens	Converted Tokens	Period Earnings	Remaining Tokens
	1	0 in 13	1900	0	1900	1000	€0.60	900
	2	0 in 13	1900	900	2800	1000	€0.60	1800
	3	0 in 13	1900	1800	3700	1000	€0.60	2700
	4	0 in 13	1900	2700	4600	500	€0.53	4100
	5	0 in 13	1900	4100	6000	300	€0.47	5700
	6	0 in 13	1900	5700	7600	2500	€0.68	5100
	7	0 in 13	1900	5100	7000	3000	€0.70	4000
x	8	1 in 13	1900	4000	5900	400	€0.50	5500
	9	1 in 12	1900					
	10	1 in 11	1900					
	11	1 in 10	1900					
	12	1 in 9	1900					
	13	1 in 8	297					
	14	1 in 7	255					
	15	1 in 6	213					
	16	1 in 5	171					
	17	1 in 4	129					
	18	1 in 3	87					
	19	1 in 2	45					
	20	1 in 1	3					

In this period you earned € 0.50.

Now the computer draws a ball from the urn.

When you are ready, click "Draw" to see the result of the draw.



Choose Option A or Option B

	Option A	Option B	Choose
1	1/10 chance for 2.00, 9/10 chance for 1.60	1/10 chance for 3.85, 9/10 chance for 0.10	A ● ○ B
2	2/10 chance for 2.00, 8/10 chance for 1.60	2/10 chance for 3.85, 8/10 chance for 0.10	A ● ○ B
3	3/10 chance for 2.00, 7/10 chance for 1.60	3/10 chance for 3.85, 7/10 chance for 0.10	A ● ○ B
4	4/10 chance for 2.00, 6/10 chance for 1.60	4/10 chance for 3.85, 6/10 chance for 0.10	A ○ ● B
5	5/10 chance for 2.00, 5/10 chance for 1.60	5/10 chance for 3.85, 5/10 chance for 0.10	A ○ ● B
6	6/10 chance for 2.00, 4/10 chance for 1.60	6/10 chance for 3.85, 4/10 chance for 0.10	A ○ ● B
7	7/10 chance for 2.00, 3/10 chance for 1.60	7/10 chance for 3.85, 3/10 chance for 0.10	A ○ ● B
8	8/10 chance for 2.00, 2/10 chance for 1.60	8/10 chance for 3.85, 2/10 chance for 0.10	A ○ ● B
9	9/10 chance for 2.00, 1/10 chance for 1.60	9/10 chance for 3.85, 1/10 chance for 0.10	A ○ ● B
10	10/10 chance for 2.00, 0/10 chance for 1.60	10/10 chance for 3.85, 0/10 chance for 0.10	A ○ ● B

Please click "Next", after you choose either option A or option B at each row

You cannot proceed if you have not made 10 choices

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