Economic Decision Making and Tax Policy Uncertainty

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Zusammenfassung

Diese Dissertation umfasst drei Beiträge zum Rahmenthema steuerpolitischer Unsicherheit und Entscheidungsfindung. Die ersten beiden Beiträge befassen sich mit dem Sparen für die Rente und mit verhaltensökonomischen Effekten. Der dritte Beitrag untersucht die Wirkung von steuerpolitischer Unsicherheit auf den Arbeitseinsatz eines Agenten und leitet Implikationen für die Wohlfahrt ab.

Der erste Beitrag analysiert, inwieweit geringere Rentensteuersätze das Sparen für die Rente erhöhen. Dabei dient Unsicherheit als Mittel zur Erhöhung der Salienz des zukünftigen Rentensteuersatzes. Die durchgeführten Online-Experimente zeigen, dass eine Verminderung des zukünftigen Rentensteuersatzes bei nachgelagerter Rentenbesteuerung keinen signifikanten Einfluss auf das Sparverhalten hat. Selbst bei Erhöhung der Salienz des zukünftigen Steuersatzes bleiben die Ergebnisse robust. Bei einer Variation des Steuersatzes, zu dem die Sparbeträge abziehbar sind, verändern die Probanden allerdings ihr Sparverhalten. Diese Ergebnisse deuten darauf hin, dass Probanden die zukünftige Rentenbesteuerung wegen verhaltensökonomischer Verzerrungen (Myopie und Confirmation Bias) unterbewerten. Als steuerpolitische Implikation kann abgeleitet werden, dass zur Erhöhung des Sparanreizes nicht geringere zukünftige Rentensteuersätze herangezogen, sondern Anreize direkt in der Sparphase gesetzt werden sollten.

Der zweite Beitrag beschäftigt sich mit dem gleichzeitigen Angebot von vor- und nachgelagert besteuerten Rentenprodukten, wobei Unsicherheit beim Steuersatz nachgelagerter Rentenprodukte in die Betrachtung einfließt. Bei Angebot zweier Produkte wird das Sparen erhöht, Begründung dafür ist eine Art soziale Norm höheren Sparens. Allerdings wird die Zufriedenheit mit der Konsumentscheidung bei Angebot zweier Rentenprodukte nicht erhöht. Oft wird das Sparen in vorgelagerte Produkte auf Grund der wahrgenommenen Einfachheit bevorzugt, obgleich deren alleiniges Angebot ökonomisch nicht vorteilhafter ist. Bei Angebot zweier Sparprodukte sparen die Individuen im Vergleich zur optimalen Lösung mehr, bei Angebot eines nachgelagert besteuerten Produktes im Vergleich zur optimalen Lösung weniger. Das Sparen in ein vorgelagert besteuertes Rentenprodukt stimmt mit der optimalen Lösung überein.

Der dritte Beitrag betrachtet die Wirkung von steuerpolitischen Unsicherheiten im Sinne von steuerpolitischen Bemessungsgrundlagenrisiken auf den Arbeitseinsatz eines Agenten in einem Prinzipal-Agenten-Modell mit risikoaversem Prinzipal und Agenten. Unter nicht beobachtbarem Arbeitseinsatz des Agenten fungiert der variable Gewinnanteil als Instrument zur Risikoteilung und Anreizsetzung. In diesem Fall des nicht beobachtbaren Arbeitseinsatzes erhöht eine anti-zyklische Steuerpolitik auf Ebene des Agenten oder eine pro-zyklische Steuerpolitik auf Ebene des Prinzipals jeweils den variablen Gewinnanteil des Agenten, dessen Erhöhung eine Steigerung des Arbeitseinsatzes bewirkt. Steuerpolitische Unsicherheiten im Sinne von Bemessungsgrundlagenrisiken ermöglichen und verstärken die Effekte. Auch kann herausgestellt werden, dass unter einer anti-zyklischen Steuerpolitik auf Ebene des Agenten Steuerbemessungsgrundlagenrisiko des Agenten bis zu einem bestimmten Grad den Gesamtnutzen und damit die Wohlfahrt erhöht.

Summary

This dissertation consists of three papers on economic decision making and tax policy uncertainty. The first two papers focus on retirement savings and behavioral effects. The third contribution examines the effect of tax policy uncertainty on effort and derives implications for welfare.

In the first paper, we investigate whether reducing the income tax rate increases savings. Uncertainty is incorporated as an instrument to increase the salience of the future pension tax rate. In a series of online experiments, we find that reducing the income tax rate on pensions has almost no significant effect on savings behavior. This holds even if we increase the salience of the future pension tax rate. However, when we vary the current tax rate at which savings are deducted, subjects adjust their savings. This suggests that individuals neglect the level of income taxes on pensions due to behavioral biases (myopia or confirmation bias). The results indicate that governments should not rely on lower income taxes on pensions but instead increase incentives directly in the savings period to increase retirement savings.

The second paper examines the economic effects of offering both a pension plan that imposes immediate taxation on pension contributions (Roth account) and a plan that defers taxation until retirement (Traditional account). In the case of deferred taxation, we take into consideration tax rate uncertainty. The offer of two accounts increases retirement savings, suggesting that the availability of two accounts signals a social norm stimulating higher savings. However, satisfaction with the consumption decision does not improve due to decision complexity. Many individuals prefer Roth accounts due to the perceived simplicity, even though they are economically inferior. Compared to rational choice theory, individuals save either too much with both accounts or too little in Traditional accounts. Savings in Roth accounts align with the benchmark.

The third paper examines the effect of tax policy uncertainty in the sense of tax base risk on effort in an agency model with risk-averse principal and agent. Under the assumption of an unobservable effort of the agent, the agent's variable share of profit acts as an instrument to share risk and incentivize effort. In this setting, a counter-cyclical tax base policy at the level of the agent or a pro-cyclical one at the level of the principal can raise the agent's variable share of profit, whose increase raises the effort of the agent. This finding supports a pro-cyclical tax policy at the company level (principal) and a counter-cyclical one at the employee level (agent). Tax policy uncertainty in the sense of tax base risk enables and reinforces these effects. Moreover, under the assumption of a counter-cyclical tax base policy at the agent's level, tax base risk at the level of the agent up to a certain level increases overall utility and thus welfare.

Schlagwörter: Steuerbemessungsgrundlagenrisiko · steuerpolitische Unsicherheit · Sparen für die Rente · Sparanreize · Rentensteuersatz · nachgelagerte Besteuerung

Keywords: tax base risk · tax policy uncertainty · retirement savings · savings incentives · pension tax rate · deferred taxation

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Chapter 1

Introduction

1.1 Motivation

In many countries (such as Belgium, Chile, Finland, Germany, Iceland, Ireland, Japan, Latvia, the Netherlands, Norway, Poland, Slovenia, Spain, Switzerland, and the United Kingdom), contributions and investment earnings are tax-free and pensions are taxed (deferred pension taxation) (OECD 2022). The income tax rate applied to pensions is often lower than that applied to working income (e.g., through extra tax allowances or the progressivity of the income tax system) (OECD 2017). This can create an incentive to save (OECD 2018b, p. 48). However, the theory is ambiguous. Rational theory predicts that savings may also be reduced or remain unchanged. Behavioral theory suggests that individuals may neglect taxes and use simple heuristics (Beshears et al. 2017) or underweight only pension taxes due to myopia or confirmation bias. Confirmation bias means that individuals may pay attention to information that confirms their intention to save (their tax refunds) and undervalue information that contradicts those intentions (pension taxes) (Feldman and Ruffle 2015; Feldman et al. 2018; Blaufus and Milde 2021). In the first article, we investigate whether reducing the income tax rate increases savings. We employ experimental methods, which allow us to manipulate the tax rates, provide individuals with information on tax rules, and control for investment alternatives. Furthermore, an important factor that influences decision making and behavioral biases is tax salience (e.g., Chetty et al. 2009; Taubinsky and Rees-Jones 2018; Fochmann and Weimann 2013). In light of this, uncertainty is incorporated in our experimental setting as an instrument to increase the salience of future pension tax rates. Further, we shed light on the tax deductibility of savings. Rational choice theory predicts that an increase in the tax refund rate results in higher savings. According to behavioral economics, an increasing tax refund rate could have different effects. On the one hand, it might have no effect at all because individuals consistently save the same percentage of their income (Beshears et al. 2017). On the other hand, it could lead to increased savings because the tax refund confirms the savings intentions (confirmation bias) (Blaufus and Milde 2021) or because the tax refund rewards the doer according to behavioral life-cycle theory (Shefrin and Thaler 1988). Additionally, some countries (such as Costa Rica, the Czech Republic, Hungary, Israel, Lithuania, Luxembourg, and Mexico) tax retirement savings immediately. Contributions

are taxed and investment earnings and pensions are tax-free (OECD 2022). We examine if governments can raise after-tax pensions without changing the level of tax revenues by shifting from deferred to immediate taxation.

The second article also investigates savings behavior. We analyze the economic effects of offering both a pension plan that imposes immediate taxation on pension contributions (Roth account) and a plan that defers taxation until retirement (Traditional account). The advantage of deferred taxation is that the future tax rate on the pension is likely to be lower, the disadvantage is that it is uncertain. In contrast, in the case of immediate taxation, the tax rate is certain. Therefore, the diversification of savings contributions between Roth and Traditional accounts can create economic advantages (Brown et al. 2017). However, the diversification opportunity does not necessarily increase savings. Rational choice theory predicts slightly lower retirement savings for most subjects under diversification. Other studies derive that increased choice alternatives can result in higher investment and consumption amounts (Kahn and Wansink 2004; Morrin et al. 2008). There are different explanations, for example, the "tax neglect" hypothesis that subjects always save a certain percentage of pre-tax income (Beshears et al. 2017) and the use of a "naive" diversification heuristic and partition dependence (Benartzi and Thaler 2001; Fox et al. 2005). Other studies identify positive emotions as driving forces behind increased savings (Guven 2012). Alternatively, diversification opportunities may signal a social norm to increase savings. In the context of consumption (e.g., Kahn and Wansink 2004; Rolls et al. 1981; LeMagnen 1956) and with respect to charitable giving (Weisz and Cikara 2020), previous studies provide evidence for a corresponding norm. We investigate savings behavior when two tax-advantaged savings products are offered and explore the underlying behavioral economic factors. Additionally, as far as we know, previous studies have not examined the influence of tax differences in retirement plans on individuals' satisfaction. We address this gap because due to decision complexity, satisfaction may not necessarily improve. Moreover, we examine people's preferences regarding the provision of a Traditional account, a Roth account or both accounts. According to empirical observations, most employees in the United States use Traditional accounts (Iacurci 2022). Cuccia et al. (2022) find that individuals prefer a Roth account even if a Traditional account is more economically advantageous. In contrast to Cuccia et al. (2022), we examine a choice between both plans that affects the experimental payoff. Our findings have implications for policy and firms. In many countries, only a Traditional account exists (OECD 2022), and not all US firms offer the option to contribute to Roth accounts (Iacurci 2022).

While the first and the second article focus on savings decisions and incorporate deviations from rational decision making, the third article concentrates on tax policy uncertainty in a theoretical model. Tax policy uncertainty is quite exposed to criticism. For example, Adam Smith states:

"The certainty of what each individual ought to pay is, in taxation, a matter of so great importance that a very considerable degree of inequality, it appears, I believe, from the experience of all nations, is not so great an evil as a very small degree of uncertainty." (Smith 1776, Book 5)

Nevertheless, it has already been argued that uncertainty can increase labor supply (e.g., Eaton and Rosen 1980; Parker et al. 2005; Flodén 2006). In contrast to the existing literature, this article focuses on an agency model with risk-averse individuals and incorporates tax policy uncertainty in the sense of tax base risk. Additionally, the article examines when tax policy should respond in a pro- or counter-cyclical manner, both at the company and the employee level. This topic is a current one. In Germany, tax base reductions were implemented as counter-cyclical measures through the Corona Tax Assistance Act. For example, at the level of private individuals, a lump sum for working from home was introduced and the relief amount for single parents was raised. At the company level, the amount of degressive depreciations was increased. In contrast, other countries implemented pro-cyclical measures. For example, France temporarily introduced a tax for private healthcare suppliers (OECD 2021, pp. 40, 42).
Moreover, the model derives implications for welfare. Based on certain assumptions, tax base risk up to a certain level can increase overall utility and therefore welfare.

1.2 Main Contributions

This dissertation consists of three essays:

Table 1.1: Essay Overview

Chapter	**Title**	**Co-authors**
2	Does a Decrease in Pension Taxes Increase Retirement Savings? An Experimental Analysis	Kay Blaufus Michael Milde
3	Taxes and Retirement Planning: The Savings Impact of Simultaneously Offering Roth and Traditional Retirement Accounts	Kay Blaufus Michael Milde
4	The effect of tax policy uncertainty on effort and implications for welfare	-

According to our experimental findings of the first article, reductions in the future pension tax rate have almost no impact on the savings amount. This result even remains stable if we increase the salience of future pension taxation by including uncertainty about the future pension tax rate. Individuals may tend to underweight pension taxes due to myopia or confirmation bias. Our findings suggest that governments should increase incentives that directly arise in the savings period and should not rely on lower income taxes on pensions. However, even for an increase in the tax refund rate from zero to 45% (with a pension tax rate of 30%), the savings rate increases by only 5.3 percentage points. The effect is modest. In contrast, there is a large effect when changing from deferred to theoretically equivalent immediate taxation. Effective savings increase by 7.2 percentage points.

The second article shows that by offering two retirement products, an immediately taxed pension plan (Roth account) and a tax-deferred pension plan (Traditional account), people significantly increase retirement savings. In the experiments, effective savings increase by 9.9 percentage

points when two plans instead of one are offered. The effect increases by 5.2 additional percentage points when there is only one plan available and then another is explicitly introduced. Our findings support the hypothesis that providing two plans instead of one signals a social norm that more savings are appropriate. However, adding a savings plan decreases satisfaction due to higher decision complexity. Additionally, we find that many individuals prefer Roth accounts due to their perceived simplicity. Non-financial factors like dread of tax payments, perceived complexity, and preference for prepayment influence the preferences for Traditional or Roth accounts. Compared to rational choice theory, individuals over-save when both accounts are available, under-save when only a Traditional account is offered and align their savings with the benchmark when the savings can only be allocated to a Roth account.

The third article especially focuses on tax policy uncertainty in the sense of tax base risk that influences the uncertainty of risk-averse company (principal) and employee (agent). Under the assumption of variable tax bases, pro- and counter-cyclical tax policies are possible. A pro-cyclical tax policy at the level of the principal increases the principal's uncertainty such that the principal wants to share some of the risk with the agent. A counter-cyclical tax policy at the level of the agent hedges the risk-averse agent such that the agent is able to bear more risk. In both cases, the variable share of profit of the agent is raised. By an increase in the agent's variable share of profit, the agent bears more risk because the profit is inter alia influenced by operational company risk and therefore uncertain. Assuming an unobservable effort of the agent, the agent's effort increases along with an increase in the variable share of profit. This finding supports a counter-cyclical tax policy at employee level and a pro-cyclical tax policy at company level. Moreover, under a counter-cyclical tax base policy at the level of the agent, tax base risk at the level of the agent up to a certain level even increases utility and thus welfare. Taken together, the model derives possible positive implications of negatively connotated tax policy uncertainty.

Chapter 2

Does a Decrease in Pension Taxes Increase Retirement Savings? An Experimental Analysis*

Abstract

In a series of online experiments, we examine whether increasing the incentives to save by reducing the income tax rate on pensions results in higher savings. Our findings show that the income tax rate on pensions has almost no significant effect on saving behavior. However, if we vary the current tax rate at which savings are deducted, subjects adjust their savings. Our results are in line with the interpretation that subjects underestimate the level of income taxes on pensions due to myopia or confirmation bias. This holds even if we draw attention to income taxes on pensions by introducing uncertainty about the future income tax rate on pensions. Taken together, our results suggest that governments should not rely on lower income taxes on pensions but instead increase incentives that directly arise in the saving period to increase retirement savings. Moreover, our results demonstrate that governments could significantly raise the average after-tax pension without changing the level of tax revenues simply by switching from a deferred to an immediate pension tax system.

Keywords: retirement savings · saving incentives · pension tax rate · tax uncertainty · deferred taxation

Notes: This paper is available at SSRN (https://papers.ssrn.com/sol3/papers.cfm?abstract$_id = 4372027$).

*This chapter is co-authored by Kay Blaufus (Leibniz University Hannover) and Michael Milde (Leibniz University Hannover).

2.1 Introduction

Demographic changes, in the sense of low fertility on the one hand and increased life expectancy on the other, have a major impact on pension reforms and policies (OECD 2017). Although various countries offer a variety of incentives to save for retirement, many countries face an ongoing retirement savings crisis (Benartzi and Thaler 2013). For example, 50% of American households are at risk of not having sufficient funds to maintain their preretirement standard of living once they stop working (Munnell et al. 2021). Thus, it is particularly important to understand whether existing saving incentives are effective at all. This study examines the effectiveness of lower income tax rates on pensions to incentivize retirement saving.

Due to both the progressivity of the income tax system and the special tax treatment of retirement income (e.g., through extra tax allowances or tax credits for older people), the income tax rate applied to pensions is often lower than that applied to working income (OECD 2017). Under the widely used deferred taxation of pensions, retirement contributions are tax deductible, returns on contributions are tax exempt, and pensions are taxed. Therefore, applying a tax rate to pension income that is lower than the tax rate at which contributions are deducted should create an incentive to save (OECD 2018b, p. 48). Suppose, for example, that an individual's time preference rate equals the rate of return on his or her retirement savings, contributions are deductible at 30% and pensions are taxed at 15%; in this case, the return on a \$1 contribution amounts to $(1 - 0.15)/(1 - 0.3) - 1 = 21.43\%$. Thus, by shifting income from the work phase to the pension phase, the individual could earn high investment returns.

In this vein, it has generally been argued that lower tax rates on capital income encourage saving (e.g., Summers 1984; Hausman and Poterba 1987). However, this theory is ambiguous. First, rational choice theory predicts that an opposing income effect may offset or even overcompensate for the substitution effect; thus, savings may also remain unchanged or even be reduced when the income tax rate on pensions (hereinafter the pension tax rate) decreases (e.g., Power and Rider 2002). Second, from a behavioral economics and psychology perspective, a reduction in pension tax rates may have no effect at all, representing a particularly ineffective and costly subsidy. This is because individuals may either ignore taxes altogether, using simple heuristics such as consistently saving the same percentage of income regardless of pension taxes (Beshears et al. 2017), or underweight only pension taxes due to myopia or confirmation bias; i.e., people may pay attention to information that confirms their saving intentions (their tax refunds) but underweight information that contradicts those intentions (pension taxes) (Feldman and Ruffle 2015; Feldman et al. 2018; Blaufus and Milde 2021).

Prior empirical evidence on the effect of tax incentives on overall private savings is inconclusive. Some studies find that overall savings increase, while other studies find that individuals only reallocate their savings in response to tax incentives (for an overview, see OECD 2018a, pp. 85-91). However, it is almost impossible to clearly identify the effect of saving incentives with

observational data (Engen et al. 1996). In contrast, using an experiment, (1) we are able to manipulate current and future tax rates, (2) we can provide individuals with information on tax rules in advance to ensure that the observed behavior is not due simply to a lack of tax knowledge, and (3) we can control for investment alternatives and thus prevent the problem of tax incentives, possibly resulting in simply a shift between tax-privileged investments and other investments. Thus, our study provides causal evidence on the effect of pension tax reductions. By definition, this benefit comes at the price of a certain degree of abstraction.

In total, more than 1,100 native German speakers, with an average age of 40, took part in our online experiment examining the impact of pension taxation on savings. The subjects had to make incentivized savings decisions in a life-cycle model containing seven saving periods with different income levels and three pension periods in which the subjects received income only from their previous savings. The pensions were subject to deferred taxation. In a between-subject design, we manipulated the incentive to save by either changing the pension tax rate while holding constant the tax rate at which contributions were deducted (hereinafter the tax refund rate) or by changing the tax refund rate while holding the pension tax rate constant.

Surprisingly, our findings show that reducing the pension tax rate has almost no significant effect on saving behavior, although we substantially increased the incentive to save from -29% to 43%. However, when we varied the tax refund rate, the subjects adjusted their saving. We found that a 10-percentage-point increase in the incentive to save due to a change in the tax refund rate resulted in an increase of approximately 1.2 percentage points in the savings rate.

Thus, governments that aim to increase retirement savings should not rely on lower pension tax rates but should instead increase incentives that directly arise in the saving period. However, the effect of an increase in the tax refund rate is also modest. For example, even for a large increase in the tax refund rate from zero to 45% (with the pension tax rate held constant at 30%), the savings rate increases by only 5.3 percentage points. In contrast, we show that changing the tax treatment from deferred taxation to a theoretically equivalent immediate taxation that applies to retirement savings but not pensions significantly increases effective savings by 7.2 percentage points. The observed difference between immediate and deferred taxation is large. In our experiment, only if pension taxes are halved (from 30% to 15%) do the subjects receive the same level of after-tax pensions under immediate and deferred taxation. This suggests that governments could significantly increase the average after-tax pension without changing the level of tax revenue just by switching from a deferred to an immediate pension tax system.

Our results are in line with the interpretation that individuals neglect the level of pension taxes while considering the level of current taxes on savings due to confirmation bias or myopia. This holds even if we draw attention to pension taxes, for example, by varying the amount of pension taxes relative to taxes in saving periods or by introducing uncertainty about the specific pension tax rate. Our study, therefore, complements research on tax effects in psychology and behavioral economics (for an overview, see Congdon et al. 2009; Chetty 2015; Blaufus

et al. 2022). Moreover, we contribute to prior research on the effectiveness of tax incentives to encourage retirement saving (e.g., Beshears et al. 2017; Power and Rider 2002; Chetty et al. 2014; Duffy and Li 2021; Tschinkl et al. 2021; Cuccia et al. 2022; Messacar 2023) by demonstrating that lower pension taxes do not affect savings whereas tax refund incentives that people receive immediately when they save increase people's savings rate.

The remainder of this paper is organized as follows. In the following section, we derive our hypotheses. In section 2.3, we present the experimental design and the measurement of the variables. Section 2.4 presents the results, section 2.5 presents additional analyses, and the final section discusses the results and implications for future research and policy.

2.2 Hypothesis Development

2.2.1 The Effect of Pension Tax Rates on Retirement Savings

A reduction in the pension tax rate increases the return on savings and thus the incentive to save. If we assume that the return on savings is equal to an individual's time preference rate ρ, that τ_r denotes the tax refund rate and that τ_p denotes the pension tax rate, the incentive to save equals $(1-\tau_p)/(1-\tau_r)-1$. Thus, with the tax refund rate held constant, a decrease in the pension tax rate τ_p increases the incentive to save. Therefore, one should expect an increase in savings with a decrease in the pension tax rate.

Rational choice theory, however, predicts an opposing income effect. Suppose that individuals maximize their lifetime utility U according to the following function (Modigliani and Brumberg 1954):

$$U = \sum_{t=1}^{T} \frac{u(C_t)}{(1+\rho)^t}, \tag{2.1}$$

with T denoting the lifetime, t representing a single period, C_t denoting the consumption in period t and $u(C_t)$ representing the utility of consumption in period t.

In the income phase, subjects earn an income Y_t subject to a withholding tax rate τ_w and can make savings S_t that are deductible for tax purposes at the tax refund rate τ_r. Thus, consumption C_t in the income phase amounts to $Y_t \cdot (1-\tau_w) - S_t + S_t \cdot \tau_r$, where $S_t \cdot \tau_r$ represents the tax refund due to the tax deductibility of the savings.[1] In the pension phase, subjects receive only their constant pension, which is based on their prior savings and the interest rate i. The pension P is taxed at the pension tax rate τ_p. Thus, consumption C_t in the pension phase amounts to $(1-\tau_p) \cdot P = (1-\tau_p) \cdot \sum_{t=1}^{t_I} S_t \cdot (1+i)^{t_I - t} \cdot AF$, with AF denoting the annuity factor and t_I denoting the number of periods of the income phase. Using the above definitions of consumption,

[1] Note that τ_w may not equal τ_r because savings may only be partly deductible or be deductible to more than 100%.

we can write equation (2.1) as follows:

$$U = \sum_{t=1}^{t_I} \frac{u(Y_t \cdot (1-\tau_w) - S_t + S_t \cdot \tau_r)}{(1+\rho)^t} + \sum_{t=t_I+1}^{T} \frac{u((1-\tau_p) \cdot \sum_{j=1}^{t_I} S_j \cdot (1+i)^{t_I-j} \cdot AF)}{(1+\rho)^t}. \tag{2.2}$$

If we assume a constant level of relative risk aversion, it can be shown that a decrease in the pension tax rate increases (decreases) retirement savings when the level of relative risk aversion (RRA) is lower (higher) than one because in this case, the substitution effect is larger (smaller) than the income effect (for a proof, see Appendix A, section 2.7). Thus, rational choice theory predicts an increase in savings only for individuals with an $RRA < 1$.

