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Learning to Save Tax-Efficiently: Tax Misperceptions and the Effect of Informational Tax Nudges on Retirement Savings

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Abstract
Using a series of laboratory experiments, this paper studies the effect of tax misperceptions on retirement savings and examines whether informational tax nudges and changing the form of the tax subsidy promote tax-efficient savings behavior. We find that deferred pension taxation results in after-tax pensions that are approximately 25% lower compared to an economically equivalent immediate pension tax system. This indicates substantial tax misperceptions. For subjects with low tax and financial knowledge, these misperceptions remain stable even if they have gained experience. Only if we provide subjects with recurrent numerical informational nudges on tax refunds, together with numerical informational nudges on future pension taxes, do tax distortions disappear for all subjects. Regarding the form of the tax subsidy, we demonstrate that replacing the tax deductibility of retirement savings with matching contributions increases tax-efficiency without the need to provide informational tax nudges.

Keywords
Pension Taxation · Tax Misperception · Learning Behavior · Informational Tax Nudges · Matching Contribution

JEL Classification
D91 · G4 · H20 · H30

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1. Introduction

Using laboratory experiments, this study examines how tax misperceptions affect individuals' retirement savings and whether informational tax nudges and the form of the tax subsidy can promote tax responses that are in line with rational choice predictions (referred to in the following as tax-efficient savings behavior). In many countries, public pension benefits have been reduced in recent years, while the role of private pensions, particularly defined contribution retirement plans, has been increased (OECD 2016). This change increases the importance of making efficient individual saving decisions (Goda et al. 2014). To encourage people to save for retirement, most countries offer preferential tax treatment of retirement savings (OECD 2016). However, effective tax incentives require that individuals know and understand tax rules and respond to them in the desired way. Recent research challenges this assumption. For example, using Danish income tax records, Chetty et al. (2014) estimate that 85% of individuals are "passive savers" who are unresponsive to tax subsidies. In addition, Beshears et al. (2015a), using administrative company data, report that retirement savings are almost insensitive to the introduction of differently taxed retirement plans, and their supplemental survey results suggest that many employees are unaware of the tax treatment being applied to their savings.

If this unresponsiveness is simply caused by a lack of tax knowledge, then informing subjects about tax rules may be sufficient to eliminate the observed distortions. Similar to Beshears et al. (2015a), we therefore compare the same two widely used variants of pension taxation (OECD 2015). However, we use a lab experiment that enables us to inform subjects about pension taxation and to control their understanding of tax rules before they make their saving decisions. In the first regime, contributions to the pension plan are not tax-deductible, but withdrawals in retirement and returns on investment are tax-exempt. This regime is known as immediate pension taxation or TEE (Taxable – Exempt – Exempt); it has been implemented in countries such as Hungary, Luxembourg, and the U.S. (as Roth individual retirement arrangements and Roth 401(k) plans) and has recently been proposed in the UK (HM Treasury 2015). In the second regime, both contributions and returns on investment are exempt from taxation, while withdrawals in retirement are subject to tax. This system is known as deferred pension taxation or EET (Exempt – Exempt – Taxable) and is currently offered in countries such as Austria, the

Netherlands, Norway, the UK, and the U.S. (401(k) plans). If the tax rate is constant and time-invariant, both tax systems imply identical economic savings incentives (Beshears et al. 2015a).

However, despite individuals being informed about the tax rules before making saving decisions, we observe similar results to those reported in Beshears et al. (2015a). Under deferred taxation, subjects earn after-tax pensions that are approximately 25% lower compared to the economically equivalent immediate pension tax system. This result indicates the existence of substantial tax misperceptions. Moreover, after informing subjects about their after-tax pensions, we asked subjects whether their after-tax pensions met their expectations. Despite the large objective treatment difference in after-tax pensions, we find no significant difference regarding the evaluation of expectation fulfillment. In addition, the average participant in both tax systems stated that he or she would have continued to save the same amount if he or she had been given the opportunity to change their savings decisions. This indicates that subjects who save under deferred taxation do not aim to choose the tax-optimal level of savings, which could be explained by the fact that individuals under deferred taxation need higher cognitive capacities to process tax information, to understand the tax system and to determine savings consequences compared to individuals in an immediate taxation system.[1] However, there are limits on the cognitive capacity of decision-makers. Hence, in a more complex environment, subjects search heuristically for available alternative decision-making strategies until an acceptable aspiration level is reached. This concept of "satisficing economic behaviour" goes back to Simon (1957). Furthermore, in line with the concept of satisficing by Sauermann and Selten (Selten 1998), we find that subjects under deferred taxation become satisfied with their lower after-tax pensions over time.

For subjects with low tax and financial knowledge, the observed tax misperceptions do not disappear even if they have gained experience. The complexity of the deferred pension tax system seems to prevent them from learning through experience. Therefore, we study whether additional informational nudges regarding the tax deductibility of savings and the taxation of pension payments eliminate the observed distortions. In line with Saez (2009), we find that

[1] In contrast, under immediate taxation, there is neither a tax refund nor a pension tax to consider which simplifies decision making. In line with this, we find no significant difference regarding retirement savings between a no-tax setting and the immediate taxation setting (see section 5.3).

details matter. First, providing recurrent (numerical) informational nudges regarding the size of the tax refund that results from the tax deductibility of retirement savings does not affect our results. Second, providing recurrent abstract or numerical informational nudges about the taxation of pensions also does not change observed behavior. However, if recurrent numerical informational nudges about both the tax refund *and* the after-tax pension are provided, behavioral differences between immediate and deferred taxation disappear. Moreover, subjects who have experienced these informational tax nudges in the past are able to transfer their knowledge to other environments.

Still, the provision of recurrent informational nudges may be costly. Therefore, we tested an alternative way to achieve tax-efficient savings behavior. Instead of allowing a tax deduction of retirement savings, countries could change the form of the tax subsidy by matching retirement contributions. Despite the economic incentives being the same, we demonstrate that matching contributions result in a tax-efficient level of after-tax pensions even though we do not provide any additional informational nudges. The reason is simple: under such a system, fully tax ignorant and fully rational people will earn the same after-tax pensions. Thus, in contrast to traditional deferred tax systems, which are based on the tax deductibility of pension savings, tax ignorance is not punished in a matching contribution system.

As mentioned above, our findings are based on a series of laboratory experiments. Following the idea of the life-cycle consumption model (Modigliani and Brumberg 1954), subjects make savings and spending decisions in a 15-period life-cycle experiment that includes certain and constant income in the first ten periods of the experiment. The income is earned from a real-effort task. In the last five periods of the experiment, subjects earn no working income, but they do earn a constant pension, which results from their entire savings in the prior ten periods. Subjects know that only one period will be randomly chosen to determine their payoff. Despite the usual concerns regarding the external validity of laboratory experiments, such an experiment has several advantages in our context and thus complements prior research. First, in a lab experiment, we can ensure that immediate and deferred taxation are economically identical by controlling the tax rate to be certain, time-constant and the same in both tax systems. Second, in a lab experiment, we can separate the effect regarding the provision of tax-related information from the effect of general pension-related information. In this way, we add to research on the effectiveness of informational nudges about retirement income projections on pension savings

(e.g., Mastrobuoni 2011, Goda et al. 2014, Beshears et al. 2015b, Dolls et al. 2016). Third, an experiment allows us to vary the details of the informational nudges under controlled conditions. Fourth, using a lab experiment, we are able to define a reference point of tax-efficient savings behavior using a no-tax treatment as benchmark.

The remainder of this paper is organized as follows. In the next section, we present a model regarding the effect of tax misperceptions on retirement savings and derive our hypotheses. In section 3, we present our results from the baseline experiment that compares immediate and deferred taxation. In section 4, we present the results regarding the effect of providing informational tax nudges. Section 5 presents additional analyses, and section 6 concludes.

2. Tax Misperceptions and Retirement Savings: A Model and Hypotheses

2.1 The Optimal Consumption Path

We follow previous research on retirement savings and use a life-cycle framework (Browning and Crossley 2001). The life-cycle model assumes that subjects maximize their lifetime wealth according to the following utility function (Modigliani and Brumberg 1954):

$$U = \sum_{t=1}^{T} (1+\rho)^{-t} u(C_t), \tag{1}$$

with T denoting a subject's lifetime, C_t denoting consumption in point of time t, and $1+\rho$ denoting the subject's discount rate. The subject's lifetime is divided into t_s savings periods and t_r pension periods, with $T = t_r + t_s$. We assume a positive decreasing marginal utility: $u'(C_t) > 0,\ u''(C_t) < 0$. Subjects earn after-tax working income Y_t in all savings periods $(\mathrm{t} \leq t_s)$. After retirement, individuals do not earn working income. Instead, they receive a constant pension payment P in all pension periods. The pension is fully financed by their prior retirement savings S_t, so that P can be calculated as follows:

$$P = \frac{\sum_{t=1}^{t_s} S_t (1+i)^{t_s - t}}{PVAF}, \tag{2}$$

with $PVAF = \frac{(1+\mathrm{i})^{t_r} - 1}{(1+\mathrm{i})^{t_r} \cdot \mathrm{i}}$ denoting the present value annuity factor and i denoting the interest rate on savings. Note that we abstract from uncertainty in this model to focus on tax effects only.

We consider two pension tax systems. First, under immediate taxation, subjects pay income taxes on their working income. Retirement savings are not tax deductible, and pensions are not subject to tax. Second, under deferred taxation, retirement savings are tax deductible and pensions are fully subject to tax. As with immediate taxation, interest on savings is tax-free.

We begin with the examination of the optimal consumption path in the case of deferred taxation. Assuming a constant tax rate τ for all periods and allowing for a misperception regarding the tax deductibility of savings and the taxation of pensions, we can write the budget constraints as follows:

$$Y_t = C_t + S_t(1 - \alpha\tau) \qquad \forall \;\; t \leq t_s, \tag{3}$$

with α denoting the perception factor regarding the tax treatment of savings. If $\alpha = 1$, subjects' perceptions of the tax refund from retirement savings are correct. With $\alpha < 1$ $\left(1 < \alpha < \frac{1}{\tau}\right)$ subjects partly neglect (overweight) their tax refunds.

In the pension periods, the following constraints apply:

$$(1 - \beta\tau)P = C_t \equiv \; C_r \qquad \forall \;\; t > t_s, \tag{4}$$

with β denoting the perception factor regarding the tax treatment of pensions. If $\beta = 1$, subjects' perceptions regarding pension taxation are correct. With $\beta < 1$ $\left(1 < \beta < \frac{1}{\tau}\right)$ subjects partly neglect (overweight) pension taxes.

Equations (3) and (4) can be summarized to the following budget constraint:

$$\sum_{t=1}^{t_s} Y_t(1+i)^{-t} = \sum_{t=1}^{t_s} C_t(1+i)^{-t} + C_r \cdot \frac{PVAF}{(1+i)^{t_s}} \, \frac{(1-\alpha\tau)}{(1-\beta\tau)}. \tag{5}$$

According to the budget constraint, the present value of subjects' working income must be equal to the present value of subjects' consumption. Note that the price for consumption in the pension period is affected by tax misperceptions, if $\alpha \neq \beta$. To study the effects of tax misperception on pension savings in the case of deferred taxation, we simply solve the following Lagrange function:

$$\mathcal{L} = \sum_{t=1}^{T}(1+\rho)^{-t}\cdot u(C_t) + \lambda\left(\sum_{\mathrm{t=1}}^{t_s} Y_t(1+i)^{-\mathrm{t}} - \sum_{\mathrm{t=1}}^{t_s} C_t(1+\mathrm{i})^{-\mathrm{t}} - C_r\cdot\frac{PVAF}{(1+i)^{t_s}}\,\frac{(1-\alpha\tau)}{(1-\beta\tau)}\right). \qquad (6)$$

From the first-order conditions, we obtain the optimal intertemporal allocation of consumption:

$$u'(C_t) = u'(C_r)\left(\frac{1+i}{1+\rho}\right)^{t_s-t}\frac{PVAF_\rho}{PVAF}\,\frac{(1-\beta\tau)}{(1-\alpha\tau)} \quad \forall\ t \le t_s, \qquad (7)$$

with $PVAF_\rho = \frac{(1+\rho)^{t_r}-1}{(1+\rho)^{t_r}\cdot\rho}$. The optimal allocation of consumption over time according to (7) implies $u'(C_t) = \frac{1+i}{1+\rho}\cdot u'(C_{t+1}),\ \forall\ t \le t_s$, which is known as Euler's rule. Thus, Euler's rule itself is not affected by deferred pension taxation, regardless of whether subjects misperceive the tax treatment.

The above analysis concerns deferred pension taxation. However, we can also use the derived equations for immediate pension taxation. Because savings are not tax deductible and pensions are tax-free, we simply have to apply a tax rate τ of zero.

2.2 Deferred and Immediate Pension Taxation without Tax Misperceptions

In the first step, we assume that subjects perceive the deferred pension tax treatment correctly $(\alpha = \beta = 1)$ and compare the effects of deferred and immediate pension taxation. Under immediate taxation, τ equals zero. Thus, the optimum condition (7) simplifies to $u'(C_t) = u'(C_r)\left(\frac{1+i}{1+\rho}\right)^{t_s-t}\frac{PVAF_\rho}{PVAF} \quad \forall\ t \le t_s$. Under deferred taxation, the same equation results with $\alpha = \beta = 1$. Therefore, for each point in time, optimal consumption is identical under deferred and immediate taxation: $C_t^{Def} = C_t^{Imm}\ \forall\ \mathrm{t} \le \mathrm{T}$. This implies $S_t^{Def} = \frac{S_t^{Imm}}{1-\tau}$. Subjects save more under deferred than under immediate taxation. However, they receive a tax refund for retirement savings, so that their consumption is reduced only by $(1-\tau)\frac{S_t^{Imm}}{1-\tau} = S_t^{Imm}$, leading to the same consumption level in all saving periods as under immediate taxation $(Y_t - S_t^{Imm})$. Moreover, during the pension periods, subjects also consume the same amount $\left(1-\tau\right)\frac{\sum_{t=1}^{t_s}\frac{S_t^{Imm}}{1-\tau}(1+i)^{t_s-t}}{PVAF} = \frac{\sum_{t=1}^{t_s}S_t^{Imm}(1+i)^{t_s-t}}{PVAF} = P^{Imm}$. In summary, if subjects make no perception errors and the tax rate is constant over their lifetime, deferred and immediate taxation result in the same pension level.

This neutrality result is well known in prior tax research and leads to the first hypothesis to be tested:

H1: Subjects receive the same after-tax pension under deferred taxation as under immediate taxation.

Next, we study the effect of misperceptions regarding tax treatment under deferred taxation.

2.3 Deferred and Immediate Pension Taxation with Tax Misperceptions

In the previous section, we showed that the equivalence of immediate and deferred taxation is based on the assumption that subjects perceive the pension tax correctly under deferred taxation. However, there is growing evidence that many subjects underreact to changes in nonsalient taxes (e.g., Chetty et al. 2009, Goldin and Homonoff 2013, Feldman and Ruffle 2015), focus on pre-tax-values instead of after-tax returns (Fochmann et al. 2013), assign tax payments a higher disutility than economically equivalent payments (Blaufus and Möhlmann 2014), and use simple decision heuristics to reduce the cognitive effort demanded by tax complexity (Blaufus et al. 2013).