Behavioral economics offers different predictions. First, if one assumes that individuals follow a simple heuristic such that their savings equal a certain percentage of their income independent of the tax treatment of retirement savings (Beshears et al. 2017), a decrease in pension taxes would not affect retirement savings. In line with this, Beshears et al. (2017) find no evidence that individuals' contribution rates differ between immediately taxed pension plans and deferred-tax pension plans, suggesting that many people indeed ignore and/or neglect these tax rules.

Second, due to confirmation bias, individuals may ignore or underweight information that contradicts their saving intentions (pension taxes) while considering information that is in line with their saving intentions (tax refunds). In this case, a change in the tax rate on pensions would also have no effect or only a small effect. Blaufus and Milde (2021) provide evidence that is consistent with the interpretation of a confirmation bias. Using lab experiments with university students, they find that even after informing their subjects about the tax rules, the subjects underweight the pension tax rate while perceiving the tax refund rate almost correctly. The authors derive their conclusions by comparing economically equivalent immediate and deferred pension taxation using a time-invariant tax rate and the provision of informational nudges on the pension tax rate, the tax refund rate, or both. However, the authors do not examine whether their subjects respond to changes in the tax rates. This is important because individuals may neglect taxes simply because the rates are the same for current and future income. This would be in line with prospect theory, which proposes that individuals simplify their choices during an editing phase in which they discard information that is common to two options (Kahneman and Tversky 1979). Thus, the observed tax ignorance may also stem from the application of the same tax rate to future and current income, and individuals may discard this information because it is common to future and current income. Moreover, prior behavioral research has shown that salience is important in terms of reducing tax misperceptions (e.g., Chetty et al. 2009; Finkelstein 2009; Taubinsky and Rees-Jones 2018). The use of deviating pension and tax refund rates should increase the salience of taxes and thus attract individuals' attention, which might reduce potential confirmation bias.

Third, individuals often act myopically (e.g., Thaler et al. 1997; Benartzi and Thaler 1999). In

this vein, behavioral life-cycle theory assumes that individuals behave as if they have a dual preference structure, namely, one dimension that is concerned with the short run ("the doer") and one that is concerned with the long run ("the planner") (Shefrin and Thaler 1988). In the current context, this means that the doer would focus primarily on the information associated with current consumption, i.e., the tax refund that rewards the doer, and underweight or even ignore the long-term tax consequences of savings, i.e., the income taxation of pensions. Accordingly, a reduction in the pension tax rate would have little or no impact.

Overall, the theory is ambiguous, so it is ultimately an empirical question whether a decrease in pension taxes increases savings. Prior empirical research that directly studies the effect of lower pension taxes is rare. Some studies examine the effect of changing tax rates, but this usually implies also changing the tax refund rate. These studies find some evidence that an increase in the tax price of future consumption[2] results in a decrease in the probability of contributing to pension plans and a decrease in retirement savings (e.g., Power and Rider 2002). Thus, a decrease in pension taxes should increase savings. Moreover, there is indirect evidence from research on the choice between immediately taxed and deferred-tax pension plans. In an experiment, Cuccia et al. (2022) find that an increase in pension tax rates increases the preference for immediately taxed pension plans, which implies that at least some individuals consider the effect of pension tax rates in their decisions and decrease their contributions to deferred pension plans when pension tax rates increase. Therefore, we test the following hypothesis:

Hypothesis 1 *A decrease in the income tax rate on pensions (the pension tax rate) increases the savings rate.*

2.2.2 The Effect of Tax Refund Rates on Retirement Savings

Instead of reducing the pension tax rate, one could increase the tax refund rate to enhance intentions to save. Indeed, deferred-tax pension plans are often advertised with reference to the tax deductibility of savings. For example, Capital One tells its customers how they can maximize their tax savings by contributing to deferred-tax plans: "If you can save money on your taxes while saving for your future, you can feel good about your financial decisions on two fronts at once" (Capital One 2018). Moreover, Messacar (2023) shows that taxpayers actually exploit the tax deductibility of savings to change their final tax balances, suggesting that taxpayers are aware of the benefit of tax deductibility and should therefore respond to the tax refund rate.

In the case of an increase in the tax refund rate, rational choice theory unambiguously predicts an increase in savings (for a proof, see Appendix A, section 2.7). However, behavioral economics predicts either no effect at all if individuals use the heuristic of consistently saving the same percentage of their income independent of the tax treatment of savings (Beshears et al. 2017) or increases in savings because the tax refund information that they receive confirms their saving

[2]The tax price of future consumption is the reciprocal of the incentive to save plus one.

intentions and is thus considered and not ignored (confirmation bias) (Blaufus and Milde 2021) or because the tax refund rewards the doer according to behavioral life-cycle theory (Shefrin and Thaler 1988). In line with the rational choice prediction, as well as the prediction from confirmation bias or behavioral life-cycle theory, we state our second hypothesis as follows:

Hypothesis 2 *An increase in the tax rate at which savings are deducted (the tax refund rate) increases the savings rate.*

2.2.3 Comparing the Effect of Pension Tax Rates and Tax Refund Rates on Retirement Savings

Since both pension tax rates and tax refund rates can be used separately to increase the incentive to save, it is important to determine which of these alternatives is more effective in terms of encouraging retirement saving. Rational choice theory predicts ambiguous results that depend on individuals' RRA. However, in the experimental life cycle used in this paper, an increase in the tax refund rate should be more effective if an individual's RRA is less than one. Moreover, for individuals with an RRA greater than one, a reduction in the pension tax rate is never effective because it does not increase savings but rather reduces them (section 2.2.1). Thus, for these individuals, an increase in the tax refund rate is always more effective than a decrease in the pension tax rate.[3]

The implications derived from behavioral economics differ depending on which approach is used. Again, if we assume that individuals save the same percentage of their income regardless of the tax treatment of savings (Beshears et al. 2017), it should make no difference whether the tax refund rate or the pension tax rate is changed since both parameters are neglected or ignored. However, if individuals suffer from confirmation bias as proposed by Blaufus and Milde (2021), an increase in the tax refund rate would be more effective in terms of encouraging saving because the pension tax rate (but not the tax refund rate) is underweighted or ignored.

Moreover, some researchers even argue that tax refunds could be overweighted because a tax refund provides an "immediate reward for saving" (Thaler 1994, p. 189). The reasoning is based on behavioral life-cycle theory (Shefrin and Thaler 1988). In this vein, Bernheim (2002, p. 1204) also argues that the benefit of deferred taxation is that it "coopts impatient selves with the immediate reward of a current-year tax deduction". As a result, increases in tax refund rates could be more effective than reductions in deferred income taxes on pensions.

In contrast, Cuccia et al. (2022) argue that people who contribute to a deferred-tax pension plan may perceive this as trading an immediate gain (the tax refund) for a future loss (the pension tax). Due to loss aversion (Kahneman and Tversky 1979) and the fact that the discount rates of

[3] Alternatively, the pension tax rate could be increased for these individuals to encourage saving. However, in the experimental life cycle used in this study, an increase in the tax refund rate is still more effective than an increase in the pension tax rate if the relative risk aversion does not exceed 3.36.

losses are lower than those of gains (Thaler 1981), the effect of a pension tax rate reduction (loss reduction) should be greater than that of an increase in the tax refund rate (gain increase).

Due to these opposing arguments, it is unclear whether a change in the tax refund or a change in the pension tax rate is more effective. We follow the rational choice prediction, the prediction of confirmation bias and the short-term thinking argument of behavioral life-cycle theory, testing the following hypothesis:

Hypothesis 3 *Increasing the incentive to save by increasing the tax refund rate is more effective in terms of stimulating saving than decreasing the pension tax rate.*

2.3 Experimental Design

2.3.1 Procedure and Treatments

To test our hypotheses, we conduct an online experiment with 1,143 subjects. The subjects make retirement savings decisions over a life cycle (Modigliani and Brumberg 1954) that consists of an income phase (seven periods) and a pension phase (three periods). During the income phase, the subjects receive an increasing and certain amount of income in each period with which to make savings decisions for the pension phase.[4] After each savings decision, the subjects complete a tax return for the respective period, in which they declare information about their pretax income and their tax-deductible savings amount. In the pension phase, the subjects do not receive an exogenous income; rather, they receive a constant income depending on their savings during the income phase. To keep the experiment as simple as possible, we do not consider lifetime or income uncertainty or interest on savings.[5] The income received during the income phase is subject to a 30% withholding tax. Savings contributions, by contrast, are taxed on a deferred basis; i.e., the savings are tax deductible (resulting in a tax refund), while the pension is fully taxable. However, the pension tax rate and the tax deductibility of savings vary depending on the treatment (see below).

At the end of each period, the subjects receive an overview of their savings, the result of the tax return and the payoff for the period (income after withholding taxes - savings + tax refund). They also receive information on their potential pretax pensions if they continue to save the average amount saved over the past periods until the beginning of the pension phase. At the end of the life cycle, the subjects receive summary information on their savings and the resulting pretax and after-tax pension. Afterward, the subjects complete a questionnaire with sociodemographic questions. We present a translation of the instructions and screenshots of the experiment in the

[4] We use increasing income instead of constant income to maintain the subjects' attention. In addition, this allows us to clearly distinguish between the simple heuristic of saving the same absolute amount each time and the rational decision to smooth consumption.

[5] This approach is quite common in experimental studies of retirement decision making. A good overview of different experimental designs is provided in Table 1 in the study by Bachmann et al. (2023).

online appendix.[6]

In some experimental life-cycle studies, researchers use induced utility functions, which provide the opportunity to test saving behavior against an optimal benchmark (e.g., Brown et al. 2009; Ballinger et al. 2011; Duffy and Li 2019). However, this also significantly increases the experimental complexity (Koehler et al. 2015). Since we are interested only in saving behavior under different saving incentives, it is not necessary to introduce a specific utility function, and we rely on the subjects' own exogenous preferences. To motivate consumption smoothing and to adapt our experimental design to the underlying rational choice model with an additively separable utility function (see Equation 2.1), only one of the 10 periods is randomly assigned for payoff at the end of the experiment, as in (Blaufus and Milde 2021).[7] Thus, subjects maximize their experimental wealth according to the following expected utility function:

$$E(U) = \frac{1}{10} \sum_{t=1}^{10} u(C_t). \tag{2.3}$$

In addition to receiving a fixed payoff of €2.00, the subjects receive a variable payoff. The latter consists of the payoff depending on the saving behavior during the life cycle and the payoff based on two postexperimental questions on loss aversion and risk-taking.

To study the effect of different saving incentives, subjects are randomly assigned to the two treatments *Tax Refund Incentive* and *Pension Tax Incentive*. In the *Tax Refund Incentive* treatment, the pension tax is constant at 30%. In this treatment, each subject is randomly assigned to one of the following tax refund rates: 0%, 15%, 30%, and 45%. To this end, subjects are informed that savings are either nondeductible or deductible at a rate of 50%, 100%, or 150%.[8] In the *Pension Tax Incentive* treatment, the tax refund rate is constant at 30%, and each subject is randomly assigned to one of the following pension tax rates: 0%, 15%, 25%, 30%, 35%, and 50%.[9] In cases where both the tax refund rate and the pension tax are 30% (i.e., the incentive to save is zero), the overall experimental design is the same for both treatments, and we use these observations for both treatment groups.

In some analyses, we look separately at the subgroup with an incentive to save of zero, i.e.,

[6] The online appendix is available here: `https://osf.io/4kn3u/files/osfstorage/647f189da51a5400bff0c548`.

[7] The advantage of this design choice is that the decision task is much easier for subjects to understand. One drawback, however, is that risk-neutral individuals will save everything (nothing) if the incentive to save is positive (negative). Moreover, risk-loving subjects may gamble by concentrating most consumption in just one period (Bachmann et al. 2023). The number of risk-neutral and risk-loving subjects is, however, usually small. In the current experiment, the percentage of risk-loving and risk-neutral subjects amounts to only 12%. Thus, in our opinion, the benefit of the design simplicity largely outweighs this drawback. Moreover, in the empirical analysis, we control for whether the results are affected by risk-loving or risk-neutral subjects.

[8] Note that income Y_t is subject to a tax rate $\tau_w = 30\%$. Thus, deductibility of savings at a rate of 50%, 100%, or 150% corresponds to tax refund rates of $30\% \cdot 50\% = 15\%$, $30\% \cdot 100\% = 30\%$, and $30\% \cdot 150\% = 45\%$.

[9] In the case of a pension tax of 0%, the subjects are informed that their pension income is tax free. In the case of a tax refund of 0%, the subjects are informed that their savings cannot be claimed for tax purposes and that they will not receive a tax refund for their savings.

that with the same pension tax rate and tax refund rate of 30%. This subgroup is referred to as *Deferred30*. To test whether subjects simply save a certain percentage of their income after withholding taxes and fully neglect the tax treatment of savings, we conduct an additional treatment in which there is no tax (*No Tax*). We reduce the income in this treatment to make it economically equivalent to that in the previously mentioned subgroup *Deferred30*. We also conduct a treatment in which the savings contributions are taxed immediately at a rate of 30%, but pensions are tax-free (*Immediate*). From a rational choice perspective, this treatment is economically identical to *No Tax* and *Deferred30*.

We provide descriptive statistics depicting the average sociodemographic characteristics of the subjects in Table 2.1. To test whether there are no systematic differences in the sociodemographic characteristics of the subjects between treatments, we perform a joint Chi^2 test from a multinomial logit model for the null hypothesis that there are no differences between treatments across all control variables (untabulated). We find that our randomization is successful with respect to sociodemographic characteristics between treatments (p = 0.545).

Table 2.1: Descriptive Statistics

	Pension Tax	Tax Refund	No Tax	Immediate	Total
Risk Attitude					
$0 < RRA < 1$	16.53%	15.78%	16.00%	25.45%	17.06%
$RRA \geq 1$	71.71%	69.84%	75.00%	60.00%	70.17%
Male	47.21%	50.12%	37.00%	49.09%	47.59%
Age					
Age 18-25	19.12%	17.17%	25.00%	16.36%	18.63%
Age 26-35	33.07%	30.86%	27.00%	30.91%	31.50%
Age 36-45	17.93%	18.79%	16.00%	18.18%	18.11%
Age 46-60	16.93%	19.03%	19.00%	17.27%	17.94%
Age 60+	12.95%	14.15%	13.00%	17.27%	13.82%
University Degree	48.01%	49.42%	41.00%	53.64%	48.47%
Income					
Income €0-1,000	25.70%	27.61%	30.00%	21.82%	26.42%
Income €1,000-2,000	30.68%	27.38%	30.00%	35.45%	29.83%
Income €2,000-3,000	25.50%	25.75%	24.00%	28.18%	25.72%
Income €3,000 +	18.13%	19.26%	16.00%	14.55%	18.02%
Married	39.04%	39.91%	42.00%	34.55%	39.20%
Cognitive Ability	28.88%	29.70%	26.00%	36.36%	29.66%
Tax Aversion	41.63%	46.40%	54.00%	36.36%	44.01%
Loss Aversion	39.84%	43.62%	41.00%	36.36%	41.03%
Preference for Prepayment	82.47%	82.37%	83.00%	84.55%	82.68%
Tax Knowledge	21.91%	22.27%	32.00%	23.64%	23.10%
Observations	606	431	100	110	

Note: We define our control variables *Risk Attitude*, *Male*, *Age*, *University Degree*, *Income*, *Married*, *Cognitive Ability*, *Tax Aversion*, *Loss Aversion*, *Preference for Prepayment* and *Tax Knowledge* in section 2.3.3.

2.3.2 Subjects and Data

The experiment was conducted in Germany and was programmed with oTree (Chen et al. 2016). All the subjects were native German speakers over 18 years old and were recruited from the survey platforms Clickworker, Prolific and Respondi.[10] This approach provided an advantage in that we were able to access a heterogeneous population, especially in terms of age and education. A total of 1,143 subjects were randomly assigned to the following three treatments: *Tax Refund Incentive* (431 subjects), *Pension Tax Incentive* (606)[11], *Immediate* (110), and *No Tax* (100). A total of 47.6% of the subjects were male, and the subjects' average age was 39.8 years (SD 15.8). On average, their earnings amounted to €4.94 (SD €1.27), with a minimum of €1.10 and a maximum of €9.57. The median time to complete the experiment was 26 minutes, yielding a median hourly wage of €11.40.

To use reliable data in the analysis, we considered the following elements in the design: (1) At the beginning of the experiment, the subjects received detailed instructions on the experimental procedure and the tax rules (see Appendix A). These were written in neutral language. In this way, we kept the subjects from using individual scripts when interpreting the loaded terms. For example, we did not use the terms *retirement* or *pension contributions* but rather terms such as *income phase*, *rest phase*, *savings decision*, and *payout*. (2) The subjects underwent a training round to ensure that they fully understood the task.[12] (3) The subjects had to complete two comprehension tests (one regarding the experimental design before the training round and one regarding the tax rules and the compensation). (4) We included some attention checks during the experiment. The subjects were allowed to participate in the experiment only if they answered all the comprehension questions correctly and passed all the attention checks.[13]

2.3.3 Measurement of Variables

Dependent Variable

We use $SavingsRate_t$ as the dependent variable, which measures the percentage of income (after withholding tax) that a subject contributes to his or her pension plan (S_t) in a given period t and is calculated as follows:

[10] To prevent possible data distortions due to the use of different platforms, we run our main regressions controlling for the platforms (not tabulated). The results remain qualitatively unchanged.

[11] In cases where both the tax refund rate and the pension tax were 30% (104 observations), the overall experimental design was the same for the treatments *Tax Refund Incentive* and *Pension Tax Incentive*, and we used these observations for both treatments.

[12] In the training round, taxes were not accounted for in a total of three periods in the income phase and two periods in the rest phase. The payoffs in the training round were not relevant for the actual payout at the end of the experiment.

[13] A total of 345 subjects (18.02%) failed one of the two comprehension tests, and 46 subjects (2.4%) failed both attention checks. These subjects were not allowed to participate in the experiment. Another 381 subjects (19.9%) did not complete the experiment for other reasons. The completion rate is thus slightly higher than the completion rate that is common in other life cycle experiments (e.g., Bachmann et al. 2023).

$$SavingsRate_t = \frac{S_t}{Y_t \cdot (1 - \tau_w)}. \tag{2.4}$$

In bivariate tests, we use the average savings rate of the subjects over the seven periods as the dependent variable. In the *No Tax* treatment, the income received in each period amounts to the income after withholding tax ($Y_t \cdot (1 - \tau_w)$). No taxes are withheld, nor are savings tax deductible or pensions taxable. Thus, the subjects in the *No Tax* treatment are economically equivalent to the subgroup of subjects treated with an incentive to save of zero (*Deferred30*).

Independent and Control Variables

As independent variables, we use the incentive to save (*Incentive*), which measures the after-tax rate of return on savings. The incentive to save is affected by the tax rate on tax-deductible savings τ_r and the pension tax rate τ_p and is measured as follows:

$$Incentive = \frac{(1 - \tau_p)}{(1 - \tau_r)} - 1. \tag{2.5}$$

We distinguish the incentive to save arising from the tax refund rate (*Tax Refund Incentive*) and the incentive to save arising from the pension tax rate (*Pension Tax Incentive*). We also use the independent variables *Immediate*, *No Tax* and *Deferred30*. *Immediate* and *No Tax* are dummy variables equal to one if the observation belongs to the respective treatment. *Deferred30* is another dummy variable equal to one for observations belonging to the deferred taxation setting, where the current tax rate on income, the tax refund rate, and the pension tax rate are each 30%. *Period* is a metric variable denoting the periods of the income phase (from one to seven).

In multivariate analyses, we consider different sociodemographic control variables, such as risk attitude (*Risk Attitude*), age (*Age*), gender (*Male*), school education (*University Degree*), monthly net income (*Income*), marital status (*Married*), tax knowledge (*Tax Knowledge*), cognitive ability (*Cognitive Ability*), tax aversion (*Tax Aversion*), loss aversion (*Loss Aversion*) and the preference for prepayment (*Preference for Prepayment*).

We measure the subjects' risk attitudes using a short, incentivized lottery task. The subjects were given 20 choices between a fixed lottery and a certain payout, which was increased by 5 ECUs for each decision. At the end of the experiment, we randomly chose one of the 20 decisions and used it to calculate the payoff for this task. This is a modified and simpler version of the experimental design used by Holt and Laury (2002). Assuming a utility function with constant relative risk aversion, we are able to calculate the Arrow–Pratt measure of relative risk aversion (*RRA*) for each subject. We categorize the subjects' risk attitude into three different categories: subjects with an *RRA* less than or equal to zero (*Non–Risk Averse*), subjects with an *RRA* between zero and one ($0<RRA<1$), and subjects with an *RRA* greater than or equal to one ($RRA \geq 1$).[14]

[14] In the task, the certain payment always increases by 5 ECU. Thus, the actual RRA cannot be perfectly approxi-

Age is a categorical variable consisting of five levels: 18–25, 26–35, 36–45, 46–60 and 61 or older. *Male* is a binary variable equal to one if the subject is male and zero otherwise. *University Degree* is another binary variable that equals one if a subject has at least a university degree and zero otherwise. The categorical variable *Income* measures individual net income after taxes and social insurance with the following categories: less than €1,000, €1,001–2,000, €2,001–3,000 and €3,001 or more. The dummy variable *Married* equals one for subjects who are married or in a civil partnership. To account for the impact of financial knowledge on savings decisions (e.g., Jacobs-Lawson and Hershey 2005; Parker et al. 2012; Blaufus and Milde 2021), subjects rated their personal tax knowledge on a scale from 1 ("no knowledge at all") to 9 ("tax expert/professional"). In particular, we want to control for above-average tax knowledge. Hence, the binary variable *TaxKnowledge* is equal to one if the subject rates his or her knowledge as at least six. We measure cognitive ability with the simple three-item cognitive reflection test from Frederick (2005). The variable *Cognitive Ability* takes the value of one if the subject answers all three questions correctly and zero otherwise. Since tax aversion implies that some people perceive an additional disutility associated with tax payments (McCaffery and Baron 2003; Blaufus and Möhlmann 2014), we ask the subjects whether they would rather invest money in a tax-free bond or in a slightly more economically favorable taxable bond (Sussman and Olivola 2011). The dummy variable *Tax Aversion* is equal to one if the subject would rather invest money in the tax-free bond.

Because the amount of taxes differs across and within treatments and taxes may be perceived as losses, we also control for loss aversion. *Loss Aversion* is measured with an incentivized lottery choice task (Gächter et al. 2022). The subjects have to decide whether to accept (play) or reject (receive nothing) a lottery. The amount of the loss is 400 ECU in the first decision and is increased by 200 ECU each time until the sixth and last decision, reaching 1,400 ECU; the amount of gain is fixed at 1,200 ECU. Finally, one decision is randomly selected for payout. In the case of a lottery, the lottery payoff amount is randomly determined (win or loss). *Loss Aversion* is a dummy variable equal to one if the focal subject's loss aversion is greater than the median of all the observations.

The preference for prepayment is an important factor in the context of saving behavior in various retirement tax systems (Cuccia et al. 2022). To measure the preference for prepayment, we ask the subjects to imagine that they plan to be unemployed for an entirely predictable and short period of time in six months (based on Prelec and Loewenstein 1998; Patrick and Park 2006). Then, they are told that the cost associated with this period is €1,200 and that it can be paid in two ways: (1) in six monthly payments of €200 for six months after the scheduled unemployment or (2) in six monthly payments of €200, beginning six months before the scheduled unemployment. The variable *Preference for Prepayment* equals one if the payment before the planned unemployment is chosen and zero otherwise.

mated. Therefore, precise separation of risk-neutral and risk-averse subjects is not possible, and subjects with a very low *RRA* may also be present in the *Non–Risk Averse* category.

2.3.4 Estimation Strategy

We test our hypotheses using bivariate and multivariate analyses. In the bivariate analyses, we use Pearson's tests to examine the relationship between the incentive to save and the subjects' average savings rate. To control for various sociodemographic variables and the subjects' incentives to save, we run random effects regressions that account for the dependence among the observations within each subject i (the seven savings decisions in the income phase) while estimating the parameters of interest.[15] The baseline regression with the variables defined in section 2.3.3 is as follows:

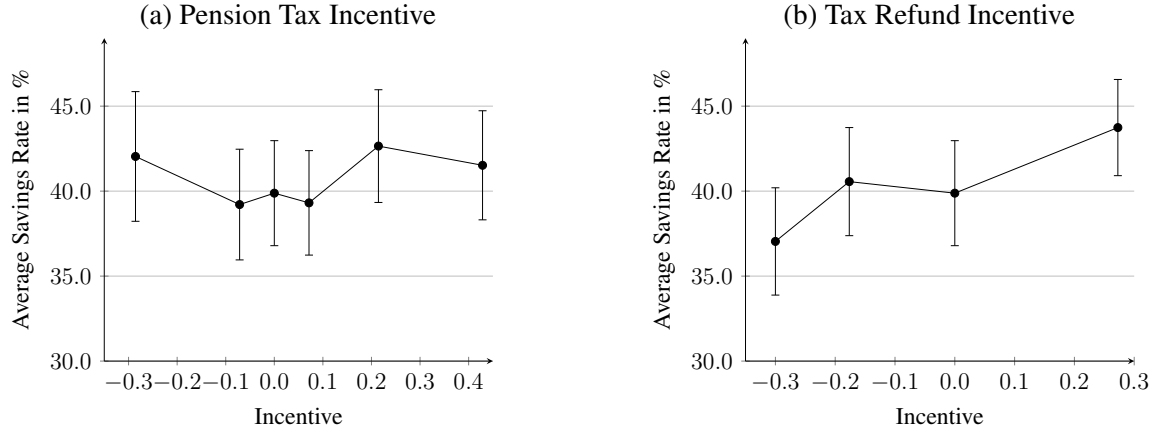
$$SavingsRate_{i,t} = \alpha + \beta_1 \cdot Incentive_i + \sum_{n=2}^{12} \beta_n \cdot Controls_i + \beta_{13} \cdot Period_t + \epsilon_{i,t} + u_i. \quad (2.6)$$

2.4 Empirical Results

2.4.1 Saving Incentives from Differing Pension Tax Rates

According to H1, we examine the extent to which different incentives to save due to changes in tax rates affect saving behavior. Figure 2.1a shows the average savings rate depending on the incentive to save. At first glance, one can see that the incentive has almost no impact on saving behavior. We also find no significant correlation between the level of the pension tax and saving behavior (ρ = 0.0211; p = 0.604; Pearson correlation coefficient).

Figure 2.1: Incentive to Save



Notes: The two figures show the average savings of the subjects depending on the incentive to save. In Figure 2.1a [2.1b], the incentive to save is changed by varying the pension tax rate [tax refund rate]. The *Savings Rate* measures the percentage of income (after withholding tax) that a subject contributes to the pension plan in a given period. The incentive to save (*Incentive*) determines the after-tax rate of return on savings according to equation 2.5. Error bars show 95% confidence intervals.

[15] The fact that the *SavingsRate* is censored between 0% and 82% (the maximum savings rate in our experiment) does not cause a problem in the analyses, since only 0.73% [2.05%] of the observations have a savings rate equal to 0% [82%]. In addition to the random-effects panel regressions, we run untabulated pooled OLS regressions (with clustered standard errors at the subject level and robust standard errors). Moreover, we run robust cross-sectional regressions as proposed by Huber (1973, Huber's M-estimator) with the subjects' average savings rate as the dependent variable. All the results remain qualitatively unchanged.

Our multivariate analyses with and without control variables confirm our bivariate finding that the level of the incentive does not have a significant impact on saving behavior (see Models 1 and 3 in Table 2.2).[16] Therefore, we reject our first hypothesis.

Table 2.2: Random-Effects Regressions: Pension Tax Rates

	(1) Savings Rate	(2) Savings Rate	(3) Savings Rate	(4) Savings Rate
Pension Tax Incentive	**0.0163**	**0.0808**	**0.00494**	**0.0800**
	(0.0321)	**(0.0930)**	**(0.0314)**	**(0.0942)**
RRA $\geq$ 1 x Pension Tax Incentive		-0.0442		-0.0536
		(0.0993)		(0.101)
RRA $\geq$ 1		-0.00838	-0.00377	0.000956
		(0.0212)	(0.0192)	(0.0219)
Non Risk-averse			-0.0327	
			(0.0291)	
Male			-0.00955	-0.0159
			(0.0145)	(0.0149)
Age 26-35			0.00196	0.0137
			(0.0222)	(0.0236)
Age 36-45			-0.0168	-0.0144
			(0.0264)	(0.0275)
Age 46-60			-0.0751***	-0.0706***
			(0.0250)	(0.0255)
Age 61+			-0.0693***	-0.0723***
			(0.0267)	(0.0274)
University Degree			0.00923	0.0159
			(0.0142)	(0.0150)
Income €1,001-2,000			0.0141	0.000251
			(0.0200)	(0.0201)
Income €2,001-3,000			-0.00370	-0.00252
			(0.0210)	(0.0220)
Income €3,001+			0.0228	0.0160
			(0.0264)	(0.0276)
Married			0.00451	0.00771
			(0.0156)	(0.0162)
Cognitive Ability			0.0182	0.00973
			(0.0158)	(0.0164)
Tax Aversion			-0.0128	-0.0238*
			(0.0140)	(0.0144)
Loss Aversion			0.00211	-0.000802
			(0.0143)	(0.0149)
Preference for Prepayment			0.00443	0.00597
			(0.0187)	(0.0196)
Tax Knowledge			0.0132	0.0216
			(0.0160)	(0.0169)
Period	0.0155***	0.0158***	0.0155***	0.0158****
	(0.000980)	(0.00106)	(0.000981)	(0.00106)
Constant	0.345***	0.351***	0.360***	0.357***
	(0.00795)	(0.0200)	(0.0306)	(0.0325)
Observations	4,242	3,738	4,242	3,738
Number of IDs	606	534	606	534
Chi^2	251.14***	224.64***	292.08***	265.39***

Notes: This table presents random-effects models without (Models 1 and 2) and subsequently with controls (Models 3 and 4). *Savings Rate* is the dependent variable. The *Savings Rate* measures the percentage of income (after withholding tax) that a subject contributes to the pension plan in a given period. *Pension Tax Incentive* measures the after-tax rate of returns on savings depending on the tax rate of the pension (see equation 2.5). The control variables *RRA* $\geq$ *1*, *Non Risk-averse*, *Male*, *Age* (categorial), *University Degree*, *Income* (categorial), *Married*, *Cognitive Ability*, *Tax Aversion*, *Loss Aversion*, *Preference for Prepayment*, *Tax Knowledge* and *Period* are described in section 2.3.3. In Model 2, we consider only subjects who are risk-averse. The standard errors are clustered at the level of the subjects and reported in parentheses. *, **, and *** represent significance at the 0.10, 0.05, and 0.01 levels, respectively.

[16] We also consider the possibility that subjects in earlier and later periods might respond differently to different pension tax rates. To this end, we run the same regressions separately for the first and last three periods of the income phase (not tabulated). We find that the treatment effect is homogeneous across periods, i.e., we find no effect of pension tax rates on saving in either the first three periods or the last three periods

However, this does not automatically mean that the incentive is completely neglected. According to rational choice theory, for risk-averse individuals with a relative risk aversion less (greater) than one, an increasing incentive to save due to lower pension tax rates should increase (decrease) savings. Consequently, our result could arise because the different saving behaviors of the two groups ($0 < RRA < 1$ versus $RRA \geq 1$) cancel each other out by chance. To test this, we run two additional regressions (without and with controls) with risk-averse subjects only and examine whether there is an interaction between the two groups on saving behavior (see Models 2 and 4 in Table 2.2). However, we find no such effect. In particular, there is neither a positive effect of the incentive to save in the group of subjects with an $RRA < 1$ nor a negative effect in the group of subjects with an $RRA \geq 1$.

Despite the different pension tax rates, which range from 0% to 50%, individuals do not respond at all to the variation in saving incentives when making savings decisions. Since no tax has to be accounted for in the case of a pension tax of 0%, we conclude that it is also not considered in the case of a positive pension tax. This is consistent with myopic behavior; with confirmation bias, which makes individuals tend to ignore information (in this case, pension taxation) that undermines their saving intentions (Blaufus and Milde 2021); with the explanation that individuals fully ignore taxes because they follow a heuristic, saving a certain percentage of their income independent of the tax treatment of savings (Beshears et al. 2017); and with the heuristic that subjects save the same percentage of their income after withholding taxes.

To examine the latter explanation, we compare the *Savings Rate* under deferred taxation with a tax refund rate and a pension tax rate amounting to 30% (*Deferred30*) with that under a net equivalent no-tax treatment (*No Tax*). We find that nominal savings are significantly higher in the case of deferred taxation than in the case without taxation (see Models 1 and 3 in Table 2.3). Thus, we can rule out the possibility that subjects simply save the same percentage of their income after withholding taxes.

Next, we examine the explanation that subjects always save the same percentage of their pretax income, i.e., that they fully neglect taxes (Beshears et al. 2017). For this purpose, we compare two economically equivalent treatments, *No Tax* and *Immediate*, which differ in the level of pretax income but are identical in after-tax income. If taxes were completely ignored, we would expect subjects to save more in the *Immediate* treatment. However, we find that subjects save the same amount in both treatments (see Models 2 and 4 in Table 2.3) and conclude that subjects are not anchored to pretax income when making the decision to save. In the next section, we examine the extent to which the level of a tax refund affects saving behavior.

Table 2.3: Random-Effects Regressions: No Tax Treatment

	(1) Savings Rate	(2) Savings Rate	(3) Savings Rate	(4) Savings Rate
No Tax	**——————— Base ———————**			
Deferred30	**0.0382***		**0.0506*****	
	(0.0203)		**(0.0195)**	
Immediate		**-0.00872**		**-0.00376**
		(0.0179)		**(0.0182)**
RRA $\geq$ 1			0.0179	-0.0180
			(0.0233)	(0.0243)
Non Risk-averse			0.0340	0.0231
			(0.0347)	(0.0331)
Male			-0.0294	-0.00878
			(0.0217)	(0.0201)
Age 26-35			0.0158	-0.0235
			(0.0319)	(0.0247)
Age 36-45			-0.00343	-0.0186
			(0.0354)	(0.0273)
Age 46-60			-0.0693*	-0.0626**
			(0.0370)	(0.0306)
Age 61+			-0.107***	-0.0944**
			(0.0374)	(0.0383)
University Degree			0.00888	-0.000493
			(0.0199)	(0.0189)
Income €1,001-2,000			0.0173	0.00220
			(0.0279)	(0.0239)
Income €2,001-3,000			1.92e-05	0.00859
			(0.0282)	(0.0254)
Income €3,001+			0.0199	0.0415
			(0.0459)	(0.0333)
Married			-0.0116	-0.0109
			(0.0241)	(0.0228)
Cognitive Ability			0.0238	-0.0131
			(0.0228)	(0.0183)
Tax Aversion			0.0463**	0.0250
			(0.0217)	(0.0176)
Loss Aversion			-0.0388**	-0.0179
			(0.0195)	(0.0187)
Preference for Prepayment			0.0265	0.0429
			(0.0289)	(0.0292)
Tax Knowledge			0.0395	-0.000478
			(0.0240)	(0.0205)
Period	0.0104***	0.00533***	0.0104***	0.00533***
	(0.00165)	(0.00147)	(0.00166)	(0.00147)
Constant	0.319***	0.339***	0.280***	0.345***
	(0.0144)	(0.0141)	(0.0433)	(0.0477)
Observations	1,428	1,470	1,428	1,470
Number of IDs	204	210	204	210
Chi^2	41.60***	13.42***	83.06***	41.32***

Notes: This table presents random-effects models without (Models 1 and 2) and subsequently with controls (Models 3 and 4). *Savings Rate* is the dependent variable. The *Savings Rate* measures the percentage of income (after withholding tax) that a subject contributes to the pension plan in a given period. *No Tax*, *Deferred30* and *Immediate* are dummy variables that take the value of one if the focal observation belongs to the respective treatment. In the *No Tax* treatment, taxes are not taken into account. In the *Deferred30* treatment, the withholding tax rate, the tax refund rate and the pension tax rate are 30%. In the *Immediate* treatment, the withholding tax rate is also 30% and the contributions are taxed immediately at a rate of 30%. Both tax treatments are net equivalent to the treatment without taxes. The control variables *RRA* $\geq$ *1*, *Non Risk-averse*, *Male*, *Age* (categorial), *University Degree*, *Income* (categorial), *Married*, *Cognitive Ability*, *Tax Aversion*, *Loss Aversion*, *Preference for Prepayment*, *Tax Knowledge* and *Period* are described in section 2.3.3. The standard errors are clustered at the level of the subjects and reported in parentheses. *, **, and *** represent significance at the 0.10, 0.05, and 0.01 levels, respectively.

2.4.2 Saving Incentives from Tax Refunds

In this section, we examine the effect of tax refund incentives on pension saving behavior (Hypothesis 2). Figure 2.1b gives an initial impression of the results. In contrast to the incentive provided by lowering the pension tax rate, the incentive provided by increasing the tax refund has a significant positive effect on saving behavior (ρ = 0.1333; p = 0.006; Pearson correlation coefficient).

Models 1 and 2 in Table 2.4 show that this relation is highly significant. If we vary the tax refund rate such that the incentive to save increases by 10 percentage points, the savings rate increases by 0.95 percentage points. This implies that a 10-percentage-point increase in the tax refund rate leads to a 1.18-percentage-point increase in the savings rate.[17] In summary, we cannot reject Hypothesis 2. An increase in the tax rate at which savings are deducted increases the savings rate.

[17] We also consider the possibility that subjects in earlier and later periods might respond differently to different tax refund rates. To this end, we run the same regressions separately for the first and last three periods of the income phase (not tabulated). We find that the treatment effect is homogeneous across periods.

Table 2.4: Random-Effects Regression: Tax Refund Rates

	(1) Savings Rate	(2) Savings Rate
Tax Refund Incentive	**0.102*** **	**0.0945** **
	(0.0353)	**(0.0380)**
RRA $\geq$ 1		0.0261
		(0.0220)
Non–Risk Averse		0.0248
		(0.0284)
Male		0.000538
		(0.0169)
Age 26-35		0.00158
		(0.0255)
Age 36-45		-0.00358
		(0.0288)
Age 46-60		-0.0160
		(0.0286)
Age 61+		-0.0417
		(0.0289)
University Degree		0.0104
		(0.0154)
Income €1,001-2,000		-0.0114
		(0.0207)
Income €2,001-3,000		-0.00147
		(0.0226)
Income €3,001+		0.0419
		(0.0313)
Married		-0.0438**
		(0.0186)
Cognitive Ability		0.00134
		(0.0179)
Tax Aversion		-0.00610
		(0.0172)
Loss Aversion		-0.0129
		(0.0163)
Preference for Prepayment		0.0169
		(0.0217)
Tax Knowledge		0.00463
		(0.0203)
Period	0.0148***	0.0148***
	(0.00119)	(0.00119)
Constant	0.349***	0.337***
	(0.00862)	(0.0362)
Observations	3,017	3,017
Number of IDs	431	431
Chi^2	157.48***	186.75***

Notes: This table presents the results of a random-effects regression without (Model 1) and subsequently with (Model 2) controls. *Savings Rate* is the dependent variable. The *Savings Rate* measures the percentage of income (after withholding tax) that a subject contributes to the pension plan in a given period. *Tax Refund Incentive* measures the after-tax rate of the return on savings depending on the tax refund rate (see equation 2.5). The control variables *RRA* $\geq$ *1*, *Non Risk-averse*, *Male*, *Age* (categorial), *University Degree*, *Income* (categorial), *Married*, *Cognitive Ability*, *Tax Aversion*, *Loss Aversion*, *Preference for Prepayment*, *Tax Knowledge* and *Period* are described in section 2.3.3. The standard errors are clustered at the level of the subjects and reported in parentheses. *, **, and *** represent significance at the 0.10, 0.05, and 0.01 levels, respectively.

2.4.3 Comparison of Saving Incentives from Pension Tax Rates and Tax Refund Rates

We have already shown that incentives in the form of pension tax reductions are ineffective in terms of encouraging higher savings contributions while incentives in the form of higher tax refunds are an effective tool to increase savings. Models 1 and 2 in Table 2.5 show that this result is significant (Wald tests; p = 0.067). Thus, we cannot reject our third hypothesis. Increasing the incentive to save by increasing the tax refund rate is more effective in terms of stimulating saving than lowering the pension tax rate. This is in clear contrast to the expectation that reducing the pension tax rate is more effective because it reduces a future loss, which is weighted higher according to prospect theory, than increasing a tax refund gain (Cuccia et al. 2022).

Table 2.5: Random-Effects Regression: Comparison of Saving Incentives

	(1) Savings Rate	(2) Savings Rate
Pension Tax Incentive	**0.0140**	**0.00556**
	(0.0314)	**(0.0309)**
Tax Refund Incentive	**0.102*** **	**0.0948*** **
	(0.0353)	**(0.0365)**
Controls	NO	YES
Observations	6,531	6,531
Number of IDs	933	933
Chi^2	348.32***	394.85***
Wald Test (p-value)		
Pension Tax vs. Tax Refund	0.067	0.068

Notes: This table presents the results of a random-effects regression without (Model 1) and subsequently with (Model 2) controls. *Savings Rate* is the dependent variable. The *Savings Rate* measures the percentage of income (after withholding tax) that a subject contributes to the pension plan in a given period. *Pension Tax Incentive* [*Tax Refund Incentive*] measures the after-tax rate of return on savings depending on the tax rate of the pension [tax refund rate] (see equation 2.5). The control variables *RRA* $\geq$ *1*, *Non Risk-averse*, *Male*, *Age* (categorial), *University Degree*, *Income* (categorial), *Married*, *Cognitive Ability*, *Tax Aversion*, *Loss Aversion*, *Preference for Prepayment*, *Tax Knowledge* and *Period* are described in section 2.3.3. The standard errors are clustered at the level of the subjects and reported in parentheses. *, **, and *** represent significance at the 0.10, 0.05, and 0.01 levels, respectively.

However, the question arises as to why individuals respond to tax refunds but not to pension taxes. One reason for this could be that the pension tax is less salient than the tax refund and therefore the pension tax is not considered during the decision (McCaffery and Baron 2006). One argument in support of this conjecture is that the subjects receive feedback on the consequences of the tax refund after each savings decision with the tax return whereas the consequence of the pension tax is not experienced until the pension phase. However, we find no evidence for this possibility. First, we assume that subjects are aware of both the tax refund and the pension tax. This is ensured by the instructions and the associated comprehension test, as well as by the repeated presentation of the tax rules at each saving decision. Second, we conduct the analyses only for the first period, in which there is no feedback on the tax refund (untabulated). Additionally, for the first period, the tax refund rate has a significant effect on saving behavior

(p = 0.062; linear regression with controls).

We suggest, however, that this result is consistent with confirmation bias, as individuals consider information that is consistent with their saving intentions (tax refund information) but underweight information that contradicts these intentions (pension tax information). Furthermore, this finding could be due to myopic behavior. According to behavioral life-cycle theory (Shefrin and Thaler 1988), individuals may pay attention to tax refunds because the immediate benefit of a tax refund rewards the doer and thus weakens the doer's opposition to saving. However, Blaufus and Milde (2021) find that individuals respond to a matching contribution that is paid directly into the pension fund and thus increases the future pension. If individuals ignore all future benefits due to myopic behavior, they should also ignore the matching contribution. Since individuals do not ignore a future benefit that is consistent with their saving intentions but ignore the tax burden on their pension that is inconsistent with their saving intentions, we argue that our results are best explained by confirmation bias, which has also been shown to explain tax effects on consumption behavior (Feldman and Ruffle 2015; Feldman et al. 2018). However, our design does not allow a definite answer, so myopic behavior cannot be clearly ruled out as an explanation.

2.5 Additional Analyses

2.5.1 Uncertainty of Future Tax Rates

We have shown that pension taxes are neglected on average. In this context, we want to investigate the extent to which increasing salience can counteract this neglect of pension taxes. Chetty et al. (2009) and Taubinsky and Rees-Jones (2018) demonstrate, for example, that consumers do not react as strongly to nonsalient taxes, and Fochmann and Weimann (2013) show that increasing tax salience can reduce tax misperceptions. Uncertain pension tax rates should thereby increase the salience of the pension tax rate and thus attract individuals' attention.[18]

To test the effect of tax rate uncertainty, we conducted another experiment with a new treatment, *Pension Tax Uncertainty*. We implemented uncertainty as a mean-preserving spread (Rothschild and Stiglitz 1978), allowing for a higher or lower pension tax rate with equal probability. Under uncertainty, the pension tax rates differ by -15/+15 percentage points in each case from the treatment *Pension Tax Incentive*, with certain pension tax rates of 15%, 25%, 30%, and 35%. Thus, with the (expected) tax incentive controlled for, the treatments *Pension Tax Incentive* and *Pension Tax Uncertainty* differ only with respect to pension tax rate uncertainty.

A total of 417 additional individuals participated in the experiment. The timing of data collection

[18] The uncertain tax rate increases the salience of the pension tax because there are now two states and there is a probability compared to the certain tax rate treatment. To this end, the subjects in the experiment were shown a table, while the subjects with a certain tax rate saw only one tax rate.

for this experiment was the same as for the other treatments, and there were no significant sociodemographic differences in terms of gender, age, education level or school degree between this treatment and the *Pension Tax Incentive* treatment (unreported).

Models 1 and 2 in Table 2.6 show the results of our analysis. In the regressions, we include a dummy variable, *Uncertainty*, which equals one if the subject is in the *Pension Tax Uncertainty* treatment. Finally, using the interaction of incentives and salience (certain versus uncertain tax rates), we examine the effect of increasing salience. However, the interaction term is not significant. Moreover, in the treatment with an uncertain pension tax rate (main effect of *Pension Tax Incentive*), we do not find a significant effect of decreasing pension tax rates. Thus, we find that the taxation of pensions is neglected despite increasing salience.

Table 2.6: Random-Effects Regression: Uncertainty

	(1) Savings Rate	(2) Savings Rate
Pension Tax Incentive	**0.0810**	**0.0740**
	(0.0769)	**(0.0756)**
Certainty	-0.00317	-0.00638
	(0.0124)	(0.0122)
Pension Tax Incentive x Certainty	0.0376	0.0272
	(0.110)	(0.108)
Controls	NO	YES
Observations	5,845	5,845
Number of IDs	835	835
Chi^2	372.54***	415.83***

Notes: This table presents the result of a random-effects regression without (Model 1) and subsequently with (Model 2) controls. *Savings Rate* is the dependent variable. The *Savings Rate* measures the percentage of income (after withholding tax) that a subject contributes to the pension plan in a given period. *Pension Tax Incentive* measures the after-tax rate of return on savings depending on the (expected) tax rate of the pension (see equation 2.5). *Certainty* is a dummy variable equal to one if the observation belongs to the treatment group with a certain pension tax rate. Additionally, we include an interaction term of *Pension Tax Incentive* and *Certainty*. The control variables *RRA* $\geq$ *1*, *Non Risk-averse*, *Male*, *Age* (categorial), *University Degree*, *Income* (categorial), *Married*, *Cognitive Ability*, *Tax Aversion*, *Loss Aversion*, *Preference for Prepayment*, *Tax Knowledge* and *Period* are described in section 2.3.3. The standard errors are clustered at the level of the subjects and reported in parentheses. *, **, and *** represent significance at the 0.10, 0.05, and 0.01 levels, respectively.

2.5.2 Immediate Taxation

We have shown that saving behavior is subject to significant tax misperceptions under deferred taxation. This is mainly due to the neglect of the pension tax. These tax misperceptions are unlikely to exist under immediate taxation, where savings are not tax deductible while future pensions are tax free.