Regarding tax complexity, deferred and immediate taxation differ significantly. Under immediate taxation, only wage taxes arise, which are commonly withheld by the employer. In contrast, subjects under deferred taxation must also consider the tax deductibility of savings and the taxation of pensions. Prior experimental analyses find that increasing the complexity of the tax system leads to higher tax misperceptions and reduces subjects' decision performance (De Bartolome 1995, Rupert and Wright 1998, Rupert et al. 2003, Boylan and Frischmann 2006, Blaufus and Ortlieb 2009). It seems that subjects can only consider a limited number of tax rules (Abeler and Jäger 2015). Moreover, Blaufus and Ortlieb (2009) report that with rising tax complexity, subjects increasingly ignore taxes and base their savings decisions on pre-tax rather than on after-tax returns.

With respect to retirement savings, Beshears et al. (2015a) provide evidence of significant tax misperceptions in deferred pension tax systems. Using administrative company data, they find that contributions do not significantly differ between employees hired before versus after the introduction of an immediately taxed retirement savings plan. In a survey experiment, they find only small differences between savings in immediately and deferred taxed products.

Furthermore, they report that only 25% (33%) of the participants know how withdrawals from an immediately (deferred) taxed pension product are taxed.

In contrast to the survey by Beshears et al. (2015a), in our experiment, we will provide participants with all information on pension taxation before they make their savings decisions. Nevertheless, to consider the possibility that subjects completely ignore the taxation of their savings and pensions ($\alpha = \beta = 0$) despite being fully informed before making a decision, we test the following hypothesis:

H2: After-tax pensions under deferred taxation are equal to: $P_t^{Def} = P_t^{Imm}(1-\tau)$.

Following the literature presented above, it is, however, reasonable that the average subject neither perceives the tax burden correctly nor ignores taxes completely in the savings decisions. To examine the effect of (partial) tax misperceptions regarding tax refund (α) on optimal savings, we determine the total differential of (7) with respect to α and S_t. After rearranging, we obtain:

$$\frac{dS_t}{d\alpha} = \frac{u''(C_t)\tau S_t - \frac{u'(C_r)(1-\beta\tau)\tau}{(1-\alpha\tau)^2}\left(\frac{1+\mathrm{i}}{1+\rho}\right)^{t_s-t}\frac{PVAF_\rho}{PVAF}}{u''(C_t)(1-\alpha\tau) + u''(C_r)\left(\frac{1+\mathrm{i}}{1+\rho}\right)^{t_s-t}(1+\mathrm{i})^{t_s-t}\frac{PVAF_\rho}{PVAF^2}\frac{(1-\beta\tau)^2}{(1-\alpha\tau)}}. \quad (8)$$

As long as we assume a concave utility function, i.e., $u'(C_t) > 0,\ u''(C_t) < 0$, we obtain $\frac{dS_t}{d\alpha} > 0$. Thus, if subjects underweight the tax refund, we would expect retirement savings to decrease so that, ceteris paribus, subjects may receive lower after-tax pensions under deferred compared to immediate taxation. In contrast, if subjects overweight tax refunds, this will increase retirement savings, so that subjects under deferred taxation may earn after-tax pensions above the level of the immediate taxation system.

To calculate the effect of (partial) tax misperceptions regarding pension taxation (β) on optimal savings, we determine the total differential of (7) with respect to β and S_t. After rearranging, we obtain:

$$\frac{dS_t}{d\beta} = \frac{\tau \frac{PVAF_\rho}{PVAF(1-\alpha\tau)} \left(\frac{1+\mathrm{i}}{1+\rho}\right)^{t_s-t} u'(C_r)[1 - RRA(C_r)]}{u''(C_t)(1-\alpha\tau) + u''(C_r)\left(\frac{1+\mathrm{i}}{1+\rho}\right)^{t_s-t}(1+\mathrm{i})^{t_s-t} \frac{PVAF_\rho}{PVAF^2}\frac{(1-\beta\tau)^2}{(1-\alpha\tau)}}. \quad (9)$$

With $u'(C_t) > 0,\ u''(C_t) < 0$, the sign of the above derivate depends only on the subject's relative risk aversion *RRA*. Assuming a constant relative risk aversion equal to one, which implies $u(C_t) = ln(C_t)$, misperceptions regarding the taxation of pension payments do not affect the amount of savings $\left(\frac{dS_t}{d\beta} = 0\right)$. For subjects with a constant relative risk aversion greater (less) than one, savings increase (decrease) with increasing β. Thus, the following cases must be differentiated:

- Subjects with a constant relative risk aversion amounting to one earn smaller (larger) after-tax pensions under deferred than under immediate taxation if they underweight (overweight) tax refunds.
- Subjects with a constant relative risk aversion greater than one earn smaller (larger) after-tax pensions under deferred than under immediate taxation if they underweight (overweight) tax refunds and pension taxes, i.e., $\alpha, \beta < 1$ $(\alpha, \beta > 1)$. The effect of tax misperceptions on after-tax pensions is ambiguous, if $\alpha < 1, \beta > 1$ or $\alpha > 1, \beta < 1$.
- Subjects with a constant relative risk aversion less than one, earn smaller (larger) after-tax pensions under deferred than under immediate taxation if they underweight (overweight) tax refunds and overweight (underweight) pension taxes, i.e., $\alpha < 1, \beta > 1$ $(\alpha > 1, \beta < 1)$. The effect of tax misperceptions on after-tax pensions is ambiguous, if $\alpha, \beta < 1$ or $\alpha, \beta > 1$.

Unfortunately, estimates of the value of *RRA* range from less than 1 (e.g., Holt and Laury 2002, Andersen et al. 2008) to significantly over 1 (e.g., Blake 1996, Dohmen et al. 2011) or amount exactly to 1 (e.g., Chetty 2006). Thus, our third hypothesis is non-directional:

H3: After-tax pensions differ between deferred taxation and immediate taxation.

2.4 Tax Misperceptions and Informational Nudges

A growing body of evidence suggests that subjects are not fully informed about the tax policies relevant to pension savings decisions (Duflo et al. 2006, Saez 2009, Jones 2010, Beshears et al. 2011, Mayer at al. 2011, Chalmers et al. 2014). As we have already argued, individuals under deferred taxation need higher cognitive capacities to process tax information, to understand the tax system and to determine savings consequences compared to individuals in an immediate taxation system. However, decision-makers have limited cognitive capacity. For example, they forget or ignore relevant information they might need to make a savings decision. Instead, individuals are bounded rationally and process information more heuristically than systematically when faced with complex choices (Chaiken and Maheswaran 1994).

In light of this evidence, we suppose that informational nudges with regard to the deferred taxation system diminish tax misperceptions and thus enable subjects to make tax-efficient savings decisions. Nudges offer a valuable framework for altering the choice structure of individuals in order to change their behavior (John et al. 2013), but they do not affect individuals' budget sets, and they encompass a wide range of different designs (Sunstein 2014). We consider tax nudges to simplify the deferred tax system, to remind people of the relevant tax rules and to inform them of the consequences of their own past choices. Prior research examines the influence on savings behavior of general information provided about the tax system (e.g., Duflo and Saez 2003, Jones 2010, Beshears et al. 2011), but there are very few papers that examine the effects of tax nudges on retirement savings. Madrian and Shea (2001), for example, find large effects of defaults on the participation rate in a 401(k) plan. To shed more light on the effects of informational tax nudges on retirement savings, we analyze which *specific* informational tax nudge is necessary to ensure that taxes are correctly perceived. The theoretical model in chapter 2.3 reveals that tax misperceptions regarding both the tax refund (α) and pension taxation (β) could affect optimal savings. Therefore, we investigate whether informational nudges regarding the tax refund and/or pension taxation increase tax efficiency. Thus, we formulate the following two hypotheses:

H4: Recurrent informational nudges regarding the tax refund increase tax efficiency.

H5: Recurrent informational nudges regarding the tax burden on pensions increase tax efficiency.

2.5 Learning through Experience

Following the widely accepted definition of "learning" by Schunk (2012), "learning is an enduring change in behavior […] which results from practice or other forms of experience". Thus, if taxes are misperceived, which results in tax-inefficient savings decisions, the question arises whether individuals learn through experience which may ease this effect (i.e., tax misperception) and cause individuals to move in the direction of the predictions of the rational choice model. If one takes the view that the complexity of the decision environment can trigger status-quo effects (e.g., Samuelson and Zeckhauser 1988), then experience does not lead to the neutrality result concerning the equivalence between immediate and deferred taxation. However, there are several studies that find evidence for a correlation between experience and savings decisions.

Boylan and Frischmann (2006) examine the impact of tax complexity on investor profits. They conduct a laboratory experiment with two treatments, which differ only in tax complexity. The results show that tax complexity has a negative impact on investor profits. However, the differences between both treatments decrease over the course of the experiment. The authors ascribe the result to learning effects in the high-complexity treatment. Coppola and Gasche (2011) find that a large share of the German population is poorly informed about retirement savings incentives. However, the authors show that the misperception of eligibility for retirement savings subsidies decreases with the contractual period and, hence, experience.

Thus, we test the following hypothesis:

H6: Learning through experience increases tax efficiency.

3. Baseline Experiment: Immediate versus Deferred Taxation

3.1 Method, Data, and Procedure

To test hypotheses H1 to H3 and H6, we use a between-subject design with the pension tax regime (immediate versus deferred) as the treatment variable. Subjects make savings and

spending decisions in a life-cycle experiment with certain and constant income. All experiments were conducted from December 2016 to November 2017 at the computerized experimental laboratory of the Leibniz University of Hanover and were programmed by using the software z-Tree (Fischbacher 2007). We present a translation of the instructions and screenshots of the experiments in Appendices A1 and A2.[2]

The session starts with some general information regarding the workstation's utilities (a computer, a stack of sheets, a pen, and a calculator). The information was loudly spoken. Subsequently, a short training phase starts, in which the participants become familiar with the experimental design of the work task described below. Next, the instructions are distributed. Before the experiment starts, the participants have to answer comprehension questions with respect to both the experimental design and the tax rules to ensure that all have understood the rules before they make their savings decisions. Only after answering all questions correctly are subjects allowed to start the experiment.

Subjects participate in two sequences under the same life-cycle income process. Each sequence consists of 15 periods, separated into a working phase (periods 1 to 10) and a pension phase (periods 11 to 15). The periods of the working phase are split into two parts: a work task and a savings decision. The participants are asked to digitize 25 answers from an answer sheet of a multiple-choice exam. Each question on the answer sheet has 6 possible answers. The participants are asked to transfer each tick by clicking the respective check box on the screen.

Before each digitalization, the participants enter a four-digit number, which identifies a certain answering scheme. We use 20 varying answering schemes, each of which includes 300 different four-digit numbers. Based on the answering sheet number, the computer checks the correctness of the work tasks after five digitized answers. In the case of an incorrect transfer, the input must be checked again. There is no time limit. This work task offers an important advantage: All participants earn the same wage in each period independently of their education and abilities.

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[2] Note that we describe the experiment in neutral language to avoid subjects using individual scripts when interpreting loaded terms. In particular, we do not use the terms pension or retirement; instead, we use terms such as "working phase", "rest phase", "savings decision", and "payoff".

At the end of the work task, the participants are supplied with an overview of their gross and net wage (in ECU, an experimental currency). They receive a gross wage of 115.00 ECU (1 ECU = € 0.01) for each digitized answer. Hence, they earn 2,875 ECU (€ 28.75) before taxes per period for 25 digitized answers. Note that after reading the instructions, subjects are already aware that they have a constant gross income in each period of the working phase. The gross wage is taxed at a tax rate of 40%.[3]

The payoffs in the pension phase depend only on the savings in the working phase because participants do not receive an income during the pension phase. After the work task, participants decide how much they would like to spend in the respective period and how much they would like to save for the pension phase. To do so, they enter an arbitrary savings amount in a corresponding box. The savings, however, must not exceed the net wage. For the savings, participants earn 5% interest per period (including compound interest) until the payoff in the pension period.[4]

The two tax treatments in the baseline experiment differ solely in the point of time at which savings are taxed. In the immediate taxation treatment (*Immediate*), the savings are not tax deductible. Accordingly, the pensions are tax-free. In the deferred taxation treatment (*Deferred*), participants claim the savings as tax deductible. Due to a tax return, they receive a tax refund of 40% of the savings amount, which is paid out in the respective period. In turn, they have to pay taxes at a rate of 40% in the pension phase on both the returns of their savings as well as the invested capital.

To increase tax salience, the participants in the tax treatments are asked to complete a tax return after having made their savings decision. For this purpose, they transfer their gross wage from a wage overview to the appropriate field of the tax return. Participants in the deferred taxation treatment claim also their savings as tax deductions by typing their respective savings amount into the tax return. By clicking on "submit," their input is checked. On another screen, all

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[3] Tax revenues from this experiment are not distributed among participants. Instead, we inform subjects that they are used for further experimental research at the experimental laboratory of the Leibniz University of Hanover.

[4] We implemented a positive interest rate in our experimental design to identify heuristic savings decisions. For example, without interest, we could not distinguish a rational from a heuristic savings behavior if one third of the income had been saved in each period.

participants receive a summary of the respective period. This summary provides information on the amount of the savings and the payoff in the respective period.

After the working phase, participants are informed about the payoffs in the pension phase (periods 11 to 15). In addition to the total savings, they are also shown the amount of payoff for periods 11 to 15. In the pension phase, the participants receive a constant payoff in each period, which results from their entire savings and the resulting interest and compound interest. Depending on the treatment, taxes still have to be considered. The net amount of annuity of the savings is paid out as ordinary annuities over the pension phase (*After-Tax Pension*).

When the first sequence is finished, the second sequence starts. The second sequence mirrors the first sequence exactly and is used to test whether subjects learn from experience. After each sequence, the participants are asked how satisfied they are with the payoffs in the pension phase and to what extent the payoff in the pension phase measures up to their expectations. Additionally, at the end of the second sequence, they are asked whether they would have saved less or more if they had had the opportunity to change their savings decisions.

To identify suboptimal savings decisions, many lab experimenters use induced utility functions (e.g., Fehr and Zych 1998; Brown et al. 2009; Ballinger et al. 2011). This methodological solution enables researchers to analyze savings decisions against an optimal benchmark. However, it also adds considerable complexity to the experiment. Because we are only interested in the different savings behaviors between the two tax systems, inducing preferences is not necessary. Instead, we rely on subjects' own exogenous preferences. However, to adapt our experimental design to the underlying model of additively separable utility, only one of the 30 periods is considered for payment. To determine the relevant period, participants throw a thirty-sided dice. Hence, subjects maximize their experimental wealth according to the following utility function:

$$U = \frac{1}{T}\sum_{t=1}^{T} u(C_t). \tag{10}$$

This objective function mirrors the assumed additively separable utility function of our life-cycle model in section 2. Note, however, that time discounting does not matter in our experiment because subjects receive their payoffs at a single point in time, i.e., at the end of the experiment.

The experiment ends with a questionnaire to collect socio-demographic data. A translated version of the questionnaire is presented in Appendix A3.

The predicted hypotheses are tested using both bivariate and multivariate analyses. We present non-parametric Mann-Whitney U tests for all bivariate analyses. In addition, we verified our bivariate results using t-tests. The results do not differ. To control for different socio-demographic variables and subjects' savings incentives, we run several robust regressions proposed by Huber (1973, Huber's M-estimator). We use robust regressions to obtain estimates, which are less affected by outliers.[5]

A total of 69 participants are randomly assigned to the following two treatments of the baseline experiment: *Immediate* (34 participants) and *Deferred* (35); 55% of the participants are male, and their average age is 24.75 years (SD 6.19). Subjects earned an average of € 14.77 in approximately 90 minutes (approximately € 9.85 per hour), with a minimum of € 1.50 and a maximum of € 27.00.

3.2 Variable Measurement

3.2.1 Dependent Variable

To test whether subjects save the same amount under deferred and immediate taxation (H2), we use the pre-tax pension $P = \frac{\sum_{t=1}^{ts} S_t(1+i)^{ts-t}}{PVAF}$ as the dependent variable. Regarding the remaining hypotheses, we use *After-Tax Pension* as the dependent variable. The after-tax pension differs from the pre-tax pension only in the deferred tax treatments and amounts to

$$After\text{-}Tax\ Pension^{Def} = P_t^{Def}(1-\tau). \tag{11}$$

[5] Furthermore, it should be noted that the maximal attainable after-tax pension could be higher under immediate than under deferred taxation. This is because participants in both treatments decide how much they would like to spend from their net wage, which is the same in both systems. However, the pension is still taxed under deferred taxation. To address this problem, we run several OLS regressions where all observations are deleted that are border solutions regarding the maximal attainable after-tax pension, and additionally, in the immediate taxation treatment, all observations are deleted where the after-tax pension is above the maximal attainable after-tax pension under deferred taxation. The results remain qualitatively unchanged in all conducted analyses.

3.2.2 Independent and Control Variables

As independent variables, we use the treatment variables *Immediate* and *Deferred*. These are dummy variables equal to one if the observation belongs to the respective treatment.

As control variables in multivariate analyses, we consider different socio-demographic variables such as age (*High Age)*, gender (*Male)*, financial status (*High Income)*, tax and financial knowledge (*High Knowledge)*, risk attitude *(High Risk Taking)*, tax aversion (*Tax Aversion*), and procrastination (*High Procrastination*). *High Age* takes on a value of one if the participant's age is above the median of all observations. *Male* is also a dummy variable equal to one if the participant is male. The financial status of a participant is taken into account by another dummy variable *High Income*, which is one if the monthly disposable income (after rent) of the participant is greater than € 500. Furthermore, the theoretical model in section 2 suggests that participants may partly neglect and/or ignore taxes in the deferred taxation treatment due to higher complexity. Hence, high tax and financial knowledge might ease this effect. The variable *High Knowledge* is considered as a dichotomized and aggregated variable, which includes the answers to our two pre-experimental questions regarding tax and financial knowledge. In those questions, the participants assess their personal knowledge on a 9-point scale from 1 = no experience to 9 = much experience. The dummy variable *High Knowledge* equals one if the sum of both answers is greater than the median of all observations. In accordance with our theoretical prediction, we also control for participants' risk attitudes. Risk taking is considered the individual's self-reported risk-taking attitude on a scale from 0 = not at all willing to take risks to 10 = very willing to take risks (Dohmen et al. 2011). The dummy variable *High Risk Taking* equals one if the participant's risk taking is greater than the median of all observations. To control for tax aversion with respect to tax misperceptions (Blaufus and Möhlmann 2014), we ask the participants, in the questionnaire, if they would invest money either in a taxable bond or in an economically equal tax-exempt bond. *Tax Aversion* is considered as a dummy variable equal to one if the participant would invest the money in the tax-exempt bond (Sussman and Olivola 2011). Finally, we control for procrastination because procrastination is regarded as an important factor in individual savings decisions for retirement (Madrian and Shea 2001). Therefore, participants are presented with five statements regarding procrastination and asked to decide whether they are personally uncharacteristic or characteristic for them on a scale from 1 = very uncharacteristic to 5 = very characteristic. *High Procrastination* is also included as a

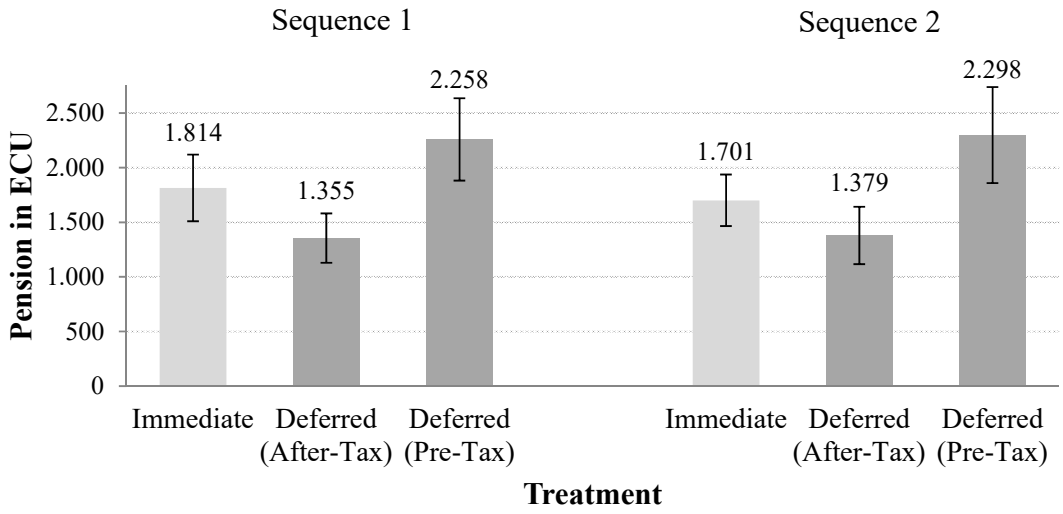
dummy variable, which is one if the procrastination of the subject, aggregated as the sum of all five answers, is above the median of all observations.

3.3 Empirical Results and Discussion

3.3.1 Immediate versus Deferred Taxation

The first three bars of Figure 1 show the average pre-tax and after-tax pensions for the treatments under immediate and deferred taxation in the first sequence. Note that in the immediate taxation treatment, the average after-tax and pre-tax pensions are the same.

Figure 1: Baseline Experiment: Average Pensions



The dependent variable *Pre-Tax [After-Tax] Pension* is calculated according to equation (2) [(11)]. Error bars show 95% confidence intervals.

First, we compare the average after-tax pensions in sequence 1. The average after-tax pension in the deferred taxation treatment amounts to 1,355 ECU and is 459 ECU lower compared to the treatment under immediate taxation. The difference is statistically significant ($p < 0.01$), and the regression result confirms our bivariate finding (see Model 1 in Table 1). Accordingly, subjects make perception errors, and we must reject hypothesis H1 but not hypothesis H3. Assuming that savings decisions are tax-efficient under immediate taxation (see chapter 5.3), the difference between the two tax systems is due to a distorted tax perception and leads to a loss of tax-efficiency under deferred taxation.

To test whether subjects fully neglect taxes (hypothesis H2), we compare the average pre-tax pensions in sequence 1 (see again Figure 1). In the deferred taxation treatment, the pre-tax pensions are, on average, 444 ECU higher compared to the treatment under immediate taxation ($p = 0.026$), and this finding is in line with our multivariate result (see Model 2 in Table 1). Thus, we reject hypothesis H2 because subjects do not fully ignore the taxation of their savings and pensions.

Table 1 shows that all control variables except *High Knowledge* in Model 2 do not significantly affect savings behavior (we examine the aspect of participants' knowledge in more detail in the additional analyses, section 5.1).[6]

3.3.2 Learning through experience

To analyze potential learning effects – produced through experience – on savings behavior (hypothesis H6), we use the second sequence of the experiment. The last three bars of Figure 1 show the average pre-tax and after-tax pensions for the second sequence of our baseline experiment. We find that the treatment effects remain statistically significant. However, the multivariate analyses (see Models 3 and 4 in Table 1) do not confirm this result with respect to the pre-tax pension, which indicates that subjects tend to fully ignore taxes in the second sequence. In addition, we conduct regression analyses using observations from both sequences, including an interaction term of *Sequence* and *Deferred.* The coefficient of the interaction term is insignificant in all these analyses with the after-tax pension as the dependent variable. Accordingly, the average subject does not learn from experience. Note that we test for the effect of tax and financial knowledge on learning through experience in the additional analyses (section 5.1).

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[6] In addition to the presented regression, we run robust regressions with personality traits as control variables. To control for personality traits, we use the five-factor model of personality defined by McCrae and Costa (1987). This model assumes that the personality of an individual can be mapped onto the following five dimensions: conscientiousness, openness, extraversion, agreeableness, and neuroticism. In our questionnaire, we use a short form of the Big Five Inventory (BFI – S) developed by Gerlitz and Schupp (2005), consisting of 15 items. Each trait is measured with an average of three questions per trait. Taking into account the personality traits, however, does not change the results regarding the treatment effects.

Table 1: Baseline Experiment: Robust Regression Analysis

	Pension Sequence 1		Pension Sequence 2	
	After-Tax	Pre-Tax	After-Tax	Pre-Tax
	(1)	(2)	(3)	(4)
Deferred	**-369.7***	**534.1****	**-388.0***	**395.0**
	(185.5)	**(225.2)**	**(203.9)**	**(251.6)**
High Age	201.9	291.0	253.4	-21.61
	(178.2)	(216.4)	(195.9)	(268.7)
Male	-180.8	-229.4	-21.54	-6.636
	(198.2)	(240.5)	(217.8)	(272.6)
High Income	-6.391	-37.01	21.26	305.5
	(201.0)	(244.0)	(220.9)	(241.7)
High Knowledge	308.7	509.1**	221.4	318.4
	(199.0)	(241.5)	(218.7)	(269.8)
High Risk Taking	-15.21	-29.45	-159.1	-266.0
	(197.7)	(240.0)	(217.3)	(268.1)
Tax Aversion	-105.9	-113.3	129.3	156.3
	(198.3)	(240.6)	(217.9)	(268.9)
High Procrastination	62.91	13.90	-77.09	-84.97
	(185.6)	(225.3)	(203.9)	(251.7)
Constant	1,558***	1,431***	1,515***	1,503***
	(241.3)	(292.8)	(265.1)	(327.2)
Observations	69	69	69	69
R^2	0.130	0.116	0.094	0.077

The dependent variable *Pre-Tax [After-Tax] Pension* is calculated according to equation (2) [(11)]. *Deferred* is a dummy variable equal to one if the observation belongs to the deferred taxation treatment. Regarding the control variables *High Age*, *Male*, *High Income*, *High Knowledge*, *High Risk Taking, Tax Aversion,* and *High Procrastination,* see chapter 3.2.2. We report standard errors in parentheses. ***, **, and * denote significance at the 1%, 5%, and 10% levels, respectively.

3.3.3 Discussion

The question is why taxes are misperceived under deferred taxation, even though participants in our experiment are fully informed about the tax rules. The starting point from which to answer this question concerns the different levels of complexity of both tax treatments. Regarding this, at the end of the experiment, we asked the participants how complicated they found the taxation in the experiment on a 9-point scale from 1 = very easy to 9 = very complicated. This question reveals that participants in the deferred taxation treatment found the taxation more complicated compared to the participants under immediate taxation (Means: *Immediate* = 3.5 and *Deferred* = 4.9, p = 0.011). We conclude that subjects are bounded rational due to the higher complexity under deferred taxation.

So, compared to individuals in an immediate taxation system, individuals under deferred taxation need higher cognitive capacities to process tax information, to understand the tax system and to determine savings consequences. However, they have limited cognitive capacity. As a result, participants search for available alternative decision-making strategies, such as heuristics, until an acceptable aspiration level is reached. This concept of "satisficing economic behavior" goes back to Simon 1957. In line with this concept, we find no significant differences between immediate and deferred tax treatments with respect to the question of whether subjects' after-tax pensions meet their expectations as indicated on a 9-point scale from 1 = not at all to 9 = perfect (Means Sequence 1: *Immediate* = 5.9 and *Deferred* = 5.4, p = 0.284; Means Sequence 2: *Immediate* = 6.3 and *Deferred* = 6.3, p = 0.966). This question was asked after informing subjects about their after-tax pensions.

According to the concept of satisficing, savings decisions are assumed to be satisfying if they meet individuals' acceptable aspiration levels. This concept was extended by Sauermann and Selten in 1962 with the aspiration adaptation theory (Selten 1998). Regarding this concept, we asked the participants how satisfied they were with the payoffs in the pension phase; we used a 9-point scale from 1 = not at all satisfied to 9 = perfectly satisfied. Although participants in the first sequence are even more dissatisfied in the deferred taxation treatment (Means: *Immediate* = 6.3 and *Deferred* = 5.0, p = 0.013), this difference disappears in the second sequence despite the sustained lower after-tax pension (Means: *Immediate* = 5.7 and *Deferred* = 5.7, p = 0.903). In line with the aspiration adaptation theory, subjects are satisfied with savings decisions that may not be optimal in the objective sense but are satisfying in terms of subjects' cognitive restrictions. This result is also consistent with the evaluation of whether the participants would have saved less or more if they had had the opportunity to change their savings decisions. Responses are made on a 9-point scale from 1 = save less to 9 = save more. This question was only asked after informing subjects about their after-tax pensions in the second sequence. Participants in both tax treatments would continue to save the same amount if they had had the opportunity to change their savings decisions (Means: *Immediate* = 5.5 and *Deferred* = 5.1, p = 0.207).

In the next section, we study whether additional informational nudges regarding the tax deductibility of savings and the taxation of pension payments eliminate the observed distortions.

4. Effect of Informational Tax Nudges on Retirement Savings

4.1 Method, Data, and Procedure

To analyze whether informational tax nudges prevent tax misperceptions, additional experiments were programmed and conducted. The setting of these experiments is the same as in the deferred taxation treatment from the baseline experiment, but we extend it by introducing recurrent informational nudges regarding the tax refund and/or pension taxation after each period in the working phase. To isolate the effect of informational tax nudges, we first exclude potential distortions regarding the calculation of the pre-tax pension. Therefore, we run two further treatments (*Imm_P* and *Def_P*) in which the subjects are additionally shown pension information (P) in the form of the gross payments during the pension period resulting from their previous average savings. After each period, we inform the participants as follows: *"If you save until the rest phase as much as you did on average in the last periods, amounting to [average savings] ECU, your payments in the rest phase resulting from the savings will correspond to [gross payments resulting from prior average savings] ECU."* Subsequently, the next of a total of ten working periods starts.

In our analysis, we compare all new experiments with the immediate taxation treatment *Imm_P*. Thus, all treatments differ only with respect to the provision of recurrent tax-related informational nudges. Table 2 presents all treatments.