To shed light on this issue, we again consider the *Immediate* treatment, where savings contributions are taxed immediately at a rate of 30%. In contrast to deferred taxation (equation 2.2), lifetime utility U under immediate taxation can be presented as:

$$U = \sum_{t=1}^{t_I} \frac{u(Y_t \cdot (1-\tau_w) - S_t)}{(1+\rho)^t} + \sum_{t=t_I+1}^{T} \frac{u(\sum_{j=1}^{t_I} S_j \cdot (1+i)^{t_I-j} \cdot AF)}{(1+\rho)^t}, \tag{2.7}$$

with t denoting a single period, t_I denoting the number of periods of the income phase, t_p denoting the number of periods of the pension phase, Y_t denoting the income subject to a withholding tax rate of τ_w, and AF denoting the annuity factor.

A comparison between equations 2.2 and 2.7 shows that immediate and deferred taxation are economically equivalent if the pension tax rate equals the tax refund rate ($\tau_r = \tau_p$) and these tax rates are equal to τ_w (e.g., Beshears et al. 2017). Subjects under deferred taxation simply have to increase their savings $S_{D,t} = \frac{S_{I,t}}{1-\tau_r}$ to obtain the same consumption in each period as that under immediate taxation, with $S_{D,t}$ [$S_{I,t}$] denoting the savings under deferred [immediate] taxation.

Therefore, we compare the saving behavior in this *Immediate* treatment with that in the deferred-tax treatment where the tax rate of both the tax refund and the pension is 30% (*Deferred30*). To make the savings rate of the deferred taxation treatment comparable to that of the *Immediate* treatment, we use *EffectiveSavingsRate*$_t$ as the dependent variable in the empirical analysis. This determines the proportion of income (after withholding tax) that an individual effectively saves and accounts for that savings result in a tax refund amounting to $S_t \cdot \tau_r$ under deferred taxation, where τ_r denotes the tax refund rate. The effective savings rate under deferred taxation is calculated as follows:[19]

$$\textit{EffectiveSavingsRate}_t = \textit{Savings Rate}_t \cdot (1 - \tau_r). \tag{2.8}$$

The timing of the data collection of this treatment was the same as that of the other treatments, and there were no significant sociodemographic differences in terms of gender, age, education level, or school completion between the two treatments (untabulated). Models 1 and 2 in Table 2.7 show the regression results. We find that in the case of deferred taxation—despite the economic equivalence—the effective savings rate is significantly lower than that in the case of immediate taxation. This confirms the finding of Blaufus and Milde (2021) and shows that their result generalizes from a laboratory environment with students to an online experiment with the general public as subjects. These results demonstrate that by introducing immediately taxed pension plans, a government can significantly increase effective retirement savings and thus after-tax pensions without changing the level of tax revenue.

[19]The effective savings rate under immediate taxation is received by the ratio of savings $S_{I,t}$ to income after withholding taxes ($Y_t \cdot (1 - \tau_w)$) in a given period t.

Table 2.7: Random-Effects Regression: Immediate versus Deferred

	(1) Effective Savings Rate	(2) Effective Savings Rate
Immediate	**—— Base ——**	**—— Base ——**
Deferred30	**-0.0727*** (0.0167)**	**-0.0721*** (0.0162)**
Controls	NO	YES
Observations	1,498	1,498
Number of IDs	214	214
Chi^2	90.80***	136.13***

Notes: This table presents the results of a random-effects regression without (Model 1) and subsequently with (Model 2) controls. *Effective Savings Rate* is the dependent variable. *Effective Savings Rate* measures the percentage of income (after withholding tax) that an individual effectively contributes to his or her pension plan in a given period; hence, it reflects that savings are tax-deductible in the case of deferred taxation (see equation 2.8). *Immediate* and *Deferred30* are dummy variables that take the value of one if the observation belongs to the respective treatment. In the *Immediate* treatment, savings contributions are taxed immediately. In the *Deferred30* treatment, the tax refund rate and pension tax rate are 30% and are therefore net equivalent to those of the treatment under immediate taxation. The control variables *RRA* $\geq$ *1*, *Non Risk-averse*, *Male*, *Age* (categorial), *University Degree*, *Income* (categorial), *Married*, *Cognitive Ability*, *Tax Aversion*, *Loss Aversion*, *Preference for Prepayment*, *Tax Knowledge* and *Period* are described in section 2.3.3. The standard errors are clustered at the level of the subjects and reported in parentheses. *, **, and *** represent significance at the 0.10, 0.05, and 0.01 levels, respectively.

2.6 Conclusion

Many countries use tax incentives to promote retirement savings. However, the effectiveness of these incentives is unclear. Using a series of experiments, we demonstrate that decreasing pension tax rates does not encourage retirement savings. Even if we greatly reduce the pension tax rate from 50% to 0%, we do not observe any significant change in peoples' saving behavior. Thus, a policy of reducing pension tax rates, for example, by providing extra tax allowances for older people, is ineffective and costly.

In contrast, an increase in the tax refund rate, i.e., the rate at which individuals can deduct their retirement savings, increases savings. This finding is in line with myopic behavior or confirmation bias (Feldman and Ruffle 2015; Feldman et al. 2018; Blaufus and Milde 2021); i.e., individuals pay attention to information (tax refunds) that confirms their saving intentions but underweight information that contradicts such intentions (pension taxes).

In the experiment, all subjects were fully informed about the tax rules and passed comprehension tests on these rules. Nevertheless, we observe significant misperceptions regarding taxes on pension income. Thus, with respect to tax policy, our results show that policies that rely on providing people with additional information to promote retirement savings, while helpful in principle (e.g., Duflo and Saez 2003; Goda et al. 2014; Dolls et al. 2018), are insufficient. Moreover, our findings suggest that, in general, an instrument that increases current tax benefits is more effective than one that decreases future tax burdens even if both instruments are economically equivalent. This result is relevant for tax incentives designed to promote retirement savings but should also carry over to other contexts. For example, building on our results, one could predict

that granting an immediate write-off of assets is more effective than exempting future investment income if the government aims to promote investment activity. Moreover, if people focus on their future pretax pensions (instead of their after-tax income) while making their savings decisions, it seems reasonable to expect that they also focus on nominal pensions (instead of real pensions). Research has already used life-cycle experiments to examine money illusion (e.g., Yamamori et al. 2018). Using similar experiments, future research may thus examine whether people who suffer from tax illusion also suffer from money illusion.

Furthermore, although prior research has shown that accounting for pension tax uncertainty is economically important for investors from a rational choice perspective (Brown et al. 2017), our findings suggest that people tend to ignore tax uncertainty, as we demonstrate that it does not change their savings. Thus, one should be very cautious when deriving policy implications from models that rely on the correct perception of uncertain tax rates.

However, our findings also speak to the limited potential of even tax refund rates to promote retirement savings. An increase of 10 percentage points in the tax refund rate leads to only a 1.2-percentage-point increase in the savings rate. In contrast, we show that substituting deferred taxation with economically equivalent immediate taxation increases the (effective) savings rate by 7.2 percentage points without changing tax revenue. Thus, policy makers may consider replacing deferred taxed pension plans with immediately taxed pension plans.

2.7 Appendix A: The Optimal Solution in the Life-Cycle Model

To derive the effects of increases in the pension tax rate and the tax refund rate, we use a simple life-cycle model (Modigliani and Brumberg 1954). We assume an additively separable utility function with constant relative risk aversion (CRRA). The following utility U is maximized:

$$U = \sum_{t=1}^{T} \frac{u(C_t)}{(1+\rho)^t}. \tag{2.9}$$

T denotes the lifetime, t the time, C_t the consumption in each period, $u(C_t)$ the utility of consumption in period t and $1+\rho$ the individual's discount rate. The life cycle can be subdivided into an income phase, consisting of t_I periods, and a resting phase, consisting of t_P periods.[20] In the income phase, the individual receives an income Y_t subject to a withholding tax rate τ_w and can save a certain amount S_t.[21] The difference between the income after withholding taxes and the after-tax savings is consumption in period t. Thus, the budget constraint is as follows:

$$Y_t \cdot (1-\tau_w) = C_t + S_t \cdot (1-\tau_r). \tag{2.10}$$

Note that the level of the tax refund rate τ_r and therefore the amount of tax deductibility of savings increases the consumption of the respective period.

In the resting phase, the subject receives a constant pension P. The term $\sum_{t=1}^{t_I} S_t \cdot (1+i)^{t_I - t}$ presents the amount of savings at the end of the income phase, including the interest rate i. P is calculated as follows:

$$P = \Big(\sum_{t=1}^{t_I} S_t \cdot (1+i)^{t_I - t}\Big) \cdot AF, \tag{2.11}$$

with AF denoting the annuity factor, which equals $\frac{(1+i)^{t_P} \cdot i}{(1+i)^{t_P} - 1}$.

The after-tax pension amounts to:

$$P \cdot (1-\tau_p) = C_r, \tag{2.12}$$

with τ_p denoting the pension tax rate.

Summarizing (2.10) and including the definition of C_r according to (2.11) and (2.12), the

[20] We use the terms *income* and *resting phase* in our main analysis to facilitate understanding.

[21] We refer to nominal savings and therefore the amount that the subjects entered in the experimental setting. See section 2.3.3 in the main analysis for more detailed explanations.

intertemporal budget constraint amounts to:

$$\sum_{t=1}^{t_I} \frac{Y_t \cdot (1-\tau_w)}{(1+i)^t} = \sum_{t=1}^{t_I} \frac{C_t}{(1+i)^t} + C_r \cdot \frac{1}{(1+i)^{t_I} \cdot AF} \cdot \frac{1-\tau_r}{1-\tau_p} \tag{2.13}$$

The optimization problem is:

$$\mathcal{L} = \sum_{t=1}^{T} \frac{u(C_t)}{(1+\rho)^t} - \lambda \cdot \Big(\sum_{t=1}^{t_I} \frac{Y_t \cdot (1-\tau_w)}{(1+i)^t} - \sum_{t=1}^{t_I} \frac{C_t}{(1+i)^t} - C_r \cdot \frac{1}{(1+i)^{t_I} \cdot AF} \cdot \frac{1-\tau_r}{1-\tau_p} \Big) \tag{2.14}$$

Rewriting the first summand, we obtain:

$$\mathcal{L} = \sum_{t=1}^{t_I} \frac{u(C_t)}{(1+\rho)^t} + \frac{u(C_r)}{(1+\rho)^{t_I} \cdot AF_\rho} - \lambda \cdot \Big(\sum_{t=1}^{t_I} \frac{Y_t \cdot (1-\tau_w)}{(1+i)^t} - \sum_{t=1}^{t_I} \frac{C_t}{(1+i)^t} - C_r \cdot \frac{1}{(1+i)^{t_I} \cdot AF} \cdot \frac{1-\tau_r}{1-\tau_p} \Big) \tag{2.15}$$

with $AF_\rho = \frac{(1+\rho)^{t_P} \cdot \rho}{(1+\rho)^{t_P} - 1}$.

Differentiating (2.15) with respect to C_t and C_r, we obtain the first-order conditions, which can be rearranged to

$$u'(C_t) = u'(C_r) \cdot \Big(\frac{1+i}{1+\rho} \Big)^{t_I - t} \cdot \frac{AF}{AF_\rho} \cdot \frac{1-\tau_p}{1-\tau_r}, \forall t \leq t_I \tag{2.16}$$

Thus, Euler's rule applies to the optimal level of consumption in the income phase:

$$u'(C_t) = \frac{u'(C_{t+1}) \cdot (1+i)}{1+\rho}. \tag{2.17}$$

To investigate the effect of an increasing pension tax rate in the optimum, we specify the total differential of (2.16) with respect to S_t and τ_p:

$$\frac{dS_t}{d\tau_p} = \frac{(\frac{1+i}{1+\rho})^{t_I - t} \cdot \frac{AF}{AF_\rho} \cdot \frac{1}{1-\tau_r} \cdot u'(C_r) \cdot (1 - RRA)}{u''(C_t) \cdot (1-\tau_r) + u''(C_r) \cdot (\frac{1+i}{1+\rho})^{t_I - t} \cdot \frac{AF^2}{AF_\rho} \cdot \frac{(1-\tau_p)^2}{1-\tau_r} \cdot (1+i)^{t_I - t}} \tag{2.18}$$

The expression *RRA* comprises the term $-C_r \cdot \frac{u''(C_r)}{u'(C_r)}$. Assuming a utility function with constant relative risk aversion (*CRRA*), this relation remains constant. With concave utility functions ($u'(C_t) > 0$ and $u''(C_t) < 0$), the effect of the future pension tax rate in the optimum (2.18) depends only on the *RRA*. A risk-averse individual[22] with *RRA* > 1 saves more if the pension tax rate increases, the income effect exceeds the substitution effect. In contrast, a less risk-averse individual with *RRA* < 1 saves less if the future tax rate increases. Here, the substitution effect

[22] Assuming a *CRRA* utility function, risk-averse individuals have an *RRA* greater than zero.

is greater than the income effect.

To examine the effect of the deductibility of savings and thus a rising tax refund rate, we examine the total differential of (2.16) with respect to S_t and τ_r:

$$\frac{dS_t}{d\tau_r} = \frac{u''(C_t) \cdot S_t - u'(C_r) \cdot (\frac{1+i}{1+\rho})^{t_I - t} \cdot \frac{AF}{AF_\rho} \cdot \frac{1-\tau_p}{(1-\tau_r)^2}}{u''(C_t) \cdot (1-\tau_r) + u''(C_r) \cdot (\frac{1+i}{1+\rho})^{t_I - t} \cdot \frac{AF^2}{AF_\rho} \cdot \frac{(1-\tau_p)^2}{1-\tau_r} \cdot (1+i)^{t_I - t}} \tag{2.19}$$

Assuming concave utility functions, expression (2.19) is greater than zero. If the tax refund rate and thus the deductibility of savings increases, the individual raises his or her nominal savings.

2.8 Appendix B: Instructions, Screenshots and Questionnaire

This appendix contains the experimental instructions (Appendix 2.8.1), screenshots (Appendix 2.8.2) and the questionnaire (Appendix 2.8.3). The presented experimental procedures were originally written in German and translated into English. We show information that is identical for all treatments and display manipulations in square brackets.

2.8.1 Instructions (translated from German)

Welcome Page

Welcome to our Study

Thank you for participating in this study. Before the study begins, please read the following carefully.

1. Procedure and Duration

In this study, several savings decisions have to be made. Furthermore, there are some questions regarding savings behavior and other socio-demographic characteristics. Please answer all questions carefully and pay attention to the control questions, which should sharpen your attention. In total, the study should take about 20 minutes.

Participation in this study is completely voluntary. If you stop the study in between, you will not be penalized, but you will not receive any compensation either.

2. Purpose of this Research Study

This study examines your general savings behavior over a life-cycle.

3. Compensation

You will receive a fixed compensation of €2.00 for completing the study. In addition, you will receive a variable compensation. The amount depends on your decisions and luck. In the following instructions you will learn how your variable compensation is calculated. The average variable compensation is €3.00.

Please note the following: We attach great importance to you conscientiously completing the task in this study and answering the questions honestly. Therefore, we will pay you an appropriate compensation. We will reject your HIT in the following cases:

- **You do not read the instructions carefully.**
- **You do not read the questions carefully or answer not conscientiously.**

4. Benefit of the Study

This study will help the research team to learn more about human behavior. We hope that in

the future, other people could benefit from this study through a better understanding of savings behavior.

5. Possible Risks of the Study

In this study, no risks or unfavorable effects are expected beyond what would normally be experienced in daily life.

6. Confidentiality

The information you provide will be kept strictly confidential. Only the project manager and his or her staff will have access to the raw data. Anonymized data from this study may be shared with qualified researchers or research institutions when deemed appropriate in accordance with academic association, journal, or university policies. All reports from this study will be at an aggregate level and/or with individual information anonymized or disguised so that participants cannot be identified. We will not share information that identifies you with others unless we are required to do so by law.

7. Contact Details

This study is conducted by Michael Milde from the Leibniz University of Hanover. If you have any questions about the study, please contact me at milde@tax.uni-hannover.de.

8. Declaration of Consent

By clicking on *Next* you confirm that you have read the points above and that you agree to participate in the study.

Instructions Training Sequence

Structure of the Study

The study consists of a **comprehension test**, a **training sequence**, another **comprehension test**, **a decision sequence** and a subsequent **questionnaire**.

Next you receive instructions for the training sequence, which also applies to the subsequent decision sequence.

Training Sequence

Both the training sequence and the decision sequence are divided into an **income phase** and a **rest phase**. These contain several periods.

The training sequence includes a total of three periods in the income phase and two periods in the rest phase.

You receive a payoff in each period. Payoffs are given in a **fictitious currency** that we call **"ECU"**. 1,000.00 ECU correspond to €1.80. Your actual payoff is calculated at the end of the study from the "earned ECU" and is then converted into Euro.

Income Phase

1. Amount of Income
In each period of the **income phase** you will receive income. In the first period the income is 1,200.00 ECU. The income increases by 100.00 ECU in each period, so that you receive an income of 1,400.00 ECU in the last period.

2. Savings Decision
In each period of the income phase you have to decide again how much of your income you want to save for the rest phase. You will no longer receive any income from us during the rest phase.

3. Payoffs in the Income Phase
The payoffs of periods 1 to 3 in the income phase depend on your savings decisions in the respective periods. The **difference between the income and the savings contribution** is the payoff for the respective period.

Rest Phase

1. Amount of Income
In the rest phase, you will no longer receive any income from us. Your income in periods 4 to

5 depends only on your savings contributions in the income phase. In each period of the rest phase, you will receive the same amount of income that results from your total savings.

2. Information on Income during the Income Phase
You will receive savings information after each period of the income phase. On the one hand, you will be informed about your average savings contributions in the previous periods in the income phase. Based on these average savings contributions, you receive, on the other hand, information on how high your income would be in the rest phase.

Example: *In the previous periods, you saved an average of XXX ECU. If you save until the rest phase as much as you did on average in the last periods, amounting to XXX ECU, your payments in the rest phase resulting from the savings will correspond to YYY ECU.*

3. Payoffs in the Rest Phase
The income is your payoff amount of the respective period.

Comprehension Questions

Before the actual study starts, we would like you to answer the following comprehension questions. If you have any comprehension questions, you can always look at the instructions again.

Please note that we will reject your HIT if you have not read the instructions carefully and consequently do not answer the following question conscientiously.

Question 1: In which periods of this training sequence do you receive an income from us?

- ☐ Periods 1 to 3 (income phase).
- ☐ Periods 4 to 5 (rest phase).
- ☐ Periods 1 to 5 (income and rest phase).

Question 2: Which of the following statements about the income in a period is correct?

- ☐ The income in the income phase increases with each period.
- ☐ The income in the income phase is the same in each period.

Instructions Decision Sequence

Structure of the Study

After you have become more familiar with the structure and content of the study in the training sequence, the actual study begins.

Next, you start with the **decision sequence** which includes **10 periods**. Otherwise, this decision sequence is identical to the training sequence. [Taxation treatments: **However, your income is now subject to taxation.**]

You will find more information on this on the following page.

Income Phase

1. Taxation of Income/ Income (treatment without taxes)

[Taxation treatments: As in the training sequence, you will receive an income from us in each period of the income phase. The gross (pre-tax) income amounts to 2,500.00 ECU in the first period and increases in each period by 100.00 ECU. Thus, you receive an income amounting to 3,100.00 ECU in period seven.

In each period, a tax prepayment will be withheld from your gross income. It is offset against the actual tax payment in the tax return. The actual tax rate is 30%. For example, if your **gross income** is 2,500.00 ECU, your **net income** would be 1,750.00 ECU. All tax payments in this experiment are used for further scientific research as well as for the fees incurred for this study.]

[Treatment without taxes: As in the training sequence, you will receive an income from us in each period of the income phase. The income amounts to 1,750.00 ECU in the first period and increases in each period by 70.00 ECU. Thus, you receive an income amounting to 2,170.00 ECU in period seven.]

2. Savings Decision and Savings Product
In each period of the income phase you have to decide again how much of your income you want to save for the rest phase. You will no longer receive any income from us during the rest phase.

One savings product is available to you - **Savings product A**.

3. Taxation of Savings [taxation treatments with a positive tax refund rate only]
Savings product A: In the income phase, your savings contributions to the savings product A are tax-deductible in the tax return.

[Tax refund rate = 15% only: You can claim half (= 50%) of the savings contributions as a tax deduction in your tax return.]

[Tax refund rate = 45% only: You can claim 1.5 times the savings contributions as a tax deduction in your tax return.]

Accordingly, you will receive a tax refund in the amount of 30% [15%; 45%] of the savings contributions, which will additionally be paid to you in the respective period of the income phase. For every ECU saved you receive a tax refund of 0,30 [0,15; 0,45] ECU.

4. Tax Return [taxation treatments only]

After you have made your savings decision, the next step is to complete a tax return.

[Tax refund rate $>$ 0: To do this, please enter your gross income and the savings contribution for savings product A, which can be claimed for tax purposes, in your tax return.]

[Tax refund rate $=$ 0: To do this, please enter your gross income in your tax return.]

5. Payoffs in the Income Phase
The payoffs for periods 1 to 7 in the income phase depend on your savings decisions in the respective periods.

[Tax refund rate $>$ 0: The **difference between the net income and the savings contribution plus the tax refund** yields the payoff amount of the respective period.]

[Tax refund rate $=$ 0: The **difference between the net income and the savings contribution** yields the payoff amount of the respective period.]

[Treatment without taxes: The **difference between the income and the savings contribution** yields the payoff amount of the respective period.]

Rest Phase

1. Taxation of the Income resulting from the Savings Contributions [taxation treatments only]

[Pension Tax Rate $>$ 0: The gross income from savings product A is subject to a tax of 30% [15 %; 25 %; 35 %; 50 %].]

[Pension Tax Rate $=$ 0: The gross income in the rest phase is tax-free.]

2. Payoffs in the Rest Phase

[Pension Tax Rate $>$ 0: The gross income less taxes is the payoff for the respective period.]

[Pension Tax Rate $=$ 0 and treatment without taxation: The income resulting from the savings is the payoff for the respective period.]

Compensation

1. Fixed Compensation

You receive a fixed compensation of €2.00.

2. Variable Compensation

Depending on how you have distributed your income, the corresponding remuneration will be paid. A random generator determines which of the total 10 periods of the decision sequence will be paid out. Consequently, only one period is remunerated! The payout of the randomly drawn period will be converted in Euro.

You can also earn additional money later in the questionnaire.

Comprehension Questions

Before the actual study starts, we would like you to answer the following questions. If you have any questions about understanding, you can look at the instructions again at any time.

Please note that we will reject your HIT if you have not read the instructions carefully and consequently do not answer the following question conscientiously.

Question 1: Which of the following statements regarding the compensation at the end of the study is correct?

- ☐ The average payoff amount for all periods is paid at the end of the study.
- ☐ The average payoff amount in the rest phase is paid at the end of the study.
- ☐ Only one of the total 10 periods will be remunerated at the end of the study.

Question 2: How is the gross income taxed in the income phase?

- ☐ The gross income is subject to a tax of 30%.
- ☐ The gross income is subject to a tax of 15%.
- ☐ The gross income is tax-free.

Question 3: How are the savings contributions taxed in the income phase?

- ☐ The savings contributions can be claimed as tax-deductible. Accordingly, you will receive a tax refund of 30% [15%; 45%] of the savings contributions.
- ☐ The savings contributions cannot be claimed as tax-deductible. Accordingly, you will not receive any tax refund.

Question 4: How is the gross income resulting from the savings contributions taxed during the rest phase?

- ☐ The gross income in the rest phase is tax-free.
- ☐ The gross income in the rest phase is subject to a tax of 30% [15%; 25%; 35%; 50%].

Question 5: Suppose you save nothing for the entire seven periods of the income phase, and at the end of the study, one period of the rest phase is paid out. What is then your payout in one period of the rest phase?

- ☐ Zero Euro.
- ☐ The average income for periods 1 to 7.