Table 2: Overview of Recurrent Informational Nudges

			Level of Recurrent Informational Tax Nudges		
Treatment	**Obs.**	**Pension Information (P)**	**Tax Refund Information (R)**	**Abstract Pension Tax Information (AbPT)**	**Numerical Pension Tax Information (NuPT)**
Baseline					
Imm_P	26	X			
Informational Nudges					
Def_P	27	X			
Def_P+R	26	X	X		
Def_P+AbPT	27	X		X	
Def_P+NuPT	28	X			X
Def_P+AbPT+R	28	X	X	X	
Def_P+NuPT+R	29	X	X		X

Each treatment contains the same pension information (P) as described above. In addition, in the treatments *Def_P+R*, *Def_P+AbPT+R*, and *Def_P+NuPT+R,* participants receive informational nudges about the numerical value of the tax refund (R). In these treatments, the summary after each period shows in detail how the tax refund is calculated and how it is included in the payoff of the respective period (see Figure A12 in Appendix A2). To confirm hypothesis H4, the additional informational tax nudges should ease the effect of tax misperceptions regarding the tax refund (α) and should increase tax-efficiency.

To analyze the effect on savings of tax misperceptions regarding pension taxation (β), subjects additionally receive informational nudges about the pension tax (PT). We examine the additional informational nudges with regard to the following two expressions: In the treatments *Def_P+AbPT* and *Def_P+AbPT+R* the participants get only the following abstract informational pension tax nudge (AbPT) after the pension information: "*Please note that all payments in the rest phase resulting from your savings are subject to tax.*" Thus, the participants are reminded that their payments are subject to taxation, but their after-tax payoffs are not calculated. In the treatments *Def_P+NuPT* and *Def_P+NuPT+R*, the participants receive the following numerical informational pension tax nudge (NuPT) after the pension information: "*These, however, would be subject to a tax of 40%. The payoffs in periods 11 to 15 therefore correspond to [after-tax pension] ECU after taxes.*" So, the participants are not only informed about the gross payoffs in the pension phase but also about the net payoffs based on the average savings for the previous periods. To confirm hypothesis H5, the recurrent informational nudges regarding the tax burden on pensions should increase tax-efficiency.

A total of 191 participants are randomly split into the mentioned treatments; 55% of the participants are male, and their average age is 23.76 years (SD 4.72). Subjects earned an average of € 14.43 in approximately 90 minutes (approximately € 9.62 per hour), with a minimum of € 4.60 and a maximum of € 31.60.

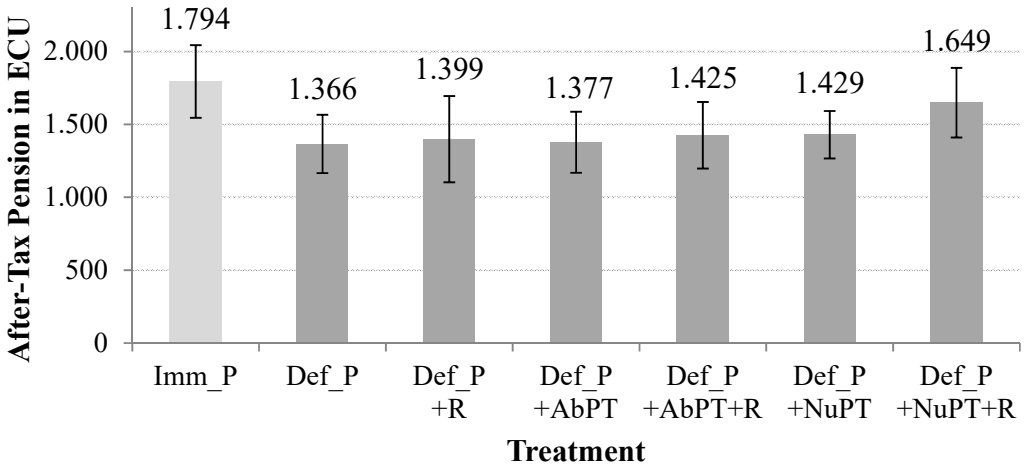
4.2 Empirical Results and Discussion

4.2.1 The Effect of Informational Tax Nudges

Figure 2 displays the average after-tax pension for the respective treatment in the first sequence. At first glance, Figure 2 shows that the more informational tax nudges the subjects receive, the

smaller is the effect of tax misperceptions on their savings behavior. However, the bivariate analysis shows that only in the treatment with recurrent informational nudges about the tax refund combined with numerical pension tax nudges (*Def_P+NuPT+R*), after-tax pensions do not significantly differ from the payments under immediate taxation with pension information ($p = 0.418$).[7] The results of the multivariate robust regressions confirm our bivariate findings (see Models 1 and 2 in Table 3). Additionally, we observe significantly positive effects of high risk-taking and tax aversion on the savings decision. All other control variables do not significantly affect the savings behavior in the first sequence.

Figure 2: Recurrent Informational Nudges: Average After-Tax Pensions



The dependent variable *After-Tax Pension* is calculated according to equation (11). The abbreviation Imm_P (Def_P) represents the treatment under immediate (deferred) taxation with pension information (P). In some treatments, the participants receive also recurrent informational nudges, such as detailed information about the tax refund (R), abstract information about the pension tax (AbPT), and numerical information about the pension tax (NuPT). Error bars show 95% confidence intervals.

[7] The average after-tax pension in the treatment *Imm_P* [*Def_P*] and the baseline treatment *Immediate* [*Deferred*] are not significantly different from each other ($p = 0.921$ [$p = 0.942$]). In line with our expectations, savings decisions are not distorted due to misperceptions regarding the level of pre-tax pensions but rather due to tax misperceptions.

Table 3: Recurrent Informational Nudges: Robust Regression Analysis

	After-Tax Pension Sequence 1		After-Tax Pension Sequence 2	
	(1)	(2)	(3)	(4)
Treatment				
Imm_P	----------	**(base)**	----------	
Def_P	**-335.8****	**-371.3****	**-340.2****	**-297.1***
	(150.7)	**(155.5)**	**(163.9)**	**(165.5)**
Def_P+R	**-314.9****	**-357.5****	**-462.9*****	**-448.0*****
	(152.1)	**(152.2)**	**(165.4)**	**(162.0)**
Def_P+AbPT	**-298.2****	**-324.0****	**-334.3****	**-283.5***
	(150.7)	**(152.8)**	**(163.9)**	**(162.6)**
Def_P+AbPT+R	**-307.4****	**-342.7****	**-324.0****	**-300.2***
	(149.4)	**(150.9)**	**(162.4)**	**(160.6)**
Def_P+NuPT	**-257.0***	**-262.1***	**-293.8***	**-157.0**
	(149.4)	**(152.4)**	**(162.4)**	**(162.2)**
Def_P+NuPT+R	**-77.88**	**-83.06**	**-205.6**	**-75.98**
	(148.1)	**(148.4)**	**(161.1)**	**(158.0)**
High Age		43.46		-49.41
		(82.00)		(87.29)
Male		136.2		25.95
		(87.84)		(93.51)
High Income		-93.33		-111.3
		(85.69)		(91.22)
High Knowledge		76.42		157.8*
		(84.29)		(89.73)
High Risk Taking		172.7**		236.2***
		(83.77)		(89.18)
Tax Aversion		141.9*		35.39
		(84.25)		(89.69)
High Procrastination		-138.7		71.98
		(83.92)		(89.34)
Constant	1,675***	1,527***	1,738***	1,511***
	(107.5)	(143.2)	(117.0)	(152.4)
Observations	191	191	191	191
R^2	0.039	0.097	0.034	0.107

The dependent variable *After-Tax Pension* is calculated according to equation (11). The treatment variables are dummy variables equal to one if the observation belongs to the respective taxation treatment. The abbreviation Imm_P (Def_P) represents the treatment under immediate (deferred) taxation with pension information (P). In some treatments, the participants receive also recurrent informational nudges, such as detailed information about the tax refund (R), abstract information about the pension tax (AbPT), and numerical information about the pension tax (NuPT). Regarding the control variables *High Age*, *Male*, *High Income*, *High Knowledge*, *High Risk Taking, Tax Aversion,* and *High Procrastination,* see chapter 3.2.2. We report standard errors in parentheses. ***, **, and * denote significance at the 1%, 5%, and 10% levels, respectively.

On the basis of these findings, we must reject hypotheses H4 and H5. Mann-Whitney U tests reveal that any single informational tax nudge does not increase savings, and thus it does not

increase tax-efficiency. If subjects are to save tax-efficiently, they need, before each savings decision, both detailed tax refund and numerical pension tax informational nudges. Furthermore, just the combination of both of these informational nudges increases savings.[8] Note that the combination of tax refund nudges and abstract pension tax nudges as it is provided in some countries (e.g., Germany) is not sufficient to achieve tax-efficient savings behavior. The superiority of numerical informational nudges over abstract verbal informational nudges is in line with prior cognitive psychology research, which has found that numerical information requires less information processing time, is recognized more quickly and accurately and is recalled more exactly than is verbal information for learning tasks (e.g., Viswanathan and Childers 1996).

4.2.2 Learning through experience

Next, we analyze the second sequence to examine possible learning effects through experience. Models 3 and 4 in Table 3 reveal that recurrent informational tax nudges principally have no significant influence on savings behavior over time. In other words, the main treatment effects in sequence two are equal to those in the first sequence. We observe, however, one small difference (see Model 4 in Table 3). In this model, the treatment effect is no longer significant if only recurrent numerical pension information is given (*Def_P+NuPT*). This indicates some learning through experience in the presence of numerical pension tax information.

4.2.3 Discussion

We find that providing recurrent numerical informational nudges about both the tax refund and the after-tax pension leads to tax-efficient savings behavior. This finding endures over time. However, the question arises whether these informational tax nudges only lead to tax-efficient savings behavior if they are given at a time close to when the savings decision is made. In other words, are the participants able to transfer their acquired knowledge to other environments?

Learning is a process that is influenced by several situational factors. In addition to experience, other factors also play an important role in the learning process, e.g., informational nudges in the

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[8] We compare the after-tax pension of the treatments Def_P and Def_P+NuPT+R and find a statistically significant difference ($p = 0.065$).

form of feedback information or reminders. Following Tversky and Kahneman (1986), effective learning "requires accurate and immediate feedback about the relation between the situational conditions and the appropriate response." The informational tax nudges used here might serve as such appropriate feedback, which could potentially facilitate learning.

To test this assumption, we conduct another experiment in which we provide tax nudges only in the first of the two sequences under deferred taxation. We then compare the results again with the savings decisions from the tax-efficient system under immediate taxation to examine whether subjects learn in the second sequence as a result of receiving informational tax nudges in the first sequence. Thus, this experiment has a mixed between and within design. The setting of the first sequence is the same as in section 4.1. In the second sequence, participants no longer receive informational tax nudges in the deferred taxation treatment. To avoid status-quo bias in the second sequence, we make some modifications to both the immediate and deferred taxation treatments. Among other modifications, the working phase now consists of only eight periods. Therefore, participants receive a higher wage in each period during the working phase. Note that the tax rules remain the same in both sequences. The new information in the second sequence is provided by an additional instruction. The following table shows the two treatments, with the level of the informational nudges in the respective sequence:

Table 4: Overview of Recurrent Informational Nudges II

			Level of Recurrent Informational Tax Nudges	
Treatment	**Obs.**	**Pension Information (P)**	**Tax Refund Information (R)**	**Numerical Pension Tax Information (NuPT)**
Baseline				
Imm_P_2	29	X		
Informational Tax Nudges				
Def_P+NuPT+R_P	30			
Sequence 1		X	X	X
Sequence 2		X		

A total of 59 participants are randomly split into the mentioned treatments; 46% of the participants are male, and their average age is 23.49 years (SD 3.04). Subjects earned an average of € 15.47 in approximately 90 minutes (approximately € 10.31 per hour), with a minimum of € 5.10 and a maximum of € 46.40.

Table 5: Learning through Experience: Robust Regression Analysis

	After-Tax Pension Sequence 1 (1)	After-Tax Pension Sequence 2 (2)
Imm_P_2	**---------- (base) ----------**	
Def_P+NuPT+R_P	**-122.4**	**-228.9**
	(172.9)	**(153.7)**
High Age	-55.32	-21.56
	(184.1)	(163.7)
Male	29.49	41.07
	(189.7)	(168.6)
High Income	61.59	-8.490
	(177.2)	(157.5)
High Knowledge	-72.61	30.69
	(186.9)	(166.1)
High Risk Taking	-151.9	-119.0
	(177.4)	(157.6)
Tax Aversion	-78.78	5.675
	(173.2)	(153.9)
High Procrastination	-101.6	-49.50
	(175.9)	(156.3)
Constant	1,769***	1,589***
	(222.5)	(197.8)
Observations	59	59
R^2	0.035	0.057

The dependent variable *After-Tax Pension* is calculated according to equation (11). The treatment variables are dummy variables equal to one if the observation belongs to the respective taxation treatment. The abbreviation *Imm_P* represents the treatment under immediate taxation with pension information (P). In the treatment *Def_P+NuPT+R_P*, participants receive additional numerical informational nudges about both the tax refund (R) and the pension tax (NuPT) in the first sequence. Regarding the control variables *High Age*, *Male*, *High Income*, *High Knowledge*, *High Risk Taking, Tax Aversion,* and *High Procrastination,* see chapter 3.2.2. We report standard errors in parentheses. ***, **, and * denote significance at the 1%, 5%, and 10% levels, respectively.

The first column of Table 5 shows the result of the robust regression analysis of sequence 1. We find no tax misperceptions in subjects' savings decisions if we present the subjects with recurrent numerical informational nudges regarding their tax refunds and future pension taxes. This is in line with our findings in chapter 4.2. To assess whether subjects learn in the second sequence as a result of receiving informational tax nudges in the first sequence, participants pass through the life-cycle a second time. However, this time, they do not receive any informational nudges in the deferred taxation treatment. The last column of Table 5 still shows no significant difference between the mentioned tax treatments with regard to the resulting after-tax pensions. In

summary, providing informational tax nudges seems to reinforce learning. As a result, participants are able to transfer their acquired knowledge to other environments, resulting in tax-efficient savings behavior.

5. Additional Analyses

5.1 The Influence of Tax and Financial Knowledge on Learning through Experience

In a survey experiment, Beshears et al. (2015a) show that future after-tax pensions differ between immediate and deferred pension tax systems. They categorize subjects by the number of tax knowledge questions answered correctly and show that participants with high financial literacy adjust their pension savings significantly in response to different tax treatments. Note, however, that in contrast to our experiment, survey participants in Beshears et al. (2015a) are not fully informed about the pension tax treatment before making their decisions.

In section 3.2.2, we show that the average subject does not learn from experience. In this section, we test for the effect of tax and financial knowledge on learning through experience. Therefore, we split our sample into two groups: participants with high knowledge and those with low knowledge (median split, see section 3.2.2 for the variable measurement). Due to our small sample size, we aggregate the treatments with and without pension information in the respective tax system for our sample split analysis (*Immediate* + *Imm_P* versus *Deferred* + *Def_P*).[9] Table **6** shows the results for both sequences.

In the first sequence, we find a treatment effect in both knowledge groups indicating tax misperceptions regardless participants' knowledge. However, in the second sequence, we find evidence that only subjects with low tax and financial knowledge do not learn through experience. The complexity of the deferred pension tax system seems to prevent subjects with low tax and financial knowledge from learning through experience.

[9] We already showed in section 3 that the additional pension information (P) has no significant effect on the after-tax pension in the respective tax system.

Table 6: High versus Low Tax and Financial Knowledge

	Immediate + *Imm_P*	*Deferred* + *Def_P*	Mann-Whitney U
Sequence 1:			
High Knowledge	1,825 (N = 35)	1,465 (N = 27)	p = 0.026
Low Knowledge	1,777 (N = 25)	1,277 (N = 35)	p = 0.009
Sequence 2:			
High Knowledge	1,752 (N = 35)	1,599 (N = 27)	p = 0.518
Low Knowledge	1,723 (N = 25)	1,229 (N = 35)	p = 0.005

This table presents average *After-Tax Pensions*, which are calculated according to equation (11). To test for the effect of knowledge, we split our sample into two groups: participants with high knowledge and those with low knowledge (median split). Regarding the variable *High Knowledge,* see chapter 3.2.2.

5.2 Tax Deductibility of Retirement Savings versus Matching Contributions

In section 4, we demonstrated that if we only provide recurrent numerical informational tax nudges regarding both the tax refund and the after-tax pension, tax misperceptions do not affect savings behavior. However, information costs for savers and the government are not considered in our analysis. Taking information costs into account, the tax system under deferred taxation may lead to a lower level of wealth than in the case of the treatment under immediate taxation, despite the fact that taxation is correctly perceived. Instead of providing informational nudges to taxpayers, one could modify the deferred tax system such that individuals choose the tax-efficient savings level regardless of whether they consider taxes correctly or fully neglect taxes. Suppose that subjects receive a matching contribution $m \cdot S_t = \frac{\tau}{1-\tau} S_t$ instead of a tax refund τS_t.

Obviously, the economic incentives are the same. Assume, for example, a tax rate τ amounting to 40%. In a tax refund setting, subjects who contribute one dollar to their retirement fund receive a tax refund of 40 cents. Thus, the effective cost of saving one dollar amounts to 60 cents. Under the matching contribution regime, subjects who contribute 60 cents to their retirement fund receive a matching contribution amounting to 40 cents, which is directly paid into the retirement fund. Thus, the effective cost of saving one dollar is 60 cents under both tax regimes. However, there is one important difference. In contrast to the tax refund regime, subjects who fully neglect pension taxes and thus save the same amount as under immediate taxation will receive the same after-tax pension as under immediate taxation. Thus, we test

whether subjects receive the same or different after-tax pensions under deferred taxation with matching contributions (*Def_MC*) as under immediate taxation.

5.2.1 Method, Data, and Procedure

To test the above question, the following treatments are compared: *Immediate* and *Def_MC.* A total of 62 participants are randomly assigned to the two treatments: *Immediate* (34 participants) and *Def_MC* (28); 68% of the participants are male, and their average age is 25.05 years (SD 6.27). Subjects earned an average of € 15.11 in approximately 90 minutes (approximately € 10.08 per hour), with a minimum of € 1.50 and a maximum of € 28.90.

5.2.2 Empirical Results and Discussion

The average after-tax pension in the matching contribution treatment is 191 ECU higher than in the treatment under immediate taxation. This difference, however, is not statistically significant ($p = 0.108$). As in the previous sections, we run a robust regression, which confirms our bivariate finding. To sum up, matching contributions result in the same tax-efficient pension level as in the immediate taxation treatment. The reason for this finding is simple. Under a deferred tax system with matching contributions, fully tax ignorant and fully rational people will earn the same after-tax pension level. Thus, in contrast to traditional deferred tax systems, which use the tax deductibility of pension savings, tax ignorance is not punished in a matching contribution system.

5.3 Tax Perception under Immediate Taxation

5.3.1 Method, Data, and Procedure

In accordance with the theoretical predictions, savings decisions under immediate taxation are not tax-distorted and, thus, are tax-efficient. To test this prediction, we conduct an additional treatment in which taxes are not taken into account (*No Tax*). To make this treatment comparable, participants receive 69.00 ECU for each digitized answer, which is equivalent to the net wage in the taxation treatments. We compare the savings decisions with the results from the treatments *Immediate* and *Imm_P*.

5.3.2 Empirical Results and Discussion

We find no statistically significant differences in the average after-tax pensions between the treatment without taxes compared to both the immediate taxation treatment (*Immediate*, $p = 0.911$) and the immediate taxation treatment with pension information (*Imm_P*, $p = 0.855$). The multivariate analyses confirm these findings. Accordingly, immediate taxation of savings does not lead to tax distortions and, thus, leads to tax-efficient savings decisions.

6. Conclusion

A recent OECD report shows that many countries apply a variant of the "Exempt-Exempt-Taxed" (EET) pension tax regime. Under this deferred tax regime, both retirement savings and returns on savings are exempt from taxation, while benefits are treated as taxable income upon withdrawal (OECD 2015). Assuming rational subjects who perceive tax payments correctly and a constant and time-invariant tax rate, this tax regime should not distort subjects' savings decisions. It should result in the same after-tax pensions as in a regime without any taxation or in an immediate pension tax system in which savings are not tax deductible but returns on savings and benefits are exempted from taxation (Beshears et al. 2015a).

Using laboratory experiments, we find, however, that deferred pension taxation results in after-tax pensions that are approximately 25% lower compared to an economically equivalent immediate pension tax system. Furthermore, we demonstrate that savings under immediate taxation are not distorted. Accordingly, our results indicate substantial tax misperceptions under deferred taxation, leading to tax-inefficient savings behavior. For subjects with low tax and financial knowledge, these misperceptions remain stable even if they have gained experience.

We examine whether informational tax nudges and changing the form of the tax subsidy promote tax-efficient savings behavior. We demonstrate that neither recurrent informational nudges regarding the tax refund alone nor recurrent informational nudges about the pension tax alone mitigate this distortion. Only if we present subjects with recurrent numerical informational nudges regarding the tax refunds, together with numerical informational nudges on future pension taxes, do tax distortions disappear for all subjects. However, as this information provision might be costly, we tested an alternative way to achieve tax-efficient savings behavior. Instead of allowing a tax deduction of retirement savings, countries could change the form of the

tax subsidy: Countries could match retirement contributions. Despite the same economic incentives, we demonstrate that matching contributions result in a tax-efficient level of after-tax pensions, even though we do not give participants any additional informational tax nudges.

Our results complement research showing that tax policy should consider that some subjects misperceive taxes (for an overview, see Chetty 2015). These findings could help politicians to design better pension information interventions and contribute to current discussions about alternatives to deferred pension taxation. If governments aim at effectively increasing retirement savings under a deferred tax regime, information about the individual expected pre-tax pension, as already provided in some countries (Dolls et al. 2016, Mastrobuoni 2011, Goda et al. 2014), should be complemented by numerical information regarding the tax consequences. Moreover, using matching contributions instead of tax deductions might reduce necessary informational costs and still achieve tax-efficient retirement savings.

Comparing immediate and deferred pension tax systems, our results are obviously in favor of the former system. However, a comparison of these two regimes must consider additional aspects that we neglected in the current analysis; for example, the effect of lower tax rates in retirement, tax rate uncertainty, and compliance costs. Moreover, by using a laboratory experiment, we are able to achieve a high internal validity of our results. However, regarding the external validity, the usual objections to experimental economics apply (e.g., Levitt and List 2007). Particularly, our experiment lasts only approximately 90 minutes, whereas real life retirement decisions are made over much longer time frames. On the one hand, this excludes the testing of the long-term learning that is possible in naturally occurring environments. On the other hand, this simplified decision-making in our setting alleviates rational choices. Thus, real life complexity may even lead to less tax-efficient savings behavior than observed in the lab.

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Appendix

A1 Instructions

We divided the instructions into two parts. The first part is identical for both treatments and describes the procedure and training period. The second part differs to some extent between the treatments. In the following, the instructions (originally written in German) are presented.

A1.1 Instructions Part 1

Welcome to our experiment!

Thank you for participating at this experiment. The experiment will last approximately 90 minutes. In the experiment, you can earn money. How much money you earn depends on your decisions. This instruction explains to you how you may influence the amount of money you earn by your decisions and in which way you earn money in the experiment. Thus, read the following paragraphs carefully.

Before the experiment begins, we want to raise some points:

- During the whole experiment, you are not allowed to communicate with the other participants or to leave your seat. Please stick to your work station with your eyes.
- Please turn off your cell phone and put it in your bag.
- Please read the instructions carefully and attentively.
- It is important that you understand the instructions. Thus, do not hesitate to ask questions. If you have any questions, please raise your hand. We will come to your place to answer your questions. Please do not ask your questions loudly.
- You can highlight and write on the instructions. You may use the pen in front of you.
- Please do not take the instructions with you, but return them to us after the experiment.
- The program with which the experiment is executed – the grey screen – may not be closed. Please do also not open any other programs as this may lead to a truncation of the whole experiment.

- Through the table tennis ball you pulled, a seat was assigned to you. Please keep the ball well. You need it to identify yourself regarding your remuneration.
- Please consider that there might be latencies during the experiment as the participants' decisions are made varyingly fast. Thus, please do not wonder if you are asked to wait several minutes to continue the experiment.

The experiment starts with a training phase, in which you get to know the design and functionality of the experiment. This period is designed to help you getting along in the experiment. You will find the instructions for the training phase on the next page.

Instructions – Part 1:

The training phase

Your task is to digitize the answers marked on the sheets in front of you into an entry form on the computer. The sheets contain the answers from a multiple-choice exam. In a first step, we ask you to enter the number of the sheet, which can be found at the top left corner of the page, into the provided field. After this, five answers per screen of the answer sheet can be entered and confirmed by clicking on the "Digitize" button. In the training phase, 25 answers must be transferred. In the case that not all answers are correctly transferred, you will be prompted to check your input. When all answers were digitized, the training phase stops. Then the actual experiment starts.

Please do not open the envelope on your desk until you have successfully completed the training phase.

A1.2 Instructions Part 2: Deferred and Immediate Taxation Treatments

1. Comprehension test

Before the actual experiment starts, you have to answer some comprehension questions about the experiment to make sure you understand the tasks. However, these are not relevant to payoff. To check your answers, click the "Verify" button.

For questions, please raise your hand. We will help you then. When all comprehension questions have been answered correctly, the actual experiment starts.

2. Experiment design

The experiment consists of **two sequences** and a subsequent **questionnaire**. Each sequence consists of **15 periods**, which in turn are divided into the following **two phases**:

1. **Working phase (period 1 to 10):**

   The first ten periods comprise the working phase. The periods of the working phase always start with a **work task** in which you earn a working wage. Following the work task, you have to make a **savings decision** (see point 5) in each period.

2. **Rest phase (period 11 to 15):**

   In the rest phase, you cannot earn a salary. The payoffs in this phase depend on the savings decisions from the previous working phase. In periods 11 to 15, you receive a constant payoff that results from your savings including interest over the first ten periods (interest rate = 5%, see points 5 and 8).

After the first sequence has been completed, the second sequence starts. This corresponds to the first sequence concerning the procedure. **Please note that only one of the 30 periods will be paid at the end of the experiment (see point 9).**

The experiment ends with a short questionnaire, which is needed to interpret the results. We explicitly point out that all information remains completely anonymous. Once all the participants have completed the experiment, you will receive your remuneration successively and you can then leave the lab.

3. Working task

The work task corresponds in both sequences to the task of the training phase. Still 25 answers must be digitized per period. In a first step, we ask you again to enter the sheet number on the computer into the corresponding field. Each sheet number can only be entered once during the experiment. At the end of the working phase, you will receive information on the amount of wage in the corresponding period.

For each digitized response, you will receive 115.00 ECU (experimental currency) gross (before deduction of taxes). 100.00 ECU correspond to 1.00 Euro. For the 25 digitized responses, you therefore earn (25 * 115.00 ECU =) 2.875 ECU (28.75 euros) per period. This wage is, however, subject to taxation (see point 4).

4. The taxation of the wage

The wage is subject to a tax of 40%, which is directly deducted. All tax payments in this experiment will accrue to the Leibniz University of Hanover and will be used for further research projects.

5. Savings decision

Following the work task, you have to make a **savings decision** in periods 1 to 10. For this purpose you will be provided with an overview first, which shows your gross and net wage for each period. In each period, you have to decide how much you want to save from your net wage (after taxes) for the rest phase. The savings brings 5% interest per period (including compound interest) up to the payoff in the rest period.

6. The taxation of the savings

[Immediate Taxation Treatment only: The taxation of the savings depends on the following rules:

1. In the working phase, you **cannot claim the savings as tax deductible** in your tax return. Correspondingly, you will not receive a tax refund.
2. All payments in the rest period resulting from the savings are **tax-free**.

Once you have made your decision, you must complete a **tax return**. For this purpose please transfer your gross wage from the wage overview in the appropriate fields of the tax return. By

clicking on “Submit” your input will be checked and you will get a summary of the respective period on the next screen. This provides information on the amount of your savings and payoff in the respective period.]

[Deferred Taxation Treatment only: The taxation of the savings depends on the following rules:

1. In the working phase, you can **claim the savings as tax deductible** in your tax return. Correspondingly, you will receive a tax refund of 40% of the savings amount, which will be paid to you in the respective period.
2. All payments in the rest period resulting from the savings are subject to **a tax of 40%**.

Once you have made your decision, you must complete a **tax return**. For this purpose please transfer your gross wage and savings from the wage overview in the appropriate fields of the tax return. By clicking on “Submit” your input will be checked and you will get a summary of the respective period on the next screen. This provides information on the amount of your savings and payoff including the tax refund in the respective period.]

[Treatments with informational (tax) nudges only: After each period, you also receive savings information. On the basis of the average savings amounts of the previous periods, the latter provides information on the amount of your payments in the rest period resulting from the savings.]

When you have made your decisions after ten periods, you will be informed about the amount of your constant payoffs in the rest period (periods 11 to 15).

7. Payoff in the working phase

The payoffs in the working phase (periods 1 to 10) depend on your savings decisions in the respective periods.

[Immediate Taxation Treatment only: The difference between the net wage and the savings yields the payoff amount of the respective period.]

[Deferred Taxation Treatment only: The difference between the net wage and the savings plus the tax refund yields the payoff amount of the respective period.]

8. Payoff in the rest phase

Your payoffs in the rest phase depend only on your savings in the working phase. In the rest phase (periods 11 to 15), you receive a constant payoff in each period, which results from your entire savings and the resulting interest and compound interest. You have already seen how the savings are taxed in point 6.

9. Remuneration

After the working and rest phase, please answer the questionnaire. All information remains completely anonymous!

Depending on how you have distributed your wage, the corresponding remuneration is carried out. With a cube, you decide which of the 30 periods of the two sequences will be paid to you. **Therefore, only one period is paid!** The period result of the diced period is converted into euros. The pips 1 to 15 represent the periods of the first sequence and the pips 16 to 30 the periods of the second sequence (example: you roll number 17 at the end of the experiment. Then, the second period of the second sequence is paid out to you).

Each participant also receives a participation fee of 1.50 Euro. The resulting compensation will be paid to you at the end of the experiment in cash.

If there are no more questions, please wait until the experiment is started and then begin to work. Many Thanks!

A1.3 Instructions Part 2: *No Tax*

Instructions – Part 2:

Points 1 to 2 remain the same as in Appendix 1.2.

1. **Working task**

The work task corresponds in both sequences to the task of the training phase. Still 25 answers must be digitized per period. In a first step, we ask you again to enter the sheet number on the computer into the corresponding field. Each sheet number can only be entered once during the experiment. At the end of the working phase, you will receive information on the amount of wage in the corresponding period.