2.8.2 Screenshots of oTree (translated from German)

Screenshots: Training Sequence

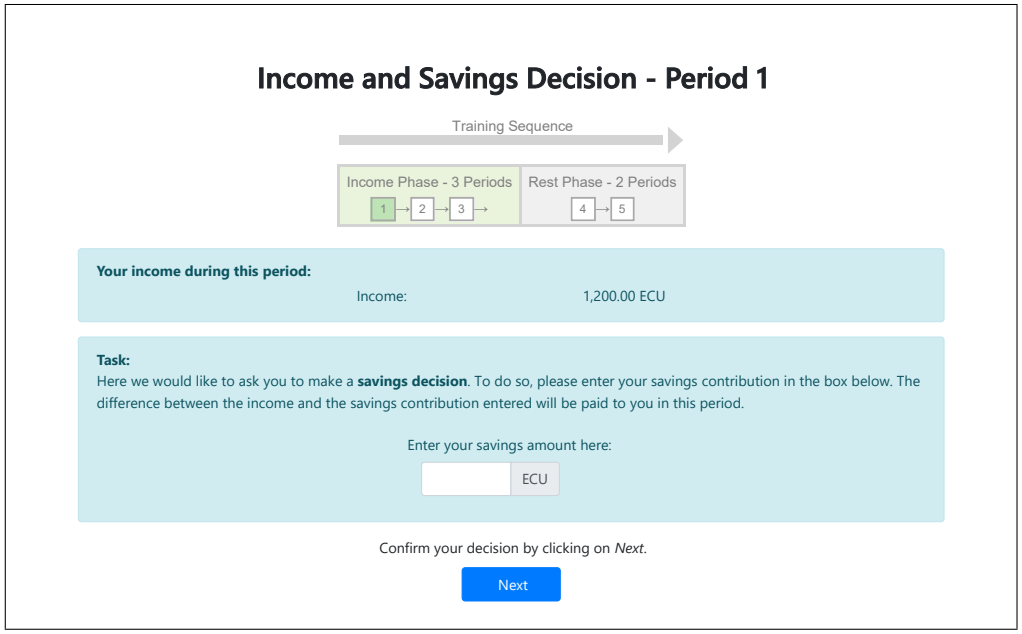


Figure 2.2: Training Sequence: Savings Decision

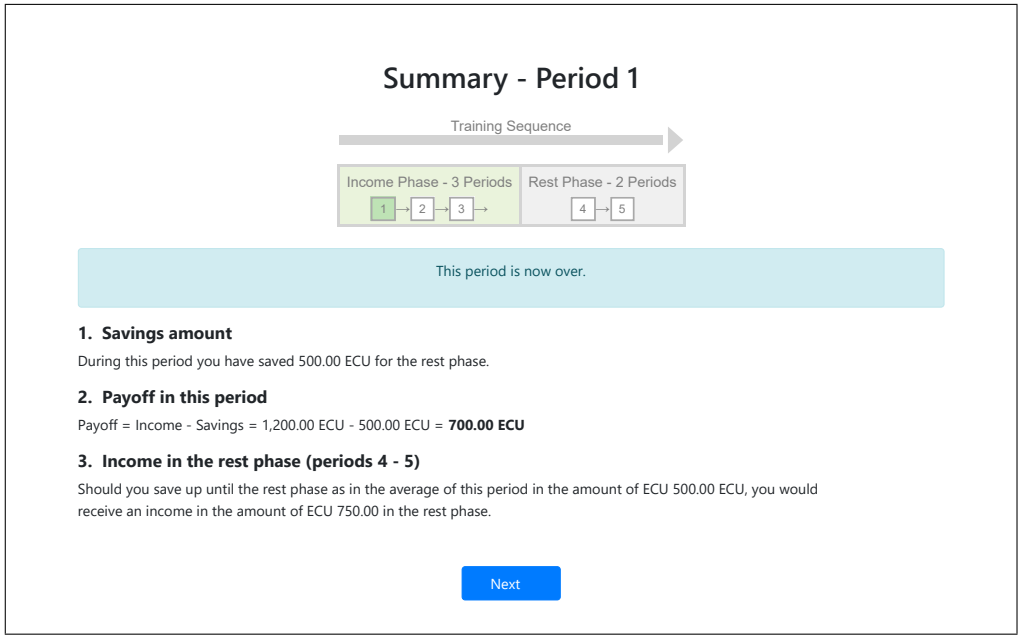


Figure 2.3: Training Sequence: Period Summary

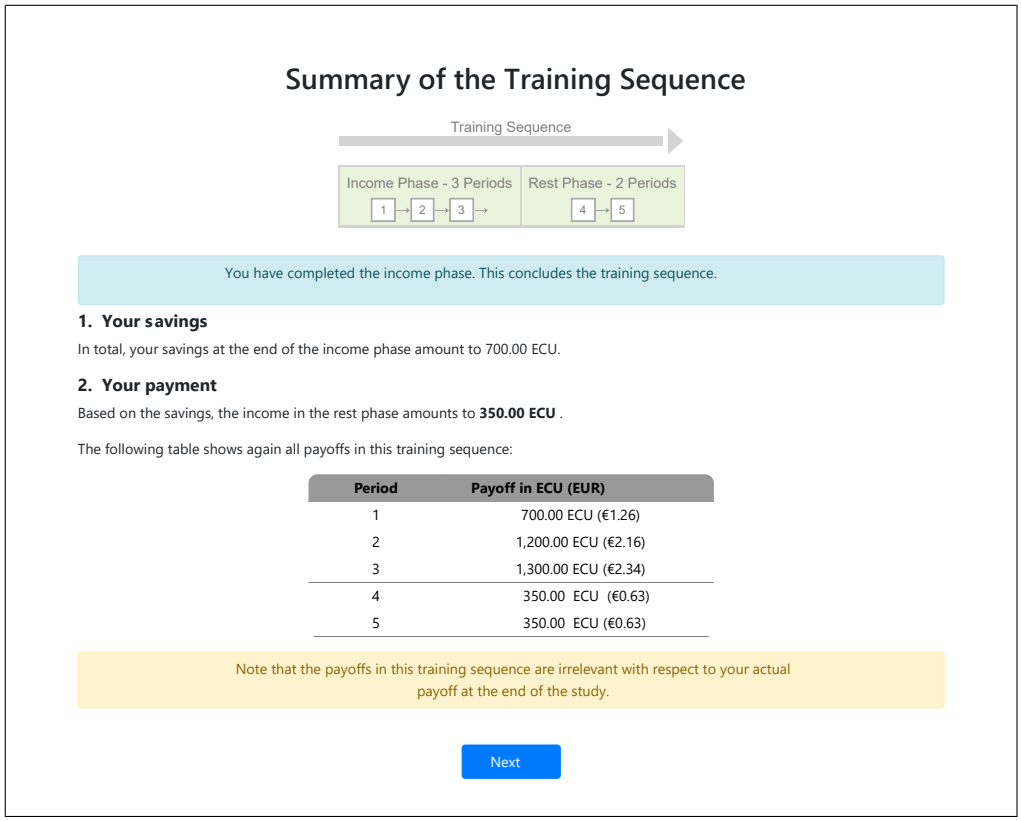


Figure 2.4: Training Sequence: Summary Training Sequence

Screenshots: Decision Sequence

Savings Decision

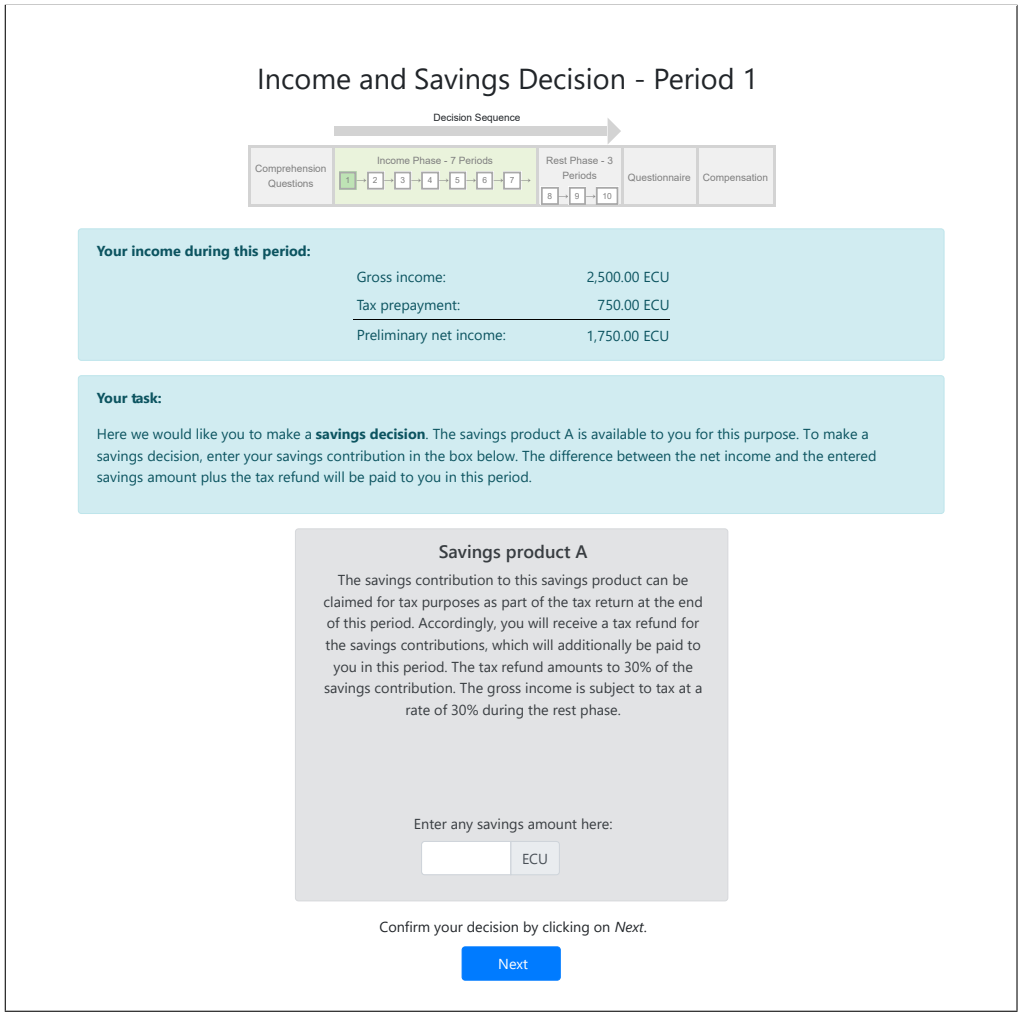


Figure 2.5: Savings Decision Income Phase: Taxation Treatments

Tax Return

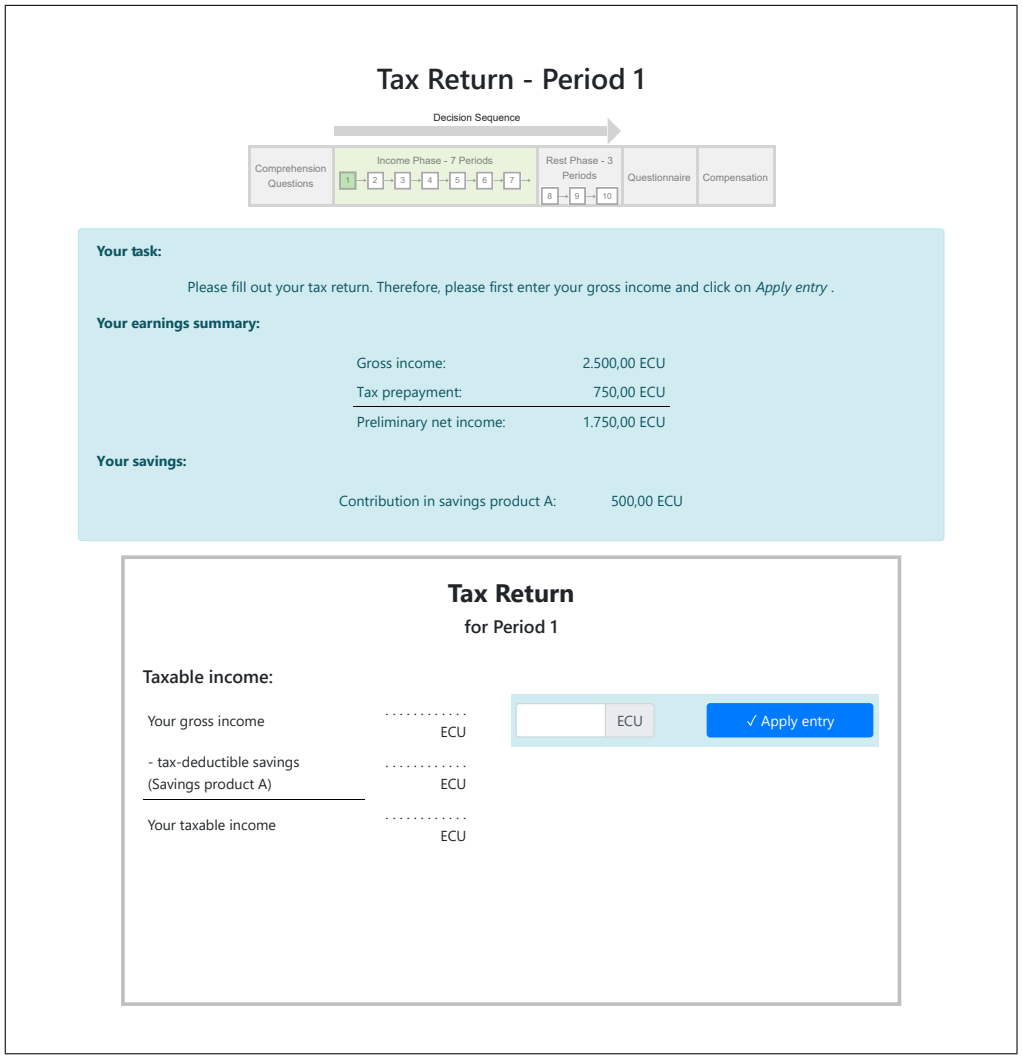


Figure 2.6: Tax Return: Enter Gross Income

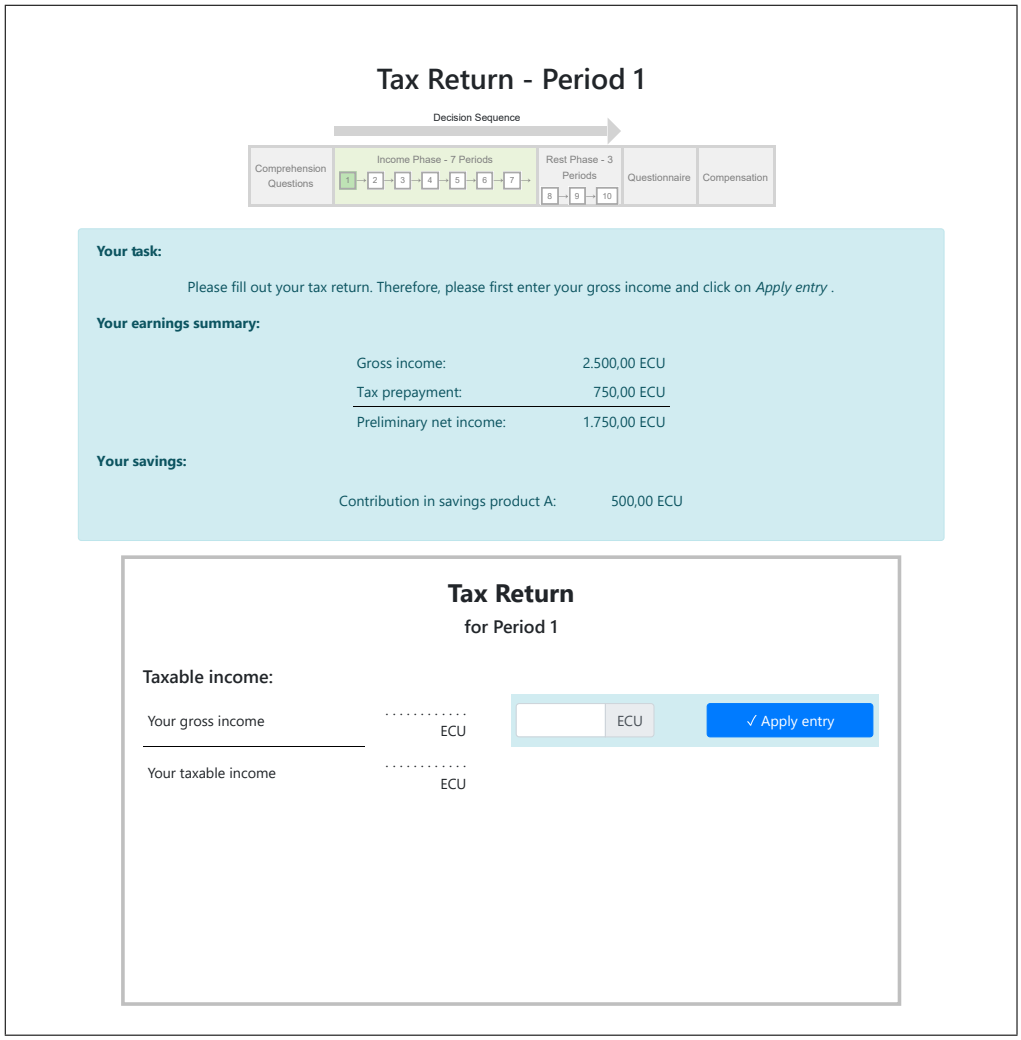


Figure 2.7: Tax Return: Enter Gross Income [tax refund rate = 0]