For each digitized response, you will receive 69.00 ECU (experimental currency). 100.00 ECU correspond to 1.00 Euro. For the 25 digitized responses, you therefore earn (25 * 69.00 ECU =) 1,725 ECU (17.25 euros) per period.

2. **Savings decision**

Following the work task, you have to make a **savings decision** in periods 1 to 10. For this purpose you will be provided with an overview first, which will show you how much your wage is for each period. In each period, you have to decide how much you want to save from your wage for the rest phase. The savings brings 5% interest per period (including compound interest) up to the payoff in the rest period.

Once you have made your decision, you will get a summary of the respective period on the next screen. This provides information on the amount of your savings and payoff in the respective period.

When you have made your decisions after ten periods, you will be informed about the amount of your constant payoffs in the rest period (periods 11 to 15).

3. **Payoff in the working phase**

The payoffs in the working phase (periods 1 to 10) depend on your savings decisions in the respective periods. The difference between the wage and the savings yields the payoff amount of the respective period.

4. Payoff in the rest phase

Your payoffs in the rest phase only depend on your savings in the working phase. In the rest phase (periods 11 to 15), you receive a constant payoff in each period, which results from your entire savings and the resulting interest and compound interest.

5. Remuneration

After the working and rest phase, please answer the questionnaire. All information remains completely anonymous!

Depending on how you have distributed your wage, the corresponding remuneration is carried out. With a cube, you decide which of the 30 periods of the two sequences will be paid to you. **Therefore, only one period is paid!** The period result of the diced period is converted into euros. The pips 1 to 15 represent the periods of the first sequence and the pips 16 to 30 the periods of the second sequence (example: you roll number 17 at the end of the experiment. Then, the second period of the second sequence is paid out to you).

Each participant also receives a participation fee of 1.50 Euro. The resulting compensation will be paid to you at the end of the experiment in cash.

If there are no more questions, please wait until the experiment is started and then begin to work. Many Thanks!

A1.4 Instructions Part 2: *Def_MC*

Points 1 to 4 remain the same as in Appendix 1.2.

5. Savings decision

Following the work task, you have to make a **savings decision** in periods 1 to 10. For this purpose you will be provided with an overview first, which shows your gross and net wage for each period. In each period, you have to decide how much you want to save from your net wage (after taxes) for the rest phase.

6. Matching contribution and interest of savings

The savings are subsidized by a bonus in the working phase. You will receive a bonus of ECU 0.40 per ECU 0.60 of savings for the rest phase. The savings including the bonus brings 5% interest per period (including compound interest) up to the payoff in the rest period.

7. The taxation of the savings

The taxation of the savings depends on the following rules:

1. In the working phase, you **cannot claim the savings as tax deductible** in your tax return. Correspondingly, you will not receive a tax refund.
2. All payments in the rest period resulting from the savings are subject to a tax of 40%.

Once you have made your decision, you must complete a **tax return**. For this purpose please transfer your gross wage and savings from the wage overview in the appropriate fields of the tax return. By clicking on "Submit" your input will be checked and you will get a summary of the respective period on the next screen. This provides information on the amount of your savings including the bonus and your payoff in the respective period.

When you have made your decisions after ten periods, you will be informed about the amount of your constant payoffs in the rest period (periods 11 to 15).

8. Payoff in the working phase

The payoffs in the working phase (periods 1 to 10) depend on your savings decisions in the respective periods. The difference between the net wage and the savings yields the payoff amount of the respective period.

9. Payoff in the rest phase

Your payoffs in the rest phase only depend on your savings in the working phase. In the rest phase (periods 11 to 15), you receive a constant payoff in each period, which results from your entire savings including the bonus and the resulting interest and compound interest. You have already seen how the savings are taxed in point 6.

10. Remuneration

After the working and rest phase, please answer the questionnaire. All information remains completely anonymous!

Depending on how you have distributed your wage, the corresponding remuneration is carried out. With a cube, you decide which of the 30 periods of the two sequences will be paid to you. **Therefore, only one period is paid!** The period result of the diced period is converted into euros. The pips 1 to 15 represent the periods of the first sequence and the pips 16 to 30 the periods of the second sequence (example: you roll number 17 at the end of the experiment. Then, the second period of the second sequence is paid out to you).

Each participant also receives a participation fee of 1.50 Euro. The resulting compensation will be paid to you at the end of the experiment in cash.

If there are no more questions, please wait until the experiment is started and then begin to work. Many Thanks!

A2 Screenshots

A2.1 *Immediate* and *Deferred*

Figure A1 - Information working task: Tax treatments (z-Tree screenshot)

Figure A2 - Working task (z-Tree screenshot)

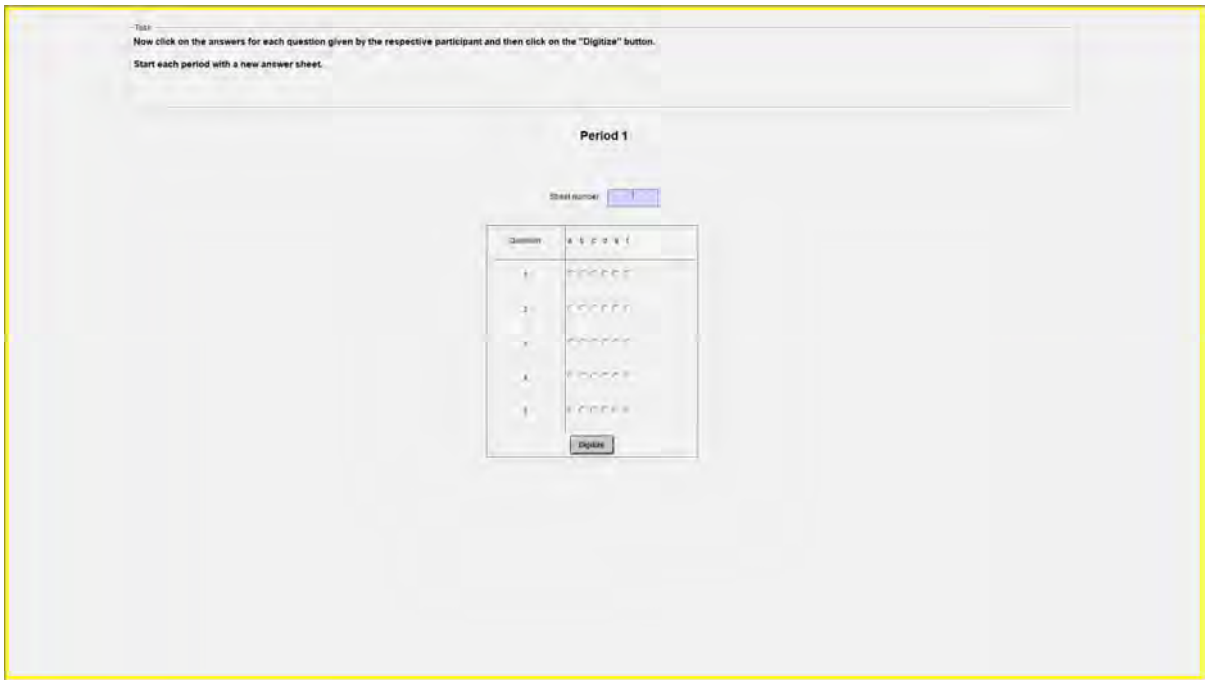


Figure A3 - Information on actual work progress: Tax treatments (z-Tree screenshot)

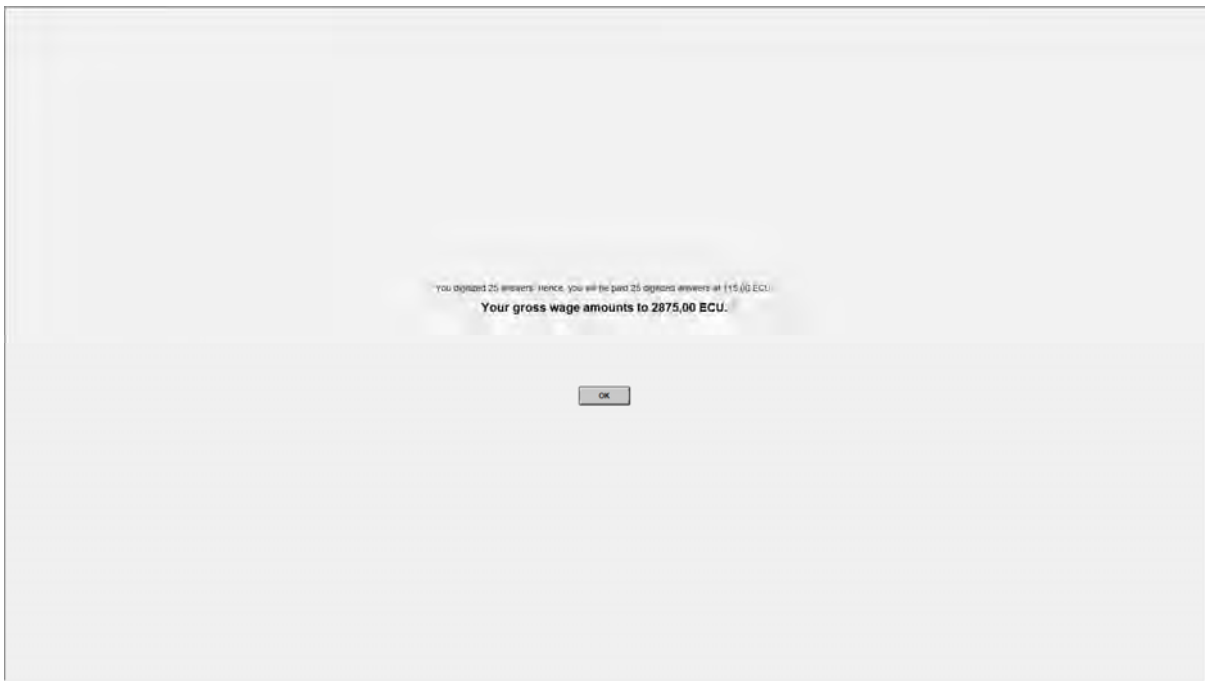


Figure A4 - Savings decision: Deferred taxation treatments (z-Tree screenshot)

Figure A5 - Savings decision: Immediate taxation treatments (z-Tree screenshot)

Figure A6 - Tax return: Deferred taxation treatments (z-Tree screenshot)

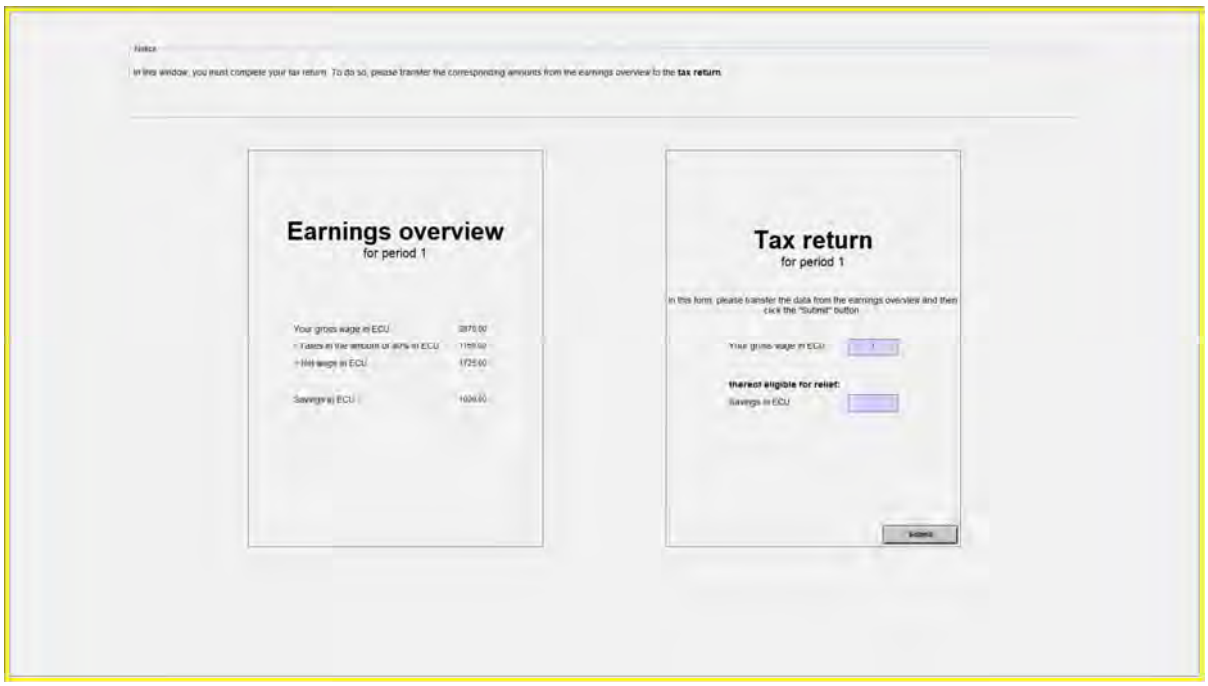


Figure A7 - Tax return: Immediate taxation treatments (z-Tree screenshot)

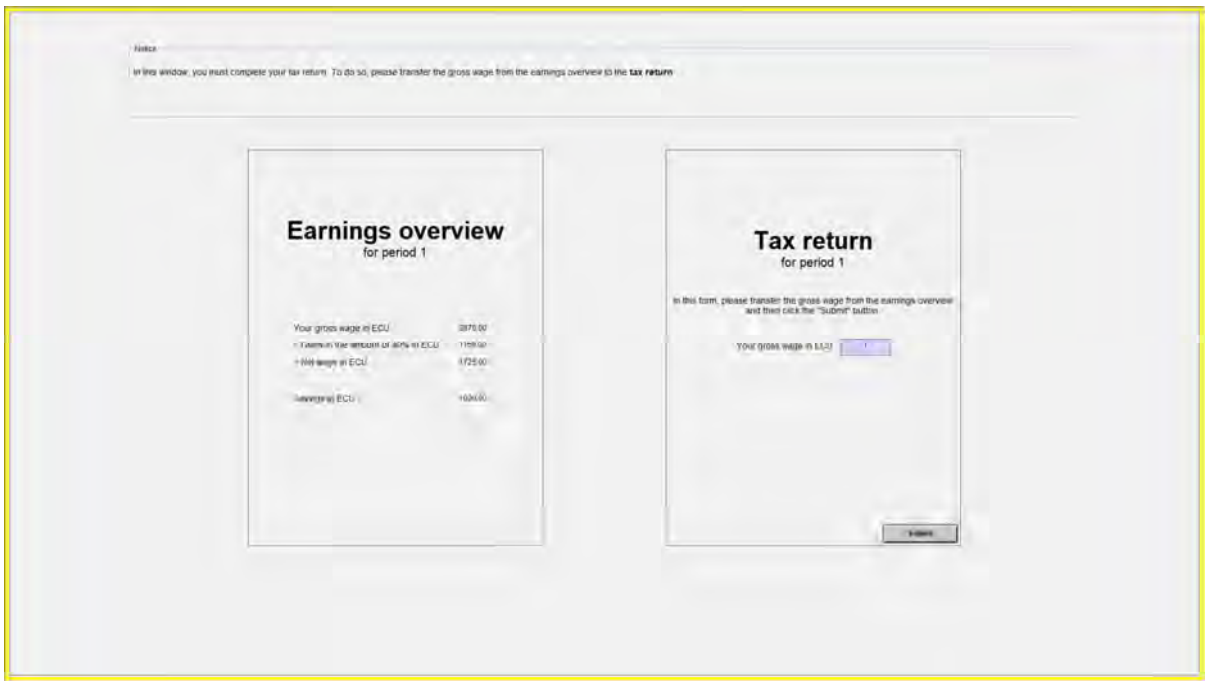


Figure A8 – Period Summary: *Deferred* (z-Tree screenshot)