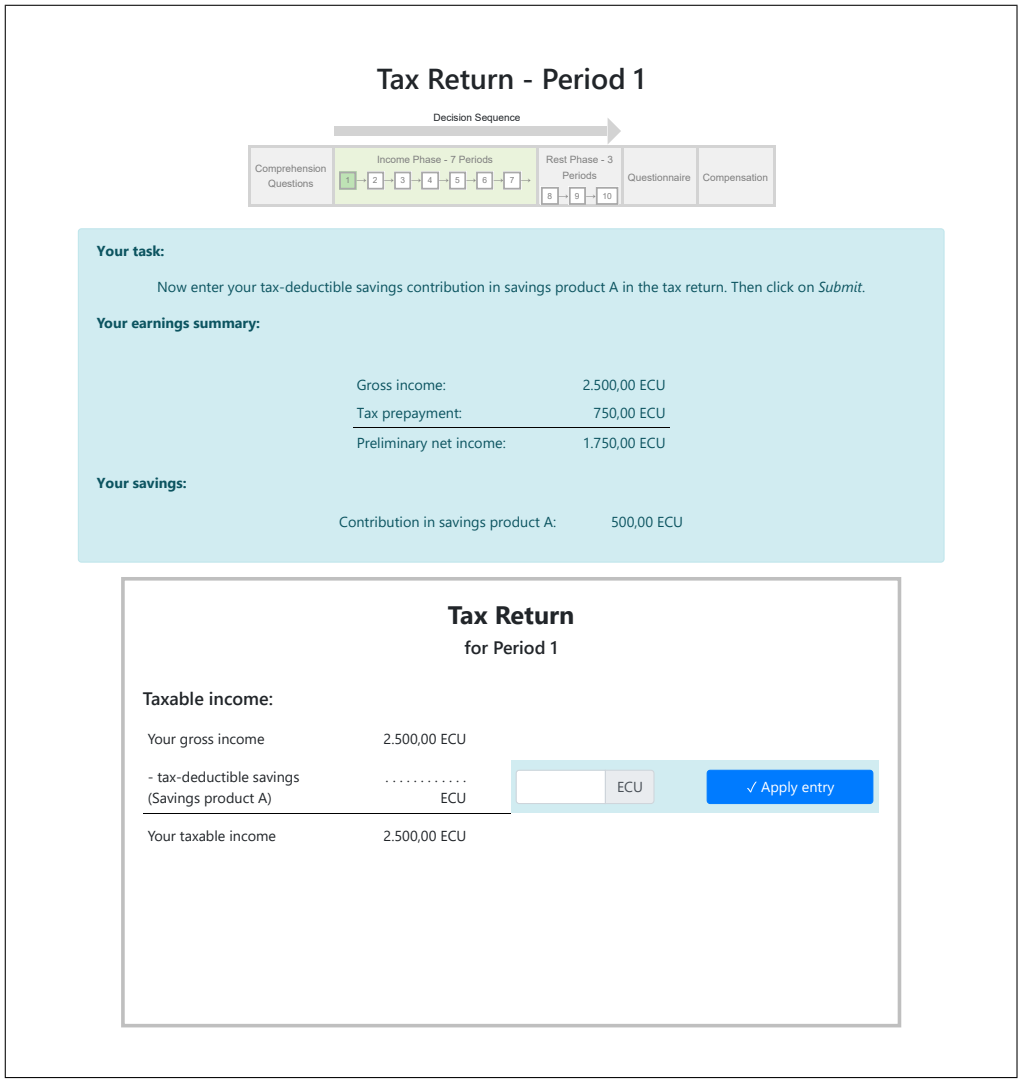


Figure 2.8: Tax Return: Enter Tax-deductible Savings

Period Summary

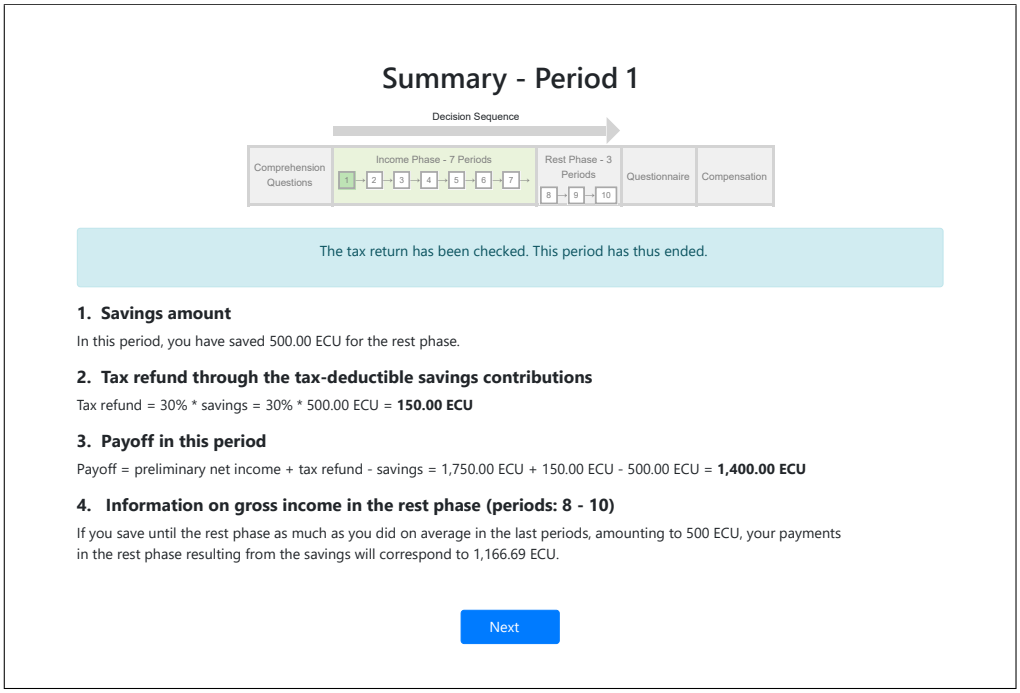


Figure 2.9: Decision Sequence: Period Summary - Taxation Treatments

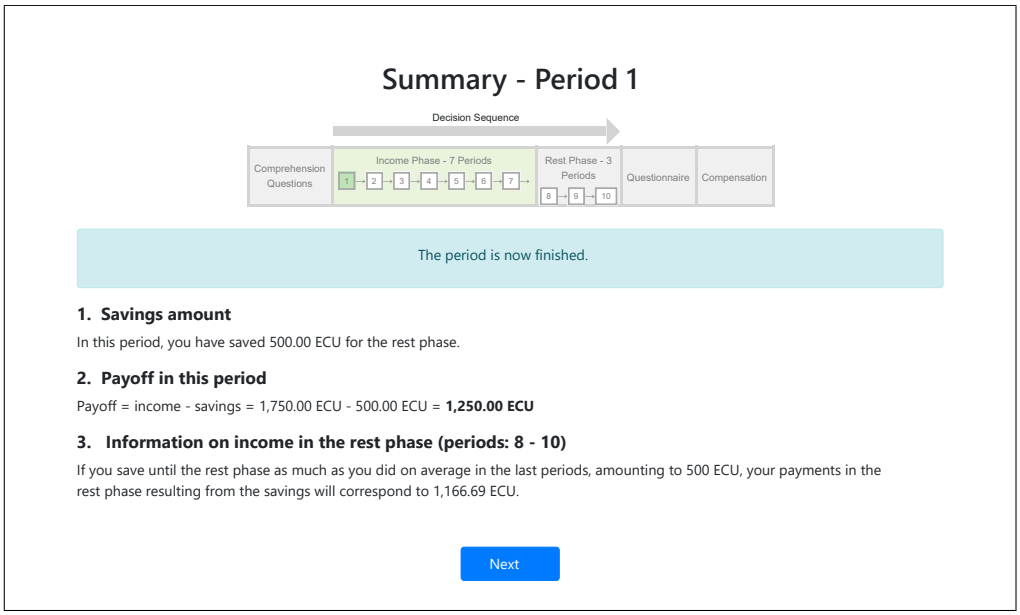


Figure 2.10: Decision Sequence: Period Summary - Tax Refund Rate = 0

Decision Sequence Summary

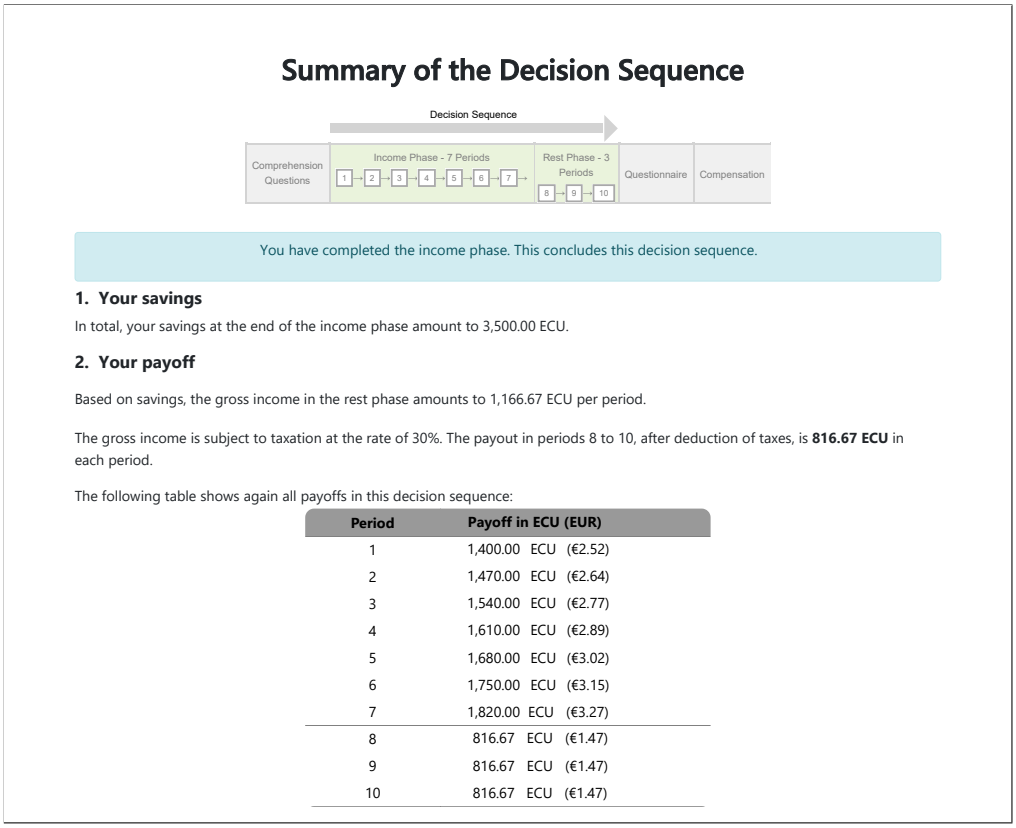


Figure 2.11: Decision Sequence Summary - Taxation Treatments

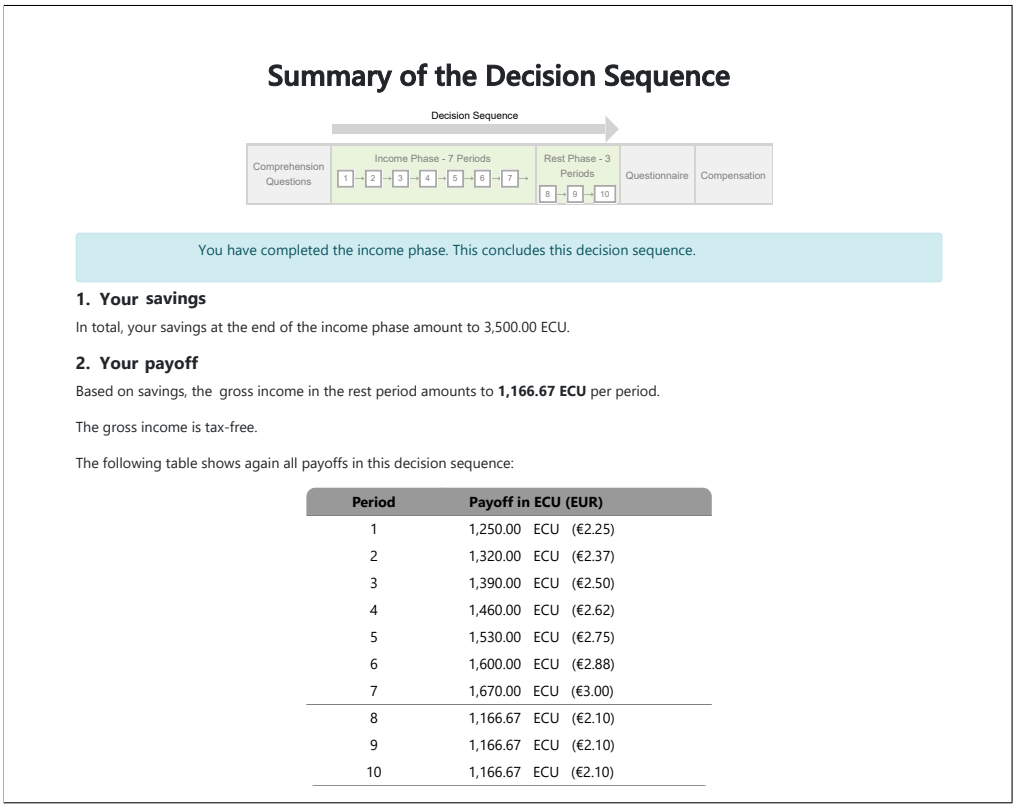


Figure 2.12: Decision Sequence: Decision Sequence Summary - Pension Tax Rate = 0

2.8.3 Questionnaire (translated from German)

Questions before the Experiment

Question 1: Are you female, male or non-binary?

☐ female
☐ male
☐ non-binary

Question 2: In which year were you born (e.g. 1962)?

☐

Question 3: How do you rate yourself personally: Are you generally a person who is willing to take risks or do you try to avoid taking risks?

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

Question 4: Did you file a tax return in the last year?

☐ Yes
☐ No

Question 5: Are you currently paying contributions in a so-called Riester or Rürup pension plan?

☐ Yes
☐ No

Questions after the life cycle

Question 1: How satisfied are you with the payoffs in the rest phase in terms of the amount of [payoff] ECU

not at all satisfied□—□—□—□—□—□—□—□—□—□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 terms of the amount of [payoff] ECU meet your expectations

not at all□—□—□—□—□—□—□—□—□—□perfect

Question 3: If you had the opportunity to change your savings decision, would you save less or more?

save less □—□—□—□—□—□—□—□—□—□save more

Question 4: This question is to check your attention. Please click here on the last answer option (= completely)

not at all □—□—□—□—□—□—□—□—□—□completely

Questionnaire at the end of the experiment

Question 1: How old are you?

Question 2: What kind of employment are you in?

- ☐ Pupil
- ☐ University student
- ☐ Employee
- ☐ Public official
- ☐ Freelancer
- ☐ Homemaker
- ☐ Unemployed/job-seeking
- ☐ No longer working (e.g. retired)

Question 3: What is your highest educational qualification?

- ☐ Secondary modern school qualification
- ☐ Secondary school certificate
- ☐ High-school diploma
- ☐ University of applied sciences degree
- ☐ University degree
- ☐ Dual university degree
- ☐ Doctorate

Question 4: What is your marital status?

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

Question 5: What is your personal monthly net income after deduction of taxes and social security?

- ☐ less than €500
- ☐ €500-1,000
- ☐ €1,000-1,500
- ☐ €1,500-2,000
- ☐ €2,000-2,500
- ☐ €2,500-3,000
- ☐ €3,000-3,500
- ☐ €3,500-4,000
- ☐ €4,000-4,500
- ☐ €4,500-5,000
- ☐ €5,000-5,500
- ☐ €5,500-6,000
- ☐ €6,000 and more

Question 6: How would you rate your own tax law knowledge?

No knowledge at all ☐—☐—☐—☐—☐—☐—☐—☐—☐—☐ Tax expert/consultant

The following question is to be answered only by participants who indicated that they filed a tax return last year.

Question 7: You have indicated that you filed a tax return last year. Did you receive a tax refund or an additional tax payment as a result?

- ☐ Tax refund
- ☐ Back tax
- ☐ Not specified

Question 8: Suppose you receive a tax refund of €1,000 after filing your next tax return. What would you use it for (several answers possible)?

- ☐ Saving for a special purpose (e.g. vacation)
- ☐ For current expenses (e.g. groceries, rent)
- ☐ Settling debts (e.g. credit)
- ☐ Saving for retirement
- ☐ Purchase of major purchases (e.g. television)

Question 9: How complicated did you find the taxation in this study?

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

Question 10: How difficult was it for you to make a savings decision?

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

Question 11: Now please imagine that you plan to be unemployed for a short and fully anticipated period of time in six months. To cover various living expenses during this period, you will need €1,200. You have two options to finance these costs. Which of the following options would you choose?

- ☐ Six monthly payments of €200 each during the six months prior to planned unemployment.
- ☐ Six monthly payments of €200 each during the six months beginning after the planned unemployment.

Question 12: How important is it to you personally to save taxes?

not at all important ☐—☐—☐—☐—☐—☐—☐—☐—☐—☐ very important

Question 13: Now please imagine that you inherit money and plan to invest it. You are offered two savings products. With the first savings product, you receive €401 every year, but at the same time you have to pay €100 in taxes annually. With the second savings product, the return is lower, €300 annually, but tax-free. Which savings product would you choose?

☐ I would invest the money in the second savings product.
☐ I would invest the money in the first savings product.

Question 14: A bat and a ball cost €22 . The bat costs €20 more than the ball. How much does the ball cost?

Question 15: If it takes 5 machines 5 minutes to make 5 widgets, how long would it take 100 machines to make 100 widgets (in minutes)?

Question 16: In a lake, there is a patch of lily pads. Every day, the patch doubles in size. If it takes 48 days for the patch to cover the entire lake, how long would it take for the patch to cover half of the lake (in days)?

Questions Risk Aversion

In this task you can earn **more money**. Below you will be presented with 20 decisions on the screen. Each of these decisions consists of a choice between ”Option A” and ”Option B”.

- **Option A:** Safe payoff amount, which increases with each decision.
- **Option B:** Two fixed payoff amounts. The probability of getting the high or the low payout amount is 50% each.

After you have made all decisions, one of the 20 decisions will be randomly selected for your payoff. If this selected decision is ”Option B”, then according to the respective probabilities it will be randomly determined whether the low or high amount will be realized for your payoff. If

it is ”Option A” you will receive the safe amount.

Option A			Option B
55 ECU certain	☐	☐	200 ECU with a probability of 50%, 50 ECU otherwise
60 ECU certain	☐	☐	200 ECU with a probability of 50%, 50 ECU otherwise
65 ECU certain	☐	☐	200 ECU with a probability of 50%, 50 ECU otherwise
70 ECU certain	☐	☐	200 ECU with a probability of 50%, 50 ECU otherwise
75 ECU certain	☐	☐	200 ECU with a probability of 50%, 50 ECU otherwise
80 ECU certain	☐	☐	200 ECU with a probability of 50%, 50 ECU otherwise
85 ECU certain	☐	☐	200 ECU with a probability of 50%, 50 ECU otherwise
90 ECU certain	☐	☐	200 ECU with a probability of 50%, 50 ECU otherwise
95 ECU certain	☐	☐	200 ECU with a probability of 50%, 50 ECU otherwise
100 ECU certain	☐	☐	200 ECU with a probability of 50%, 50 ECU otherwise
105 ECU certain	☐	☐	200 ECU with a probability of 50%, 50 ECU otherwise
110 ECU certain	☐	☐	200 ECU with a probability of 50%, 50 ECU otherwise
115 ECU certain	☐	☐	200 ECU with a probability of 50%, 50 ECU otherwise
120 ECU certain	☐	☐	200 ECU with a probability of 50%, 50 ECU otherwise
125 ECU certain	☐	☐	200 ECU with a probability of 50%, 50 ECU otherwise
130 ECU certain	☐	☐	200 ECU with a probability of 50%, 50 ECU otherwise
135 ECU certain	☐	☐	200 ECU with a probability of 50%, 50 ECU otherwise
140 ECU certain	☐	☐	200 ECU with a probability of 50%, 50 ECU otherwise
145 ECU certain	☐	☐	200 ECU with a probability of 50%, 50 ECU otherwise
150 ECU certain	☐	☐	200 ECU with a probability of 50%, 50 ECU otherwise

Questions Loss Aversion

And now for our last task: in this one you can earn **more money** again.

Below you will be presented 6 lotteries. For each of these lotteries you can decide whether you want to participate in it or not. If you participate in the lottery, a random number generator will decide whether you win or lose the lottery.

The profit or loss is then as follows:

- **Profit:** You will receive an additional payoff of 1,200.00 ECU.
- **Loss:** Your payoff will be reduced by a certain amount (see below).

The probability of winning or losing is 50% in each case. After you have made all the decisions, one of the 6 lotteries will be randomly selected. If you participated in the selected lottery, a random number generator will decide whether you win or lose the lottery.

Please decide now in which lotteries you would like to participate.

Lotteries (probability 50% / 50%)	**Participate**	**Do not participate**
Profit = 1.200 ECU / Loss = -400 ECU	☐	☐
Profit = 1.200 ECU / Loss = -600 ECU	☐	☐
Profit = 1.200 ECU / Loss = -800 ECU	☐	☐
Profit = 1.200 ECU / Loss = -1,000 ECU	☐	☐
Profit = 1.200 ECU / Loss = -1,200 ECU	☐	☐
Profit = 1.200 ECU / Loss = -1,400 ECU	☐	☐

Chapter 3

Taxes and Retirement Planning: The Savings Impact of Simultaneously Offering Roth and Traditional Retirement Accounts*

Abstract

We use experiments to examine the economic effects of offering Roth and Traditional pension accounts simultaneously. The availability of both accounts increases retirement savings, suggesting that the offer of two accounts signals a social norm encouraging higher saving. This could help reduce the retirement savings gap. However, satisfaction with consumption allocation does not improve due to decision complexity. Compared to the rational choice benchmark, individuals save either too little in Traditional accounts or too much with both accounts. In contrast, Roth account savings align with the benchmark. Moreover, many individuals prefer Roth accounts, despite being economically inferior, for their perceived simplicity.

Keywords: retirement savings · saving incentives · tax complexity · tax uncertainty · tax diversification

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3.1 Introduction

Using two preregistered experimental studies, this paper investigates the economic implications of simultaneously offering two tax-advantaged pension plans: one that imposes immediate taxation on pension contributions and another that defers taxation until retirement. In many countries, concerns have arisen regarding insufficient retirement savings, leading governments to employ tax incentives to encourage private retirement savings (OECD 2018b). Standard forms of saving are typically subject to taxation in a manner similar to other sources of income. This entails making contributions from after-tax income, taxing investment returns, and allowing tax-free withdrawals. However, to promote retirement savings, many countries deviate from this standard (OECD 2022). Numerous countries, including Belgium, Chile, Finland, Germany, Iceland, Ireland, Japan, Latvia, the Netherlands, Norway, Poland, Slovenia, Spain, Switzerland, and the United Kingdom, adopt a deferred tax system. Under this system, contributions and investment earnings are tax-free, but pensions are subject to taxation. On the other hand, countries such as Costa Rica, the Czech Republic, Hungary, Israel, Lithuania, Luxembourg, and Mexico tax retirement savings immediately. In these cases, contributions are taxed, while investment earnings and pensions remain tax-free (OECD 2022).

Unlike these countries, the United States provides both immediately taxed pension plans, referred to as Roth accounts (RA), and tax-deferred pension plans, known as Traditional accounts (TA).[1] From an investor's perspective, the advantage of deferred taxation lies in the generally lower expected tax rate on future pensions due to reduced income after retirement. However, the drawback is the uncertainty surrounding future tax rates, which can fluctuate based on individual income changes and potential tax rate adjustments. In contrast, immediate taxation eliminates tax uncertainty, as the current tax rate on savings is known. Therefore, by diversifying retirement contributions between an RA and a TA, individuals can enjoy considerable economic benefits (Brown et al. 2017). Investing in a TA may result in a lower future tax rate, while also investing in an RA provides a hedge against tax risk. Consequently, the introduction of this diversification opportunity is expected to increase individuals' utility. Nonetheless, this prediction overlooks the fact that introducing an additional pension plan with different tax implications raises cognitive decision costs. Previous research demonstrates that increased options can reduce individuals' experienced utility and have negative effects on decision-making (Chernev et al. 2015). Thus, it remains unclear whether the introduction of diversification opportunities genuinely enhances individuals' well-being.

Moreover, it is unclear how the diversification opportunity affects retirement savings. The rational choice model of lifetime consumption predicts even slightly lower retirement savings for most subjects when they diversify (see section 3.2.1 and the proof in Appendix A, in section 3.7.3). In contrast, certain behavioral economics approaches predict an increase in savings when

[1] In Canada, individuals also have the option to choose between an immediately taxed savings plan, Tax-Free Savings Account (TFSA), and a deferred taxed savings plan, Registered Retirement Savings Plan (RRSP).

individuals are presented with the choice of two tax-advantaged retirement plans simultaneously, as opposed to only one plan. Thus, the first research question we address is how the provision of two tax-advantaged pension plans (as opposed to a single plan) influences individuals' satisfaction levels and retirement savings.

If governments allow firms the flexibility to choose between offering one of the two tax options or providing both options, the question arises regarding which alternative the firm will select to attract and retain employees. Therefore, the second research question we investigate focuses on determining people's actual preferences regarding the provision of an RA, a TA, or both accounts.

To address these research questions, we conducted two incentivized online experiments involving participants recruited through the Bilendi & respondi access panel, which closely matches the demographic characteristics of the German working population in terms of age and gender.[2] While experiments involve a certain level of abstraction, they offer significant advantages in the current context. First, experiments enable us to ensure that the TA and RA differ in only their tax treatment, eliminating confounding factors such as varying income thresholds or penalty rules, as well as employer-specific regulations (e.g., automatic enrollment into TAs in some US firms, requiring employees interested in RAs to actively switch their allocation) (Iacurci 2022). Second, experiments enable us to control for participants' expectations regarding future tax rates and tax rate uncertainty. Last, by manipulating the tax treatment of RAs and TAs to create economic equivalence, we can examine nonfinancial preferences related to both plans.

In the experiments, subjects make savings decisions in a two-period life cycle. In the first period, they earn an income and decide how much to consume and how much to save for the second period. In the second period, subjects earn no exogenous income but consume their savings from the first period. The incentive to save is induced by randomly paying out only one of the periods.

In the first experiment, subjects participate in four rounds of the described life cycle. In the first round, we randomly manipulate the tax treatment of savings: savings are either in a TA or RA. In the second round, we introduce an additional tax-advantaged product such that subjects have the opportunity to diversify their savings over both products. If savings are made to an RA (TA) in the first round, a TA (RA) is additionally introduced in the second round. Comparing subjects' satisfaction with their consumption allocation and their savings between both rounds enables us to answer our first research question. The third and fourth rounds of the first experiment are identical to the second round, except that we change the tax rules for the TA, which enables us to examine subjects' savings behavior when tax diversification is no longer optimal.

In the second experiment, subjects start making their savings decision after having both a TA and an RA already in the first period. In the second round, subjects can choose whether they would like to have the opportunity to save in only the TA, only the RA, or in both accounts. Comparing

[2] We opted against utilizing a U.S. sample since both retirement plans already exist in the U.S., which could have potentially affected the results.

the first round in Experiment 2 with the second round in Experiment 1 enables us to test whether the explicit introduction of a TA or an RA affects the results. Moreover, in the second round of Experiment 2, we directly observe how attractive subjects find the provision of only the TA, only the RA, and the simultaneous provision of both plans (our second research question). The third and fourth rounds of Experiment 2 are identical to the first and second rounds, except for a manipulation in the tax treatment of the TA. The manipulation makes the tax treatment of the TA economically identical to that of the RA. This manipulation enables us to further investigate the second research question by examining nonfinancial preferences for RAs and TAs in the absence of any economic differences between the two plans.

Our findings show that providing both RAs and TAs simultaneously significantly increases retirement savings. In the experiments, effective savings increase by 9.9 percentage points (= 21.3%) when both plans are offered instead of just one. This effect increases by an additional 5.2 percentage points (= 10.0%) when the second pension plan is explicitly introduced, i.e., subjects had only one plan available before making their decision.

Contrary to rational choice predictions, we do not find that participants were more satisfied with their consumption allocation when they were offered two pension plans instead of just one. In contrast, we find that adding an additional retirement plan decreases subjects' satisfaction. Our findings indicate that this is due to the higher decision complexity when both plans are offered such that subjects have higher cognitive costs to make their savings decisions. In sum, with respect to the first research question, Experiment 1 provides causal evidence that individuals save more when both RAs and TAs are available to them than when only one plan is available, but this does not translate into higher individual satisfaction.

The positive effect on savings is in contrast to standard rational choice predictions according to which average effective savings should decline when subjects have the opportunity to diversify between both plans. Moreover, we show that the observed savings behavior cannot be explained by either the "tax neglect" hypothesis, according to which subjects always save a certain percentage of pretax income regardless of the tax treatment (Beshears et al. 2017), nor the use of a "naïve" diversification heuristic and partition dependence (Benartzi and Thaler 2001; Fox et al. 2005) nor an increase in positive emotions that has been shown in other studies to increase savings (Guven 2012). Instead, the results suggest that providing two plans instead of only one signals a social norm that more savings are appropriate.

Regarding our second research question, the results clearly indicate that, on average, individuals show a preference for RAs over TAs when given a choice. Additionally, a significant portion of participants prefer the provision of only an RA compared to having both types of accounts. One main reason for this result is the perceived difference in tax complexity. As subjects usually behave in a complexity-averse manner (e.g., Zilker et al. 2020), they favor the less complex RA, even if the TA offers a tax benefit due to a lower expected future tax rate on pensions. Moreover, more risk-averse subjects, subjects with a preference for prepayment, and subjects with less

dread about future tax payments tend to particularly favor an RA to a TA. Even without tax uncertainty and fully economically equivalent RAs and TAs, subjects prefer, on average, RAs to TAs. In this case, nonfinancial preferences such as complexity aversion and the preference for prepayment remain significant predictors of a preference for RAs. For firms that aim to attract and retain employees by offering attractive retirement plans, this shows that offering only TAs is a strategy that is dominated by offering both plans or (if allowed) only RAs. Anticipating this, governments seeking to increase the savings rate should consider rules to require firms to always offer both plans.

This study makes several contributions. First, we contribute to research on the effectiveness of tax incentives to encourage retirement savings. In a field experiment, Saez (2009) shows that offering customers of H&R Block a matching contribution instead of an equivalent tax credit increases the percentage of subjects who open an individual retirement account and the amount contributed to this account. On the basis of Danish income-tax records, Chetty et al. (2014) report that 85% of savers are unresponsive to tax subsidies and Beshears et al. (2017), on the basis of administrative company data, find that retirement savings are almost insensitive to the introduction of differently taxed plans. Moreover, their supplemental survey shows that many employees are unaware of the tax treatment being applied to their savings. Using lab experiments, Blaufus and Milde (2021) demonstrate that informing subjects about the tax rules removes this unresponsiveness but that significant tax misperceptions remain. In particular, effective savings are higher when using RAs than under (economically equivalent) TAs; moreover, government matching contributions, despite not changing the size of the financial incentive, are significantly more effective in incentivizing savings than are RAs and standard TAs. Duffy and Li (2022) present experimental evidence that providing a TA in addition to a regular savings account, where interest income is taxed, leads to higher net worth at retirement. We add to this research by demonstrating that effective savings can be significantly increased by offering both TAs and RAs simultaneously.

Moreover, to the best of our knowledge no previous study has investigated the effect of tax differences in retirement plans on subjects' satisfaction. Therefore, we complement this line of research by showing that subject satisfaction is highest when only RAs are offered, but this is the case only in a small number of countries. In addition, we contribute by examining nonfinancial preferences for RAs and TAs. We are aware of only the study of Cuccia et al. (2022) that examined preferences between RAs and TAs so far. In contrast to their study, we examine a 'real' choice between both plans and not a hypothetical one.[3] We confirm their finding of a general preference for RAs and extend their study by (i) showing that this preference is related mainly to differences in perceived tax complexity and (ii) also holds when subjects have the option to

[3]In addition to the hypothetical question about which plan subjects would contribute to, if they could only contribute to one plan, Cuccia et al. (2022) uses the proportion of total contributions allocated to the RA when both plans are offered as a measure of revealed preferences. However, this is problematic because prior studies show that subjects have severe tax misperceptions regarding TAs. For example, Blaufus and Milde (2021) show that nominal contributions are higher using TAs but that effective savings are actually lower.

choose both plans simultaneously.

Second, we contribute to research in financial economics that theoretically investigates optimal tax risk diversification (Brown et al. 2017; Lachance 2013; Dickson 2004). These studies show that tax diversification strategies in retirement savings can lead to significant welfare gains for retirement savers (Brown et al. 2017, p. 691), which is in contrast to the traditional view that TAs almost always dominate RAs due to lower marginal tax rates after retirement (e.g., Butterfield et al. 2000). On the one hand, we confirm that most subjects actually diversify between TAs and RAs, as predicted by these models. On the other hand, however, the observed diversification behavior is not so much the result of optimizing tax risk and return but rather is due to heuristic behavior and does not lead to greater satisfaction of people with their economic outcome. The reason is that the theoretical models neglect cognitive decision costs that reduce subjects' experienced utility.

Third, we contribute to research on how complexity affects individual decision making. Prior research has shown that tax complexity increases suboptimal behavior (e.g., Feldman et al. 2016; Zwick 2021) and background complexity reduces the responsiveness to new tax incentives (Abeler and Jäger 2015). Moreover, research has shown that subjects are, in general, complexity-averse. Differences in option complexity affect the choice between risky and safe options (Zilker et al. 2020) and between different savings plans (Sonsino and Mandelbaum 2001), and differences in the complexity of news titles affect how investors allocate their attention across news (Umar 2022). In addition, process simplification can increase savings (Choi et al. 2009; Tufano 2011), and simplifying the savings decision increases participation in employer-sponsored retirement saving plans (Goldin et al. 2020). We complement this research by showing that perceived differences in the complexity of RAs and TAs determine the choice between these plans and, moreover, the amount of effective contributions to these plans.

Our findings have implications for firms and policy. Currently, not all US firms offer the option to contribute to RAs.[4] Firms that decide not to provide both RAs and TAs should consider that their choice negatively affects their employees' financial well-being after retirement. Regarding tax policy, in the majority of countries in which only a TA exists, our findings suggest that this option results in the lowest effective savings compared to the provision of only RA or the provision of both plans. Introducing both tax-incentive types, as in the United States and Canada, may significantly increase retirement savings. Moreover, our results can inform policymakers in the United States who think of abolishing the choice between RAs and TAs and instead aim to "Rothify" retirement savings (Horneff et al. 2022). In contrast to rational choice predictions, our results suggest that abolishing the provision of both pension plans would reduce effective savings. More generally, our study, therefore, shows that tax policy cannot evaluate the effectiveness of tax incentives based on standard rational choice models alone, as ignoring frictions caused by

[4]However, the percentage of plans that include such an option has increased in the past decade to almost 88% (Iacurci 2022).

tax complexity may lead to incorrect conclusions.

The remainder of this paper is organized as follows. The next section describes the theoretical background and the research questions. Sections 3.3 and 3.4 describe the design and the empirical results of Experiment 1 and 2, respectively. The final section discusses conclusions and policy implications.

3.2 Theoretical Background and Research Questions

3.2.1 The Effect of Providing Two Tax-Advantaged Pension Plans on Savings and Satisfaction

To derive a rational choice benchmark of the effects of providing two tax-advantaged pension plans, we use a simple two-period life cycle in which subjects maximize the following utility function (Modigliani and Brumberg 1954):

$$U = u(C_1) + \frac{E[u(\tilde{C}_2)]}{(1+\rho)} \tag{3.1}$$

with $u'(C) > 0$, $u''(C) < 0$, C_1 denoting consumption in the first and $\tilde{C}_2$ denoting (uncertain) consumption in the second period,[5] and $1+\rho$ denoting the subject's discount rate. Without loss of generality, we assume in the following that the interest rate on retirement earnings and the subject's time preference rate ρ are both equal to zero. Consumption is then defined as follows:

$$C_1 = (Y - S_T) \cdot (1 - \tau_1) - S_R^{'} \tag{3.2}$$

$$\tilde{C}_2 = S_R^{'} + S_T \cdot (1 - \tilde{\tau_2}), \tag{3.3}$$

with Y denoting pretax income, τ_1 the tax rate in period 1, $\tilde{\tau_2}$ the uncertain future tax rate in period 2, S_T the contributions to the TA and $S_R^{'}$ the contributions to the RA. The difference between pension plans is that contributions to the TA are tax deductible while those to the RA are not. Moreover, pensions are subject to the uncertain tax rate $\tilde{\tau_2}$ when they are withdrawn from the TA but are tax-free when withdrawn from the RA. To simplify comparisons between pension plans, we define $S_R = \frac{S_R^{'}}{1-\tau_1}$ as pretax savings for RAs. Inserting in the above equations leads to

$$C_1 = (Y - S_R - S_T) \cdot (1 - \tau_1), \tag{3.4}$$

$$\tilde{C}_2 = (1 - \tau_1) \cdot S_R + S_T \cdot (1 - \tilde{\tau_2}). \tag{3.5}$$

Differentiation of (3.1) with respect to S_T and S_R using the constraints (3.4) and (3.5) results in

[5] We denote random variables using a tilde.

the following first-order condition:

$$E\big[u^{'}(\tilde{C_2}) \cdot (\tau_1 - \tilde{\tau_2})\big] = 0. \tag{3.6}$$

Because $u^{'}(\tilde{C_2}) > 0$ and $u^{''}(\tilde{C_2}) < 0$, equation 3.6 shows that diversification can be optimal only when $E[\tilde{\tau_2}] < \tau_1$. Moreover, subjects must be sufficiently risk-averse to ensure that diversification is optimal. In our experimental setting, this is the case when the constant relative risk aversion (RRA) is greater than 0.5 (see Online Appendix A), which holds for 90.0% of all participants. Under these conditions, providing both TAs and RAs simultaneously increases subjects' utility and should thus improve subjects' satisfaction with their consumption allocation.

However, the rational choice prediction neglects cognitive decision costs that may increase when two, instead of only one, pension plans are provided. There is evidence that more options may actually reduce subjects' experienced utility due to the higher complexity resulting in choice overload (Chernev et al. 2015). Thus, the overall effect on subjects' satisfaction is theoretically unclear.

In general, the rational choice prediction regarding the effect of the diversification opportunity on total retirement savings $S = S_R + S_T$ is ambiguous. If subjects have a constant RRA r greater (smaller) than one, total retirement savings decrease (increase). The proof is provided in online Appendix A, in section 3.7.3. The intuition is as follows: Compared to investing in only an RA, the advantage of the TA is that it offers a lower expected tax rate on pension income. If $r > 1$, the income effect dominates the substitution effect. Thus, expected pension income increases c.p., which discourages retirement savings. In addition, compared to only investing in a TA, the advantage of also investing in an RA is that it reduces tax risk. If $r > 1$, reducing risk of future consumption discourages savings. As prior research shows that subjects mostly have a RRA exceeding one (e.g., Szpiro and Outreville 1988), providing both tax-advantaged plans may have a detrimental effect on retirement savings.[6]

By contrast, several approaches from behavioral economics predict the opposite result. First, according to the "tax neglect" hypothesis of Beshears et al. (2017), subjects neglect the tax treatment when making their savings decision and instead follow a simple heuristic, such as always saving a specific percentage of pretax income. If one adds an RA to a TA, savings would increase if subjects do not respond to taxes because the same nominal contribution to an RA results in higher effective savings due to the missing tax deductibility of contributions. This is exactly what Beshears et al. (2017) observe in their analysis of firms that introduced RAs.[7] Thus,

[6] In our study, we assessed the participants' RRA using an incentive-based approach. Overall, 87% of participants have an RRA greater than one.

[7] Even if subjects are informed about the tax rules, tax misperceptions may remain. Blaufus and Milde (2021) show that subjects do not consider the deferred tax correctly and thus save less in TAs than in RAs. They argue that this might be due to a confirmation bias similar to what has been observed in the consumption context (Feldman and Ruffle 2015; Feldman et al. 2018), i.e., subjects underweight information that contradicts their savings intentions or a complexity-induced neglect of the future tax burden. In the current experimental design, we exclude such tax misperception, as we explicitly display after-tax payoffs.

the tax neglect hypothesis of Beshears et al. (2017) predicts an asymmetric effect of introducing an additional tax-advantaged savings plan. Adding an RA to a TA would increase effective savings, while adding a TA to an RA would reduce savings.

On the contrary, the following approaches predict a symmetric effect on savings. First, prior research shows that subjects tend to use a "naïve" diversification strategy, i.e., they tend to split their investment evenly over different alternatives using a "1/n heuristic" (Benartzi and Thaler 2001). If subjects naïvely diversify between current consumption and savings into only one pension plan, they would contribute 50% of their money to the plan. However, if subjects split their money over current consumption, an RA and a TA, they will spend 33% on each of the options such that retirement contributions increase up to 67%. Simply due to the increasing number of options retirement savings would increase – an effect that is called partition dependence (Fox et al. 2005; Beshears et al. 2017).

Second, having the choice between both plans could make people happier. Having a choice between immediate and deferred taxed plans enables subjects to maximize their utility by diversification. More generally, having more options offers option value (Reibstein et al. 1975), creates the perception of freedom of choice (Kahn et al. 1987), and supports consumers' variety-seeking behavior (e.g., Ratner et al. 1999). Thus, as long as the additional complexity does not lead to choice overload, it appears reasonable to assume that the diversification opportunity increases happiness. An increase in happiness, however, has been shown to also increase savings (Guven 2012). Thus, happiness may mediate the positive effect of providing both tax incentives on savings.

Third, simply providing more savings opportunities can signal a norm that more savings is appropriate. In the context of consumption, prior research provides evidence for a corresponding norm (Kahn and Wansink 2004). Rats ate 72% more when food with four different odors was provided than when food with one odor was offered, and cats also ate more in a setting with more variety (Rolls et al. 1981; LeMagnen 1956). Humans, when having the choice between three types of yogurt (differing in flavor, color and texture), ate more than when just one type of yogurt was offered (Rolls et al. 1981). Moreover, differences in *perceived* variety also increase consumption. If people are given an assortment of 300 M&M candies with either seven or ten different colors, those who had been given ten colors ate 43% more, although the taste of each color was identical (Kahn and Wansink 2004). Moreover, with respect to charitable giving, Weisz and Cikara (2020) show that increasing the number of options increases charitable donation. Similar to these results, we expect that an additional savings option signals to people an increasing importance of saving and appeals to the norm that more saving is appropriate.

In sum, there are arguments both for and against increasing satisfaction with additional tax-advantaged retirement savings, and there are arguments both for increasing and for decreasing savings. Thus, we formulate our first research question as follows:

RQ 1 *How does providing two tax-advantaged pension plans (a TA and an RA) affect subjects' satisfaction and retirement savings?*

3.2.2 Preferences for Providing Both Accounts, Providing only RAs, or only TAs

In the United States, where both RAs and TAs are available, a recent survey on employer-sponsored pension plans of 557 organizations shows that almost 28% of workers participating in 401(k) plans made contributions to an RA in 2021, while 80% of participants made contributions to a TA (Iacurci 2022). This suggests a preference for TAs. However, this conclusion may be misleading. First, RAs were not available before the year 2006 and employers only slowly introduced the additional RAs. In 2011, only 49% of 401(k) plans offered such an option (Beshears et al. 2017). Thus, subjects may simply get used to saving in TAs and need time to adapt their savings. Second, prior research shows that subjects misperceive the tax burden of TAs (Blaufus and Milde 2021). Thus, observed savings may not reveal true preferences.

For firms that aim to retain and attract employees, knowledge about subjects' preferences regarding pension plans is important. However, to our knowledge, only Cuccia et al. (2022) has examined preferences between RAs and TAs thus far. They find, on the basis of experiments, a systematic preference for an RA, even if it is economically dominated by a TA. Moreover, they show that preferences for RAs are positively associated with a preference for prepaying for consumption and feelings of dread over looming liabilities. Their result of a preference for RAs is in contrast to the empirical observation that most employees in the Unites States use TAs. Moreover, their experimental subjects were always offered both plans, and they were then asked to rate on a Likert scale to which plan they would contribute, if they could only contribute to one. The answer to this question does, however, not affect subjects' experimental payoff. We, therefore, aim to replicate their findings by examining a 'real' choice between both plans and not a hypothetical one. Furthermore, we examine additional determinants of subjects' preferences such as tax complexity and also investigate the preference for offering both plans as only this approach enables tax diversification benefits. Thus, the second research question we address considers what people actually prefer: RAs, TAs, or both plans.

RQ 2 *Do subjects prefer the provision of only Roth accounts, only Traditional accounts or both accounts at the same time?*

3.3 Experiment 1: Additional Savings Opportunity

3.3.1 Method, Data, and Procedure

To investigate our first research question, we conducted an online experiment with 200 participants.[8] Since our model predictions apply to only risk-averse individuals, we excluded a total of 7 individuals who are either risk-neutral or risk-taking from our analyses.[9] Consequently, the final sample for our analyses consists of 193 participants. In this experiment, participants participated in a total of four independent rounds. Each round required participants to make decisions regarding their savings allocation in the first period of a two-period life cycle, with the savings intended for the second period. We employed a within-subjects design, introducing a second savings plan to participants from the second round onwards. Our participant sample was recruited through Bilendi & respondi, a panel provider certified in accordance with ISO 20252 international standards. The sample was selected to represent the German working population in terms of age and gender, aiming for a representative distribution (Federal Statistical Office 2021). The experiment was implemented using the oTree software (Chen et al. 2016). To ensure a comprehensive understanding of the experiment, we have included translated versions of the instructions, the questionnaire, and screenshots in online Appendices B to D.

At the beginning of the experiment, participants were asked to complete a short questionnaire that gathered basic demographic information, including age, gender, and any prior experience they had with TAs. Following this questionnaire, participants received comprehensive instructions detailing the experimental procedure and the specific tax regulations associated with the savings accounts. To ensure that participants fully understood the experiment, a brief training round was conducted, allowing them to familiarize themselves with the decision-making process and the overall structure of the experiment. Subsequently, participants were required to complete a comprehension test. This test assessed their understanding of various aspects, including the savings decision process, the overall experimental procedure, and the tax rules.

During the experiment, participants engaged in four rounds, each characterized by a life cycle income process. Within each round, participants received an income of 100,000 ECU (experimental currency unit) in an income period, followed by a pension period devoid of any external

[8] In the preregistration, we started with 150 subjects. Despite randomization, there was a significant difference in gender between the two experiments. We therefore ran the experiment with an additional 50 subjects in each experiment. However, this did not change the results qualitatively.

[9] For risk-averse participants, the optimal strategy is to smooth their consumption over both periods. In contrast, risk-neutral participants will choose to save their entire income if the expected pension tax rate is less than the tax rate at which savings are tax deductible, while they will save nothing if the expected pension tax rate is higher. Risk-loving participants may gamble by concentrating consumption in just one period (Bachmann et al. 2023). To identify risk-neutral, risk-loving, or risk-averse participants, we employed an incentivized short lottery task to measure their RRA (see section 3.3.2). Consequently, participants with an RRA less than or equal to zero were excluded from the analyses. However, upon conducting the analyses, we included all participants and found that there were no qualitative differences in the results. This suggests that the exclusion of risk-neutral or risk-loving participants did not significantly impact the overall findings or conclusions of the study.

income.[10] The income acquired during the income period was subject to a 40% tax. In each round of the experiment, participants were tasked with deciding how much of their after-tax income they wanted to save for the subsequent period. In the second period, participants did not receive any external income but instead received their savings from the first period. Contributions to savings were taxed differently depending on the chosen savings account.

In the experiment, participants were presented with two distinct savings accounts, each subject to different tax regulations. The TAs involved savings contributions that were taxed on a deferred basis. This meant that the savings contributions reduced the taxable income in the first period, with a fixed tax rate of 40%. However, the resulting pension income in the second period was fully taxable. The specific pension tax rate varied from round to round, and in some rounds, it was uncertain, with an equal probability of being either high or low. The actual pension tax rate for each round was determined randomly at the end of the experiment. The RAs operated differently: savings contributions made to RAs were taxed immediately at a fixed tax rate of 40%. These contributions were not tax-deductible in the first period, which meant that they were tax-free in the second period.

In the first round, participants were randomly assigned either an RA or a TA. In subsequent rounds, a second savings plan was introduced. The placement of the savings accounts on the screen (left or right) was randomized to avoid any bias in participants' decisions. Prior to proceeding to the second round, participants received instructions regarding the newly introduced savings plan and completed a comprehension test to ensure their understanding of the task. For a summary of the tax rules and tax rates associated with both savings accounts, please refer to Table 3.1.

To facilitate the savings decision-making process, participants were provided with a slider tool. This tool allowed them to adjust their savings amount for the second period. By moving the slider (the slider ranges from zero to pretax income), participants could visually observe the impact of their savings decision on their payoffs (consumption) and tax payments for both rounds. A live graphical illustration was displayed to provide participants with real-time feedback on how their choices affected their consumption (after-tax payoffs) in both periods. By making the after-tax payoffs for all periods very salient, we ensured that tax misperceptions, as observed in Blaufus and Milde (2021), did not affect our results. For a detailed illustration of the graphical representation and the slider tool used in the experiment, please refer to Figures 1 to 3 in online Appendix D. We implemented additional elements in the design to achieve the highest possible validity and reliability: (1) At the beginning of the experiment, participants received detailed instructions about the experimental procedure and the tax rules (see online Appendix B). These instructions were written in neutral language. In this way, we prevented the subjects from using individual scripts when interpreting the loaded terms. For example, we did not use the

[10] To maintain simplicity in the experiment, we did not incorporate interest rates, as they would not inherently impact saving and allocation behavior between the two distinctively taxed savings accounts.

Table 3.1: Overview Savings Accounts and Taxation Rules

Round	No. Savings Accounts	Savings Account	Taxation Treatment of	
			Savings (Period 1)	Pensions (Period 2)
1	1	RA	taxable ($\tau_1 = 40\%$)	tax-free
		TA	tax-deductible ($\tau_1 = 40\%$)	taxable ($\tau_2 = 10\%/60\%$; $E(\widetilde{\tau_2}) = 35\%$)
2	2	RA	taxable ($\tau_1 = 40\%$)	tax-free
		TA	tax-deductible ($\tau_1 = 40\%$)	taxable ($\tau_2 = 10\%/60\%$; $E(\widetilde{\tau_2}) = 35\%$)
3	2	RA	taxable ($\tau_1 = 40\%$)	tax-free
		TA	tax-deductible ($\tau_1 = 40\%$)	taxable ($\tau_2 = 20\%/60\%$; $E(\widetilde{\tau_2}) = 40\%$)
4	2	RA	taxable ($\tau_1 = 40\%$)	tax-free
		TA	tax-deductible ($\tau_1 = 40\%$)	taxable ($\tau_2 = 35\%$)

Notes: This table gives an overview of the first experiment. Depending on the round, either a traditional account (TA) and/or a Roth account (RA) is offered. The last two columns show the corresponding taxation of the savings contributions. τ_1 denotes the tax rate on income in period 1 and τ_2 is the pension tax rate in period 2. We denote random variables with a tilde.

terms retirement, pension contributions, Traditional or Roth accounts, but rather terms such as period, savings, savings plan, deferred and immediate taxation, savings decision, and payoff. (2) Participants had to complete a training round without taxes to ensure that they understood the technique of the slider and the interpretation of the graphical visualization. (3) Participants had to complete two comprehension tests (one before the first round and one before the second round). (4) We included some attention checks during the experiment. Participants were allowed to participate in the experiment only if they answered all comprehension questions correctly and passed all attention checks.[11]

At the end of the experiment, only one of the eight periods (consisting of 4 rounds, with each round comprising 2 periods) is taken into account for determining the participants' payoff. This design choice offers several advantages. First, it induces an incentive to save without the need to induce specific utility functions. This process simplifies the decision task for participants, making it easier for them to understand the experiment. Second, it ensures that the assumption of an additively separable utility function in our life-cycle model is met (as stated in equation (3.11) in online Appendix A, in section 3.7.1). As a result, participants aim to maximize their

[11] 703 participants (55.18%) failed one of the two comprehension tests and 60 participants (4.71%) failed the attention checks. These participants were not allowed to take part in the experiment. Another 111 participants (8.71%) did not complete the experiment for other reasons. The completion rate observed in our experiment is consistent with the completion rates commonly observed in other life cycle experiments (e.g., Bachmann et al. 2023).

experimental wealth in a specific round i by selecting a savings contribution that maximizes their following (expected) utility function:

$$E[U_i] = \frac{1}{8}u(C_{i1}) + \frac{1}{8}E[u(\tilde{C_{i2}})], \tag{3.7}$$

with C_{it} denoting the consumption in round i in period t.

In addition to a fixed payoff of €2.00, participants received a variable payoff that consisted of two components. The first component was based on participants' savings behavior over the life cycles, which determined their earnings. The second component was derived from their responses to post-experimental questions related to loss aversion and risk-taking, as described in section 3.3.2. On average, participants earned €4.91 (SD €1.52), with a minimum of €2.00 and a maximum of €9.47. The median time taken to complete the experiment was 33 minutes, resulting in a median hourly wage of €8.93. At the end of the experiment, participants were asked to complete a questionnaire.

To address our research question, we employed both bivariate and multivariate analyses. To compare means across different rounds within the same participants (within-subject design), we utilized paired t-tests. To control for various sociodemographic variables, we ran random effects regressions with robust standard errors and clustered on participant ID.[12]

3.3.2 Variable Measurement

Dependent Variables

As the dependent variables, we use subjects' satisfaction with their final consumption allocation (outcome satisfaction) and the (effective) savings rate. To determine the outcome satisfaction, we asked subjects after each round how satisfied they were with the payoffs, separately for both periods, on a scale of 1 ("very dissatisfied") to 9 ("very satisfied"). The variable *Outcome Satisfaction* measures the average satisfaction of both periods.

To analyze the amount of savings deposited in a savings account, we used the savings rate as the dependent variable. The *Savings Rate* is defined as the total amount saved in the TA (S_{TA}) and RA ($S^{'}_{RA}$) in period 1 divided by the participants' pretax income Y in period 1:

$$\textit{Savings Rate} = \frac{S_{TA} + S^{'}_{RA}}{Y}. \tag{3.8}$$

To examine effective savings, we use the *Effective Savings Rate* to account for the fact that

[12] To complement the random-effects models, we also performed fixed-effects regression analyses. Regardless of this alternative methodology, the qualitative consistency of our results was maintained.

savings contributions are not tax deductible in the case of an RA:

$$\textit{Effective Savings Rate} = \frac{S_{TA} + S_{RA}}{Y}, \tag{3.9}$$

with $S_{RA} = \frac{S'_{RA}}{(1-\tau_1)}$ and τ_1 denoting the tax rate on income in period 1.

Independent and Control Variables

As an independent variable, we use *Two Plans*, a dummy variable that equals one if the participant was offered two savings plans (rounds 2, 3, and 4).