Figure A9 – Period Summary: Immediate taxation treatments (z-Tree screenshot)

Figure A10 – Summary after sequence 1: Deferred taxation treatments (z-Tree screenshot)

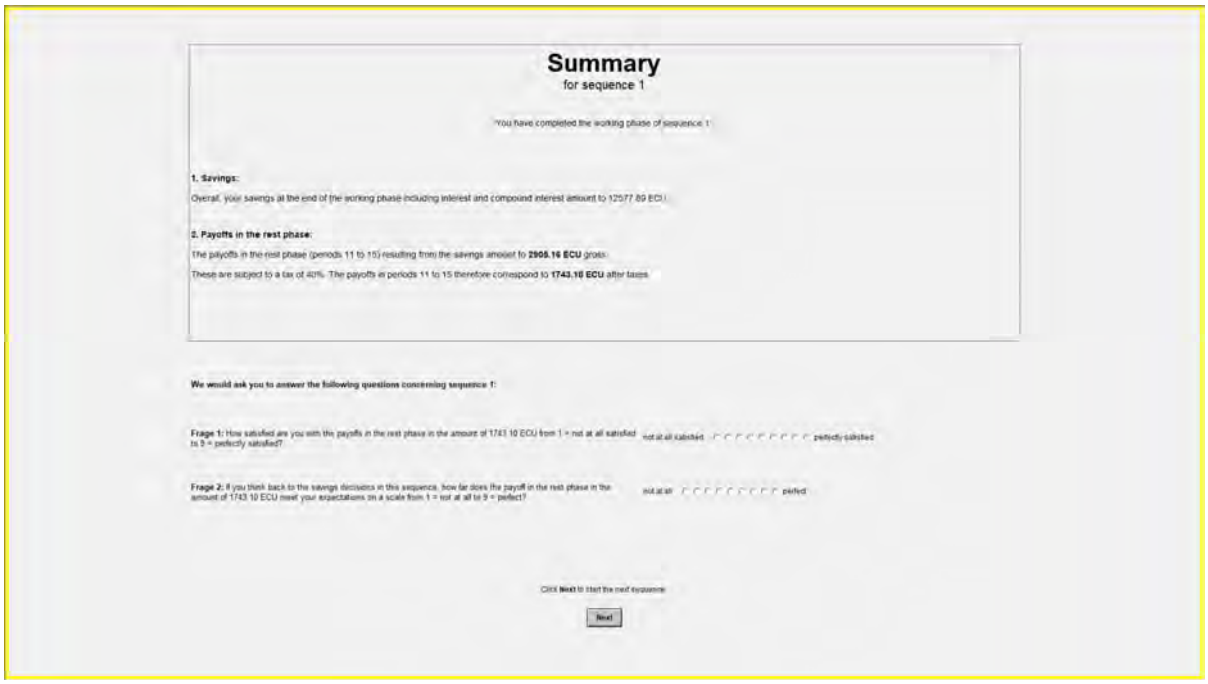
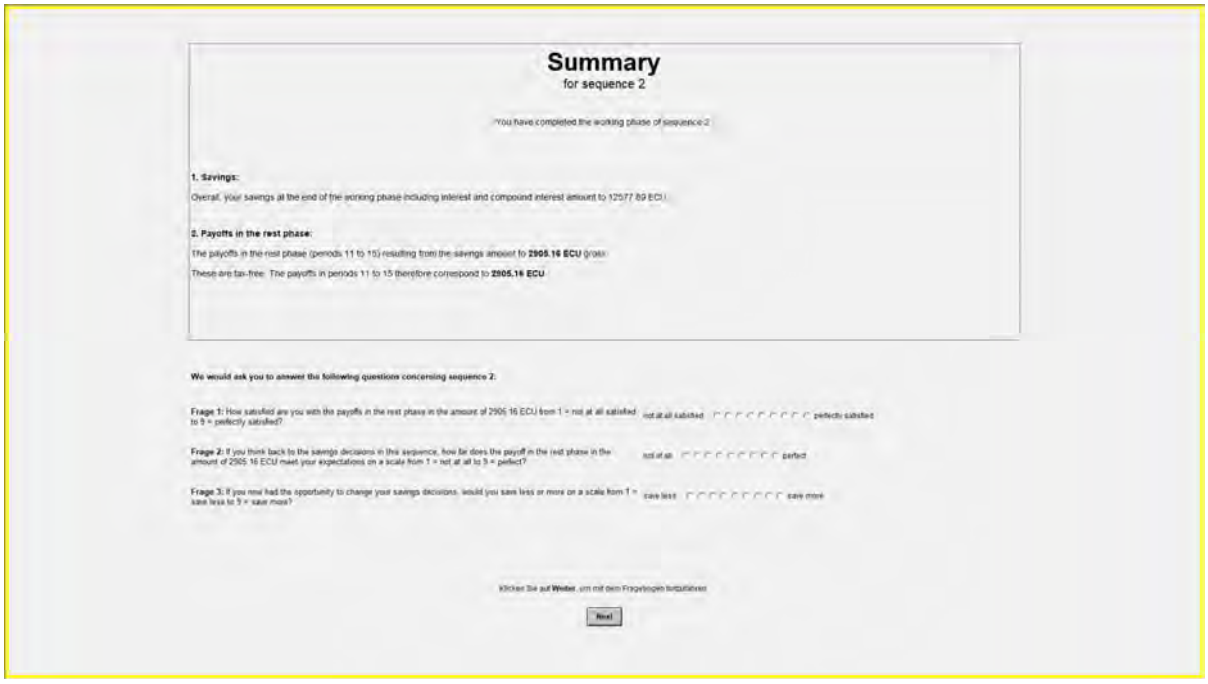


Figure A11 – Summary after sequence 2: Immediate taxation treatments (z-Tree screenshot)



A2.2 Treatments with Informational Nudges

Figure A12 – Period Summary: Deferred Tax Treatments with detailed tax refund information (R) (z-Tree screenshot)

Figure A13 – Savings information: *Imm_P* and *Def_P* (z-Tree screenshot)

Figure A14 – Savings information: Deferred Tax Treatments with abstract pension tax information (AbPT) (z-Tree screenshot)

Figure A15 – Savings information: Deferred Tax Treatments with numerical pension tax information (NuPT) (z-Tree screenshot)

A2.3 *No Tax*

Figure A16 – Information working task: *No Tax* (z-Tree screenshot)

Figure A17 - Information on actual work progress: *No Tax* (z-Tree screenshot)

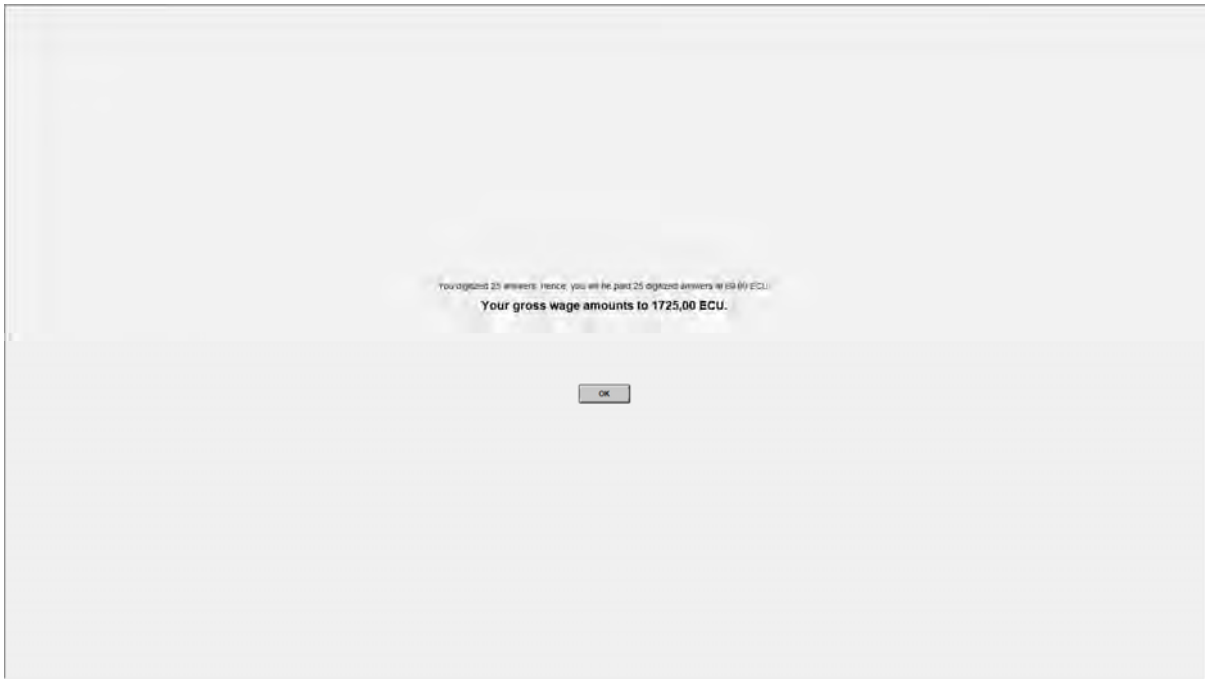
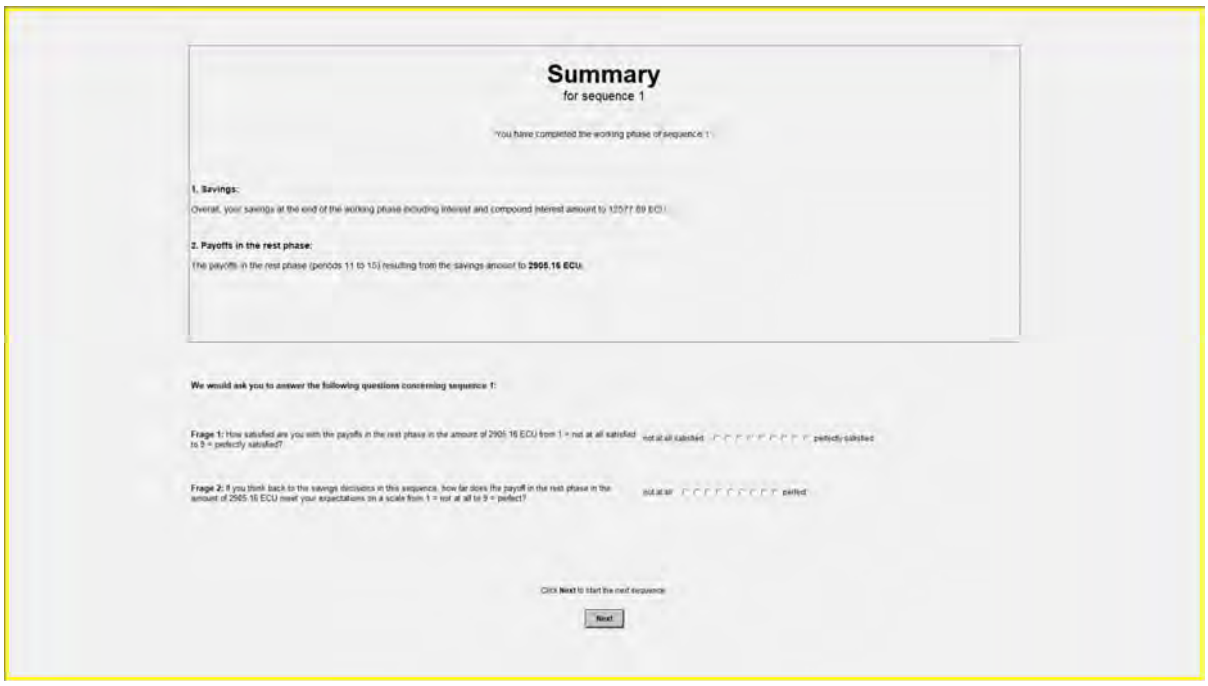


Figure A18 - Savings decision: *No Tax* (z-Tree screenshot)

Figure A19 – Period Summary: *No Tax* (z-Tree screenshot)

Figure A20 – Summary after sequence 1: *No Tax* (z-Tree screenshot)



A2.4 Matching Contribution

Figure A21 – Savings decision: *Def_MC* (z-Tree screenshot)

Figure A22 - Tax return: *Def_MC* (z-Tree screenshot)

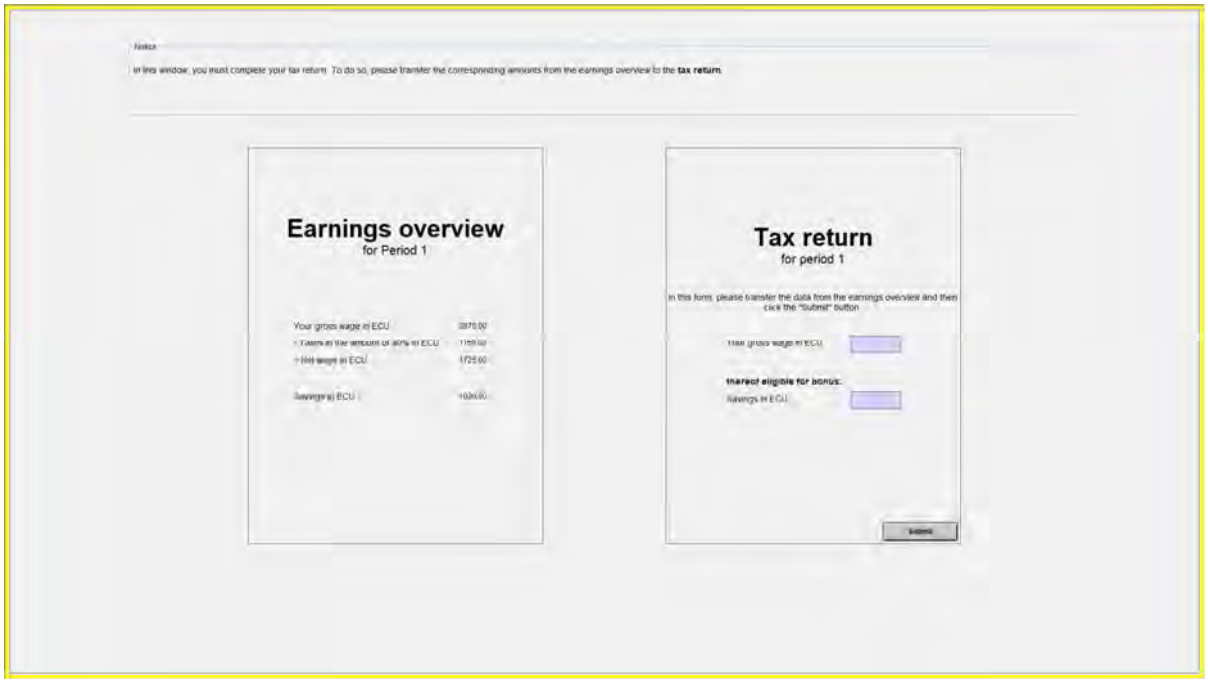
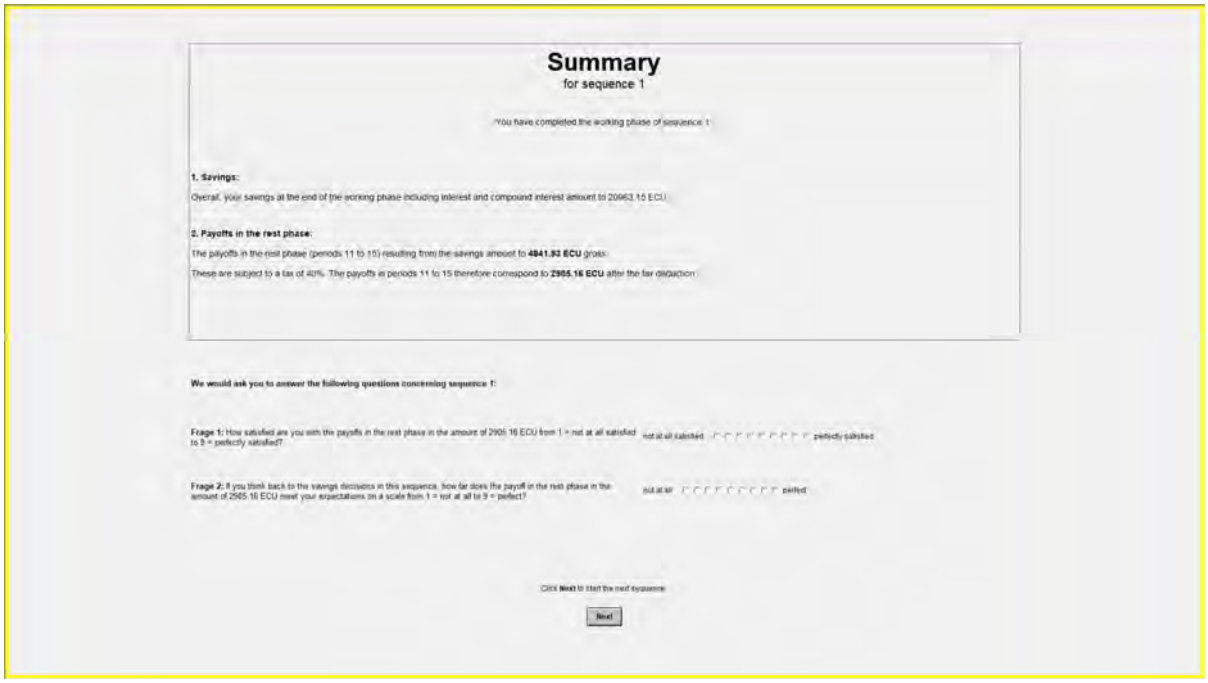


Figure A23 – Period Summary: *Def_MC* (z-Tree screenshot)

Figure A24 – Summary after sequence 1: *Def_MC* (z-Tree screenshot)



A3 Questionnaire

Control questions after the trainings phase

Question 1: How would you assess your tax knowledge on a scale from 1 = not any to 9 = expert?

not any ☐ ☐ ☐ ☐ ☐ ☐ ☐ ☐ ☐ expert

Question 2: How do you assess your personal knowledge and experience of investments in financial assets (e.g. securities, bonds, bank accounts) on a scale from 1 = no experience to 9 = much experience?

no experience ☐ ☐ ☐ ☐ ☐ ☐ ☐ ☐ ☐ much experience

Comprehension questions after the trainings phase

Question 1: Which of the following statements regarding your payoff at the end of the experiment is correct?

- ☐ The average payoff amount for all periods is remunerated at the end of the experiment.
- ☐ The average payoff amount in the rest phase is remunerated at the end of the experiment.
- ☐ Only one of the 30 total periods is remunerated at the end of the experiment.

Question 2: In which periods of a sequence do you earn a work wage?

- ☐ Periods 1 to 10
- ☐ Periods 11 to 15
- ☐ Periods 1 to 15

Question 3: How is the wage taxed in the working phase?

- ☐ The wage is subject to tax of 40%.
- ☐ The wage can be claimed for tax purposes.
- ☐ The wage is tax-free.

Question 4: How are the savings taxed in the working phase?

- ☐ The savings can be claimed as tax deductible.
- ☐ The savings cannot be claimed as tax deductible.

Question 5: How are the payoffs taxed in the rest phase?

- ☐ All payoffs in the rest phase are tax-free.
- ☐ All payoffs in the rest phase are subject to tax of 40%.

Question 6: Suppose that in the first period of the working phase you will save your entire net wage, and this period is paid to you at the end of the experiment. What is your payoff for this period?

- ☐ Zero Euro
- ☐ The amount of the tax refund [bonus] from period 1
- ☐ In the amount of the savings including interest and compound interest

Question 7: Suppose you do not save anything during the entire ten periods of the working phase, and a period of the rest phase is paid to you at the end of the experiment. What is your payoff for this period?

- ☐ Zero Euro
- ☐ The amount of tax refunds [bonuses] for periods 1 to 10 (= working phase)
- ☐ In the amount of the savings including interest and compound interest

Special questions for the matching contribution treatment:

Question 6: Which of the following statements about the bonus for the savings is correct?

- ☐ The wage is subsidized by a bonus, which is paid in the respective period of the working phase.
- ☐ The savings are subsidized by a bonus, which is paid in the respective period of the working phase.
- ☐ The savings are subsidized by a bonus, which is added to the savings.

Questions after sequences 1 and 2

Question 1: How satisfied are you with the payoffs in the rest phase in the amount of [payoff] ECU from 1 = not at all satisfied to 9 = perfectly satisfied?

not at all ☐ ☐ ☐ ☐ ☐ ☐ ☐ ☐ ☐ perfectly satisfied

Question 2: If you think back to the savings decisions in this sequence, how far does the payoff in the rest phase in the amount of [payoff] ECU meet your expectations on a scale from 1 = not at all to 9 = perfect?

not at all ☐ ☐ ☐ ☐ ☐ ☐ ☐ ☐ ☐ perfect

Question after sequence 2

Question 3: If you now had the opportunity to change your savings decisions, would you save less or more on a scale from 1 = save less to 9 = save more?

save less ☐ ☐ ☐ ☐ ☐ ☐ ☐ ☐ ☐ save more

Questionnaire at the end of the experiment (Questions 2 up to 5 are not considered in the treatment without taxation)

Question 1: How did you find the work task you were supposed to perform during the experiment on a scale from 1 = very unpleasant to 9 = very pleasant?

very unpleasant ☐ ☐ ☐ ☐ ☐ ☐ ☐ ☐ ☐ very pleasant

Question 2: How complicated did you find the taxation in this experiment from 1 = very easy to 9 = very complicated?

very easy ☐ ☐ ☐ ☐ ☐ ☐ ☐ ☐ ☐ very complicated

Question 3: How difficult it was for you to understand the taxation of the savings **at the beginning** of the experiment from 1 = very easy to 9 = very difficult?

very easy ☐ ☐ ☐ ☐ ☐ ☐ ☐ ☐ ☐ very difficult

Question 4: How difficult it was for you to understand the taxation of the savings **at the end** of the experiment from 1 = very easy to 9 = very difficult?

very easy ☐ ☐ ☐ ☐ ☐ ☐ ☐ ☐ ☐ very difficult

Question 5: How important was the taxation of the savings for your savings decision from 1 = very unimportant to 9 = very important?

very unimportant ☐ ☐ ☐ ☐ ☐ ☐ ☐ ☐ ☐ very important

Question 6: How difficult was it for you to make a savings decision from 1 = very easy to 9 = very difficult?

very easy ☐ ☐ ☐ ☐ ☐ ☐ ☐ ☐ ☐ very difficult

Question 7: Are you generally a person who is willing to take risks or do you try to avoid taking risks? Please tick a box on the scale, the value 0 means not at all willing to take risks and the value 10 means very willing to take risks.

not at all willing to take risks ☐ ☐ ☐ ☐ ☐ ☐ ☐ ☐ ☐ ☐ ☐ very willing to take risks

Question 8: Please state whether you find it correct to evade taxes if you have the possibility to do so on a scale from 1 = "You cannot do this under any circumstances" to 9 = "That is correct in any case"?

under no circumstances ☐ ☐ ☐ ☐ ☐ ☐ ☐ ☐ ☐ correct in any case

Question 9: How important is it for you personally to save taxes from 1 = very unimportant to 9 = very important?

very unimportant ☐ ☐ ☐ ☐ ☐ ☐ ☐ ☐ ☐ very important

Question 10: Imagine that you have just inherited some money that you are planning to invest. You are deciding between two different bond options. Both have the same risk and 10 year maturities. The first bond is expected to pay € 400 per year, but you will also be taxed € 100 on these earnings each year. The second bond's return is lower, € 300 per year, but it will not be taxed. Which bond would you invest in?

☐ I would put my money in the first bond.

☐ I would put my money in the second bond.

Question 11: Do you save on the following retirement products?

	Yes	no	I don't know
life assurance	☐	☐	☐
Riester retirement plan	☐	☐	☐
private pension fund	☐	☐	☐
Rürup retirement plan	☐	☐	☐
Bank-savings plan	☐	☐	☐
private real estate	☐	☐	☐
entrepreneurial investment	☐	☐	☐
company pension scheme	☐	☐	☐

Question 12: Decide for each of the following statements whether this is personally uncharacteristic or characteristic for you on a scale from 1 = very uncharacteristic to 5 = very characteristic.

	very uncharacteristic				very characteristic
In principle I do everything at the last moment.	☐	☐	☐	☐	☐
Usually, I promptly answer on telephone calls.	☐	☐	☐	☐	☐
I always get birthday and Christmas gifts at the last minute.	☐	☐	☐	☐	☐
When I receive an invoice of a small amount, I pay it immediately.	☐	☐	☐	☐	☐
I always start with the exam preparation just before the exams.	☐	☐	☐	☐	☐

Question 13: Which characteristics are particularly important to you regarding a pension product? Put the following responses in a ranking order. To do so, number each box in the order of your preference, starting with 1 = most important to 6 = least important.

Tax exemption of pension	☐
Tax deductibility of payments in savings phase	☐
Return of assets	☐
Security of pension	☐
Dependants' cover by payment in case of death	☐
Comprehensibility of form of asset	☐

Question 14: Imagine your employer offers you a one-time tax-free additional payment. You can receive the payment either immediately or you can wait 6 months to get a slightly higher payment. Please click on each line to see if you would choose 10.00 € today or the higher amount in 6 months in the right column.

Please indicate the correct answer for each point:

10.00 € today	☐	☐	10.76 € in 6 months
10.00 € today	☐	☐	11.80 € in 6 months
10.00 € today	☐	☐	12.84 € in 6 months
10.00 € today	☐	☐	13.88 € in 6 months
10.00 € today	☐	☐	14.92 € in 6 months
10.00 € today	☐	☐	15.96 € in 6 months
10.00 € today	☐	☐	17.00 € in 6 months
10.00 € today	☐	☐	18.04 € in 6 months
10.00 € today	☐	☐	19.08 € in 6 months
10.00 € today	☐	☐	20.12 € in 6 months

Question 15: Imagine your employer offers you another one-time tax-free additional payment. You can receive the payment either in 6 months or you can wait 12 months to get a slightly higher payment. Please click on each line to see if you would choose 10.00 € in 6 months or the higher amount in 12 months in the right column.

Please indicate the correct answer for each point:

10.00 € in 6 months	☐	☐	10.76 € in 12 months
10.00 € in 6 months	☐	☐	11.80 € in 12 months
10.00 € in 6 months	☐	☐	12.84 € in 12 months
10.00 € in 6 months	☐	☐	13.88 € in 12 months
10.00 € in 6 months	☐	☐	14.92 € in 12 months
10.00 € in 6 months	☐	☐	15.96 € in 12 months
10.00 € in 6 months	☐	☐	17.00 € in 12 months
10.00 € in 6 months	☐	☐	18.04 € in 12 months
10.00 € in 6 months	☐	☐	19.08 € in 12 months
10.00 € in 6 months	☐	☐	20.12 € in 12 months

Question 16: Please answer on the basis of the following scale. The value 1 means: does not apply at all. The value 7 means: fully applies. With the values between 1 and 7 you can rate your opinion.

I am someone who...

	does not apply at all						fully applies
... works thoroughly.	☐	☐	☐	☐	☐	☐	☐
... is communicative, talkative.	☐	☐	☐	☐	☐	☐	☐
... is sometimes a little bit rough to others.	☐	☐	☐	☐	☐	☐	☐
... is original, brings in new ideas.	☐	☐	☐	☐	☐	☐	☐
... often worries about things.	☐	☐	☐	☐	☐	☐	☐
... is able to forgive.	☐	☐	☐	☐	☐	☐	☐
... is rather lazy.	☐	☐	☐	☐	☐	☐	☐
... is able to come out of her shell, is sociable.	☐	☐	☐	☐	☐	☐	☐
... likes artistic experiences.	☐	☐	☐	☐	☐	☐	☐
... gets nervous easily.	☐	☐	☐	☐	☐	☐	☐
... fulfills tasks in an effective and efficient manner.	☐	☐	☐	☐	☐	☐	☐
... is reserved.	☐	☐	☐	☐	☐	☐	☐
... is considerate and friendly.	☐	☐	☐	☐	☐	☐	☐
... has a vivid phantasy/imagination.	☐	☐	☐	☐	☐	☐	☐
... is relaxed, can easily handle stress.	☐	☐	☐	☐	☐	☐	☐

Question 17: How old are you? ☐

Question 18: Are you male or female?

☐ male

☐ female

Question 19: Which faculty are you enrolled for?

- ☐ Architecture and landscape
- ☐ Construction engineering and geodesy
- ☐ Electrical engineering and computer science
- ☐ Law
- ☐ Mechanical engineering
- ☐ Mathematics and physics
- ☐ Natural sciences
- ☐ Philosophy
- ☐ Business Management and Economics
- ☐ other
- ☐ I am not a student.

Question 20: What degree are you aiming for?

- ☐ Bachelor
- ☐ Master
- ☐ Diplom
- ☐ Magister
- ☐ 1. state examination
- ☐ 2. state examination
- ☐ doctorate
- ☐ other

Question 21: Which academic semester are you in? ☐

Question 22: How many courses on business taxation you have participated at during your studies? ☐

Question 23: What is you marital status?

- ☐ married/ long-term relationship
- ☐ single
- ☐ divorced/widowed

Question 24: Do you have children?

- ☐ Yes
- ☐ No

Question 25: What is your monthly disposable income (after rent)?

- ☐ < 500 €
- ☐ 501 € - 1,000 €
- ☐ 1,001 € - 1,500 €
- ☐ 1,501 € - 2,000 €
- ☐ > 2,001 €

Question 26: How often do you pray in a week?

- ☐ not at all
- ☐ 1- to 2-times
- ☐ 3- to 5- times
- ☐ daily
- ☐ several times a day

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