As part of our analysis, we investigate the impact of prior experience with a specific savings account (TA or RA) on saving behavior when both accounts are offered in the second round. To assess this influence, we introduce the variable *New RA P2*, which takes a value of one if the subject was offered an additional RA in the second round (after having only a TA in the first round), and zero otherwise. To assess participants' sensitivity to an expanding range of investment products and its impact on savings behavior, participants were asked to rate their propensity to invest more on a 9-point Likert scale when presented with a wider variety of investment options. A higher value on this scale indicates a higher sensitivity to increased choices. We created a binary variable called *Variety Sensitive*, which is set to one if the sensitivity measure is above the median, and zero otherwise. To explore the influence of emotions on savings behavior, we asked participants to rate their feelings on a scale from 1 to 9 after each period, specifically focusing on how they felt when making the savings decision. We use principal component analysis (PCA) to summarize the responses of five emotions (contentment, goodness, anger, happiness, and overwhelm) into one factor. All responses load onto one component (rotated component loadings: (1) 0.9021, (2) 0.9177, (3) -0.7426, (4) 0.6608, and (5) -0.7455), and the generated component scores represent our *Positive Emotions* variable. Cronbach's α is 0.85.

In addition, we investigate the influence of decision complexity and tax complexity on outcome satisfaction. For this purpose, participants were asked after each round how difficult it was for them to make a savings decision (*Decision Complexity)* and how complicated they perceived the taxation of the savings plan to be (*Tax Complexity)* on a scale from 1 ("very simple") to 9 ("very complicated"). If the participant was offered two savings plans, the *Tax Complexity* variable measures the mean of both responses.

As control variables in multivariate analyses, we consider different sociodemographic variables such as gender (*Male*), age (*Age*), education (*University Degree*), tax knowledge (*Tax Knowledge*), marital status (*Married*), net income (*Income*), cognitive ability (*Cognitive Ability*), financial literacy (*Financial Literacy*), experience with retirement savings plans (*Pension Savings Experience*), risk attitude *Low Risk Aversion*, and loss aversion (*Low Loss Aversion*). *Male* (*Mar-*

ried) is a dummy variable equal to one if the participant is male (married). *Age* is a categorical variable consisting with three levels: 20-34 years, 35-49 years, 50 years or older. *University Degree* is another dummy variable that equals one if a participant has at least a university degree. Regarding individual tax knowledge, participants rate their personal tax knowledge on a scale from 1 (”no knowledge at all”) to 9 (”tax expert/professional”). *Tax Knowledge* is a dummy variable equal to one if the participant rates his/her knowledge as at least a three (median split). The categorical variable *Income* measures individual net income after taxes and social security contributions with the following three categories: less than €2,000, €2,001-4,000, and €4,001 or more. We measured participants' cognitive ability using the three-item Cognitive Reflection Test of Frederick (2005) as a simple measure of participants' cognitive ability. The dummy variable *Cognitive Ability* equals one for participants who scored 3 out of 3, indicating high cognitive ability. We also control for financial literacy, as it has a significant impact on savings behavior (Lusardi and Mitchell 2014). To measure financial literacy, we use the three questions from Lusardi and Mitchell (2008, 2011). *Financial Literacy* is a binary variable that equals one if all three questions were answered correctly and zero otherwise. In addition, we asked participants about their experience with pension plans. *Pension Savings Experience* is a dummy variable that equals one if the participant either contributes to a company pension plan or privately contributes to a German tax-subsidized pension plan (so-called Riester or Rürup pension plan).[13]

In the analyses with the *Savings Rate* as the dependent variable, we include additional control variables to account for the influence of risk attitude and loss aversion on savings behavior. The risk attitude variable captures individuals' preferences for risk and is included because the amount of savings contributions can be affected by the level of risk aversion, particularly in the presence of uncertain pension tax rates among TAs. The loss aversion variable, on the other hand, accounts for individual differences in the perception of taxes as losses, as the amount of tax differs across savings plans. We employed an incentivized short lottery task to measure participants' RRA. Participants were presented with 22 decision scenarios in which they had to choose between a certain payoff and a fixed lottery option. The certain payoff amount started at 3,100 ECU and increased by 100 ECU for each subsequent decision, culminating in a final value of 5,200 ECU. The fixed lottery offered a 50% chance of receiving 3,000 ECU, with a 50% chance of receiving 7,000 ECU instead (see section 3.9.5). At the end of the experiment, one decision from the 22 choices was randomly selected, and the corresponding payoff from that task was used to calculate the participant's outcome. This approach is a modified and simplified version of the experimental design employed by Holt and Laury (2002). By assuming a utility function with constant RRA, we were able to compute the RRA for each participant. We created the variable *Low Risk Aversion*, which takes a value of one if the participants' RRA is less than 2.5 (median split) and zero otherwise.[14] We measure participants' loss aversion using an

[13] In Germany, there are no RAs; the Riester and Rürup pension plans correspond to a TA.

[14] Since the risk attitude of risk-averse individuals does not affect savings contributions in RAs, we also computed the analyses without the variable *Low Risk Aversion*. Moreover, in our experiment, risk-averse individuals with an RRA greater than one (less than one) should slightly decrease (increase) their effective savings when offered

incentivized lottery choice task (Gächter et al. 2022). Participants are presented with a series of lottery choices, where they have to decide whether to accept (i.e., play) or reject (receive nothing) the lottery. The lotteries involve potential gains and losses of varying amounts (see section 3.9.6). The dummy variable *Low Loss Aversion* takes a value of one if the participant's level of loss aversion is smaller than the median of all the observations. Descriptive statistics for the average sociodemographic characteristics of the participants are presented in the first two columns of Table 3.2.

Table 3.2: Descriptive Statistics

	Experiment 1		**Experiment 2**		**All**	
Variables	Mean	SD	Mean	SD	Mean	SD
Independent variables						
Positive Emotions	0,24	1,65	-0,30	1,62	-0,03	1,66
Variety Sensitive	0,53	0,50	0,43	0,50	0,48	0,50
Tax Aversion	0,40	0,49	0,41	0,49	0,41	0,49
Preference For Prepayment	0,83	0,37	0,85	0,35	0,84	0,36
Temp Frame Def	0,32	0,47	0,36	0,48	0,34	0,47
Low Dread	0,25	0,54	0,35	0,56	0,30	0,55
Control variables						
Male	0,53	0,50	0,51	0,50	0,52	0,50
Age 20-34	0,29	0,46	0,30	0,46	0,29	0,46
Age 35-49	0,35	0,48	0,31	0,47	0,33	0,47
Age 50+	0,36	0,48	0,39	0,49	0,37	0,48
University Degree	0,53	0,50	0,53	0,50	0,53	0,50
Tax Knowledge	0,70	0,46	0,63	0,48	0,67	0,47
Married	0,40	0,49	0,45	0,50	0,42	0,49
Income $<$ €2,001	0,43	0,50	0,37	0,48	0,40	0,49
Income €2,001-4,000	0,46	0,50	0,50	0,50	0,48	0,50
Income $>$ €4,000	0,11	0,31	0,13	0,34	0,12	0,33
Cognitive Ability	0,34	0,47	0,40	0,49	0,37	0,48
Financial Literacy	0,84	0,36	0,82	0,38	0,83	0,37
Pension Savings Experience	0,50	0,50	0,52	0,50	0,51	0,50
Low Risk Aversion	0,34	0,47	0,34	0,48	0,34	0,47
Low Loss Aversion	0,69	0,46	0,72	0,45	0,7	0,46
Observations	193		191		384	

Notes: This table presents descriptive statistics for the variables of interest, including means and standard deviations. For a detailed description of each variable, including their definitions and measurement methods, please refer to section 3.3.2.

3.3.3 Empirical Results

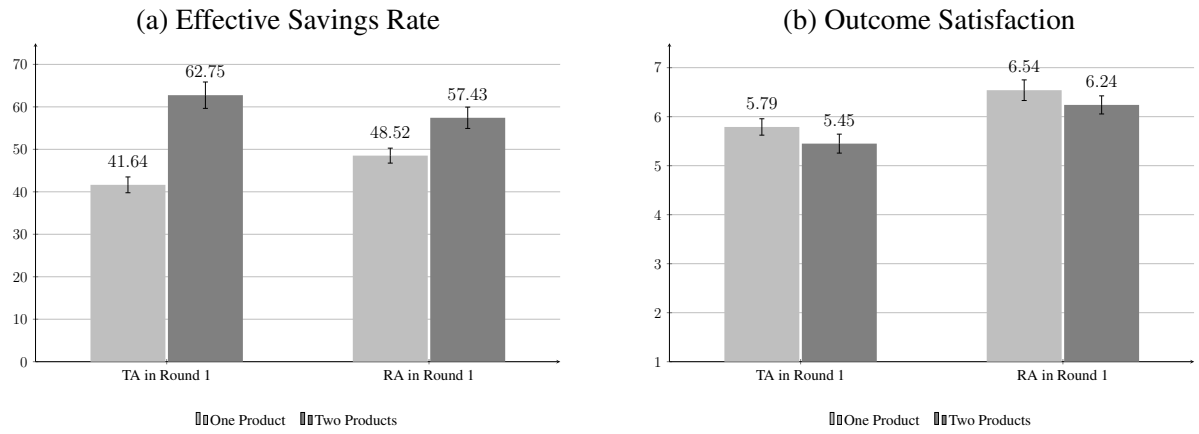
The Effect on Savings

According to our first research question, we aim to investigate how the provision of two tax-advantaged pension plans (as opposed to a single plan) affects individuals' satisfaction levels and retirement savings. We begin by analyzing the effect on savings.

an additional savings plan (see section 3.7.3). Therefore, we also ran the analyses with a variable that is one if the RRA is greater than one and zero otherwise. In both cases, the results remain qualitatively unchanged.

Figure 3.1a shows that providing RAs and TAs simultaneously increases retirement savings. Effective savings increase by an average of 31.7% when both plans are offered instead of just one ($p < 0.001$). The random effects regression (Model 1 in Table 3.3) confirms this result, as the relationship between the introduction of an additional savings account and the effective savings rate is positively significant.

Figure 3.1: Results Research Question 1



Notes: The graph presents the mean values of (a) the effective savings rate and (b) the outcome satisfaction based on the savings account offered to participants in the first round. In the second round, a second savings account was introduced accordingly. The error bars represent the 95% confidence intervals.

Moving forward, we will examine the extent to which the observed savings rates align with the theoretical predictions of the rational choice model. Specifically, we will compare the optimal savings rates, determined using the RRA measure (see section 3.3.2), with the actual effective savings rates observed in the experiment. When only one savings account is offered (Round 1), the optimal savings rate for participants with an RA does not differ from the actual savings rate, on average ($p = 0.420$). However, the actual savings rate for participants with a TA is 12.4 percentage points below the optimal savings rate ($p < 0.001$).[15] However, when an additional savings account is offered, the situation is quite different: in this case, the actual savings rate is significantly higher than the optimal savings rate ($p < 0.001$). Looking at the optimal savings rates separately for each savings account, they should be 11.1% in the TA and 39.3% in the RA. In the case of RAs, the optimal savings rate is not significantly different from the actual savings rate ($p = 0.282$), while the actual savings rate for TAs is 22.9%, which is significantly higher than the optimal savings rate ($p < 0.001$). As a result, the higher savings rate for two savings products can be explained by suboptimal 'oversaving' in TAs. Next, we will use approaches from behavioral economics to explain our main finding.

(1) We observe that participants do not typically adopt a "naive" diversification strategy, employ-

[15] Given that our experimental design effectively mitigated tax biases, such as confirmation bias, by utilizing after-tax value visualization, the observed savings gap between TAs and RAs must be attributed to other factors. In section 3.5.1, we delve further into this aspect, aiming to gain a more comprehensive understanding of the underlying factors contributing to this disparity.

Table 3.3: Random-Effects Regression Results: Savings Rate

	Savings Rate				
	(1) Effective	(2) Nominal	(3) Effective	(4) Effective	(5) Effective
Two Plans	0.151***	0.0977***	0.0891***	0.154***	0.102***
	(0.0167)	(0.0139)	(0.0192)	(0.0166)	(0.0254)
New RA P2			-0.0746***		
			(0.0288)		
Two Plans x New RA P2			0.122***		
			(0.0321)		
Positive Emotions				0.00545	
				(0.00786)	
Variety Sensitive					-0.0279
					(0.0299)
Two Plans x Variety Sensitive					0.0919***
					(0.0331)
Male	0.0467**	0.0556**	0.0548**	0.0560**	
	(0.0266)	(0.0226)	(0.0266)	(0.0272)	(0.0267)
Age 35-49	0.0117	-0.0149	0.0109	0.0140	0.0163
	(0.0328)	(0.0293)	(0.0328)	(0.0329)	(0.0335)
Age 50+	-0.0547	-0.0528*	-0.0554	-0.0540	-0.0500
	(0.0369)	(0.0303)	(0.0368)	(0.0368)	(0.0372)
University Degree	0.0522*	0.0286	0.0516*	0.0507*	0.0526*
	(0.0282)	(0.0237)	(0.0284)	(0.0286)	(0.0282)
Tax Knowledge	-0.0243	-0.0237	-0.0251	-0.0281	-0.0257
	(0.0283)	(0.0248)	(0.0281)	(0.0280)	(0.0285)
Married	0.0761***	0.0639**	0.0754***	0.0733**	0.0759***
	(0.0286)	(0.0260)	(0.0288)	(0.0294)	(0.0285)
Income €2,001-4,000	-0.0390	-0.0250	-0.0392	-0.0384	-0.0409
	(0.0320)	(0.0269)	(0.0322)	(0.0322)	(0.0321)
Income €4,000+	-0.0668	-0.0501	-0.0675	-0.0643	-0.0694
	(0.0467)	(0.0435)	(0.0470)	(0.0466)	(0.0460)
Cognitive Ability	-0.0343	-0.0250	-0.0346	-0.0345	-0.0337
	(0.0258)	(0.0218)	(0.0258)	(0.0259)	(0.0258)
Financial Literacy	0.0183	0.00385	0.0167	0.0159	0.0167
	(0.0429)	(0.0376)	(0.0431)	(0.0426)	(0.0432)
Pension Savings Experience	0.0320	0.0531**	0.0355	0.0333	0.0310
	(0.0278)	(0.0239)	(0.0281)	(0.0282)	(0.0277)
Low Risk Aversion	-0.00646	-0.0151	-0.00612	-0.00558	-0.00628
	(0.0286)	(0.0246)	(0.0288)	(0.0289)	(0.0287)
Low Loss Aversion	-0.0210	-0.0181	-0.0215	-0.0214	-0.0231
	(0.0282)	(0.0260)	(0.0284)	(0.0281)	(0.0285)
Constant	0.416***	0.343***	0.456***	0.420***	0.433***
	(0.0579)	(0.0497)	(0.0605)	(0.0581)	(0.0582)
Observations	386	386	386	386	386
Number of ID	193	193	193	193	193
Adjusted R^2	0.158	0.121	0.173	0.156	0.165
Chi^2	109.57***	78.70***	122.03***	112.00***	131.40***

Notes: This table presents the results of random-effects models and includes observations from the first two rounds. In Model 2, the dependent variable is the (nominal) *Savings Rate*, while in all other models, it is the *Effective Savings Rate*. The independent variable *Two Plans* indicates whether one or two savings plans are offered. The variables *New RA P2*, *Positive Emotions*, *Variety Sensitive*, as well as the control variables are described in section 3.3.2. The standard errors are clustered at the level of the subjects and reported in parentheses. *, **, and *** indicate significance at the .10, .05, and .01 level, respectively.

ing a "1/n heuristic" (Benartzi and Thaler 2001) to evenly distribute their disposable income across alternatives. While there are only two alternatives available in round 1 (current consumption and one savings account), there are a total of three alternatives when two savings accounts are offered. However, we find that merely 1.0% of participants allocate their after-tax income equally among all three alternatives.[16]

(2) We proceed to investigate the tax neglect hypothesis proposed by Beshears et al. (2017). This hypothesis suggests that the introduction of an RA alongside a TA would lead to a greater increase in savings compared to introducing a TA alongside an RA. However, our findings contradict this hypothesis. While adding an RA does result in a significant increase in savings compared to adding a TA (as indicated by the interaction term in Model 3 in Table 3.3), a significant increase in savings is also observed when adding a TA (as indicated by the main effect of *Two Products* in Model 3). Additionally, participants did not consistently save the same percentage of their pretax income across different tax treatments, as there is a significant increase in nominal savings when both savings accounts are offered (Model 2). Furthermore, only a small percentage of participants (4.2%) maintained a fixed savings pattern throughout all four rounds, indicating a deviation from constant savings behavior.[17]

(3) Furthermore, our findings indicate that the observed behavior cannot be explained by emotional factors. The coefficient controlled for emotions in Model 4 in Table 3.3 remains unchanged from that in Model 1 in Table 3.3 and remains significant.

(4) In line with previous studies that have shown that increased choice alternatives can lead to higher consumption or investment amounts (Kahn and Wansink 2004; Morrin et al. 2008), we propose that the higher savings observed when both plans are offered simultaneously may be perceived as a social norm signaling the need to save more. This effect is expected to be stronger for individuals who are generally more sensitive to an increasing number of choices in their decision-making. To empirically investigate this effect, we included an interaction term between *Two Plans* and *Variety Sensitive* in Model 5 of Table 3.3. The results indicate that participants with a higher propensity to invest more when presented with a greater number of investment offers save significantly more when both savings plans are available, compared to participants with low variety sensitivity.[18] Moreover, the social norm of saving more when two plans are offered extends to situations where it is optimal to save in only one of the two accounts. To investigate this result, we designed rounds 3 and 4 such that risk-averse individuals should have

[16]The diversification biases do not necessarily result in exact equal allocations for each option; rather, they bias choices toward an equal distribution. Therefore, participants were identified as employing this strategy if they effectively saved 33.3% $\pm$ 5% points in each of the two savings accounts.

[17]To categorize participants, we assessed the standard deviation of their nominal savings rate across all rounds, assuming that a standard deviation below 2.5% indicates saving approximately the same amount.

[18]In addition to examining investment behavior, we assessed participants' propensity to consume when faced with more choices, such as dining options at an all-you-can-eat buffet and the size of assortments in stores. To analyze this topic further, we combined the responses from the three questions and created a variable that indicates the overall sensitivity to consumption and investment behavior when greater product choice is available, using a median split. Even with this measurement, the results remained qualitatively unchanged.

exclusively saved in RAs in round 3 (due to a higher expected pension tax rate) and only in TAs in round 4 (due to a certain pension tax rate). We find that even in these cases, participants save more when both plans are offered, compared to when only one plan is available (untabulated).

In light of our findings, we suggest that the availability of two savings plans (instead of only one) signals individuals to save more. However, one could argue that it is not the mere presence of the two plans, but rather the *introduction* of the second plan that signals the importance to save more. We will address this question by comparing the results of the first and second experiments in section 3.4.

The Effect on Satisfaction

Figure 3.1b shows that participants do not report higher satisfaction with their consumption allocation when provided with two pension plans instead of only one. In fact, overall satisfaction with both savings plans decreases significantly ($p < 0.001$). This negative effect is observed when participants are offered an additional RA ($p = 0.010$) as well as when an additional TA ($p = 0.018$) is offered. Overall, satisfaction is highest when only an RA is offered $p < 0.000$).

We also conducted random effects regressions with *Outcome Satisfaction* as the dependent variable, and the results, as shown in Table 3.4, confirm our previous bivariate findings. Model 1 in Table 3.4 demonstrates that participants express lower satisfaction with their consumption allocation when they are presented with two pension plans instead of just one. In Model 2 (Table 3.4), we further included control variables for perceived complexity, specifically distinguishing between tax complexity and decision complexity. The results reveal that the previously observed negative and significant main effect of *Two Plans* on satisfaction diminishes and becomes insignificant when controlling for decision and tax complexity. Interestingly, tax complexity does not have a significant effect on satisfaction. However, an increase in decision complexity associated with the presence of two plans ($p < 0.001$) demonstrates a negative impact on satisfaction. These findings are surprising considering that we also identified an increase in tax complexity when an additional savings plan is introduced ($p = 0.010$). Notably, this increase in tax complexity occurs only when a more complex TA is offered simultaneously ($p < 0.001$). In sum, the negative effect of introducing an additional pension plan is fully mediated by decision complexity.

To summarize the findings related to the first research question, Experiment 1 offers causal evidence that individuals exhibit higher savings when presented with two savings accounts compared to having only one savings plan available. However, this increase in savings does not correspond to an increase in individual satisfaction. In the subsequent section, we examine the extent to which the positive effect on saving is due to the additional introduction of a second pension plan or to the mere presence of two plans. Moreover, we investigate whether participants hold nonfinancial preferences for either a TA or RA.

Table 3.4: Random-Effects Regression Results: Outcome Satisfaction

	Outcome Satisfaction	
	(1)	(2)
Two Plans	-0.326***	-0.0887
	(0.103)	(0.102)
Decision Complexity		-0.225***
		(0.0363)
Tax Complexity		-0.0551
		(0.0437)
Male	0.136	-0.145
	(0.210)	(0.205)
Age 35-49	-0.374	-0.496**
	(0.269)	(0.247)
Age 50+	-0.00869	-0.145
	(0.277)	(0.253)
University Degree	0.0613	-0.0378
	(0.220)	(0.203)
Tax Knowledge	0.431*	0.137
	(0.230)	(0.211)
Married	0.0817	-0.0349
	(0.230)	(0.207)
Income €2,001-4,000	0.324	0.347*
	(0.225)	(0.208)
Income €4,000+	0.0473	0.145
	(0.470)	(0.407)
Cognitive Ability	0.134	0.0517
	(0.218)	(0.201)
Financial Literacy	0.211	0.124
	(0.296)	(0.274)
Pension Savings Experience	-0.418*	-0.362*
	(0.218)	(0.197)
Constant	5.689***	7.589***
	(0.398)	(0.488)
Observations	386	386
Number of ID	193	193
Adjusted R^2	0.032	0.183
Chi^2	26.28***	87.36***

Notes: This table presents the results of random-effects models with *Outcome Satisfaction* as dependent variable. The independent variable, *Two Plans*, indicates whether one or two savings plans are offered. The control variables used in the models are described in section 3.3.2. The standard errors are clustered at the level of the subjects and reported in parentheses. *, **, and *** indicate significance at the .10, .05, and .01 level, respectively.

3.4 Experiment 2: Choice of Savings Plans

3.4.1 Method, Data, and Procedure

We conducted the second experiment with 200 participants at the same time as the first experiment. Subjects were randomly assigned to either Experiment 1 or Experiment 2. Again, only risk-averse participants were included in the analyses, so the final sample has 191 observations. The experimental design of the second experiment was largely identical to the design of the first experiment. In contrast to the first experiment, participants were offered both savings products

in the first period. The placement of the savings accounts on the screen (left or right) was randomized to avoid any bias in participants' decisions. Before making their savings decision in the second round, participants were given the opportunity to choose whether they wanted to have only one of the two savings accounts or if they preferred to have both savings accounts simultaneously. The tax rates in the first two rounds of this experiment are the same as in the first two rounds of Experiment 1. In the third round, both savings accounts are again available to the participants during the savings decision. In the fourth round, participants must decide which of the two savings accounts they prefer before making their savings decision. To examine this choice independently of economic factors, the pension tax rate in rounds 3 and 4 for the TA was certain and the same as the income tax rate for the RA (= 40%). Thus, both savings plans were economically equivalent, and according to the rational choice model, participants should be indifferent between the two savings accounts, which we allowed as a choice option in this round. Table 3.5 provides an overview of the tax rates and the number of savings products in each round.

Table 3.5: Overview Savings Products and Taxation Rules

Round	No. Savings Accounts	Savings Account	Tax Treatment of	
			Savings (Period 1)	Pensions (Period 2)
1	2	RA	taxable ($\tau_1 = 40\%$)	tax-free
		TA	tax-deductible ($\tau_1 = 40\%$)	taxable ($\tau_2 = 10\%/60\%$; $E(\widetilde{\tau_2}) = 35\%$)
2	1 or 2 (by choice)	RA	taxable ($\tau_1 = 40\%$)	tax-free
		TA	tax-deductible ($\tau_1 = 40\%$)	taxable ($\tau_2 = 10\%/60\%$; $E(\widetilde{\tau_2}) = 35\%$)
3	2	RA	taxable ($\tau_1 = 40\%$)	tax-free
		TA	tax-deductible ($\tau_1 = 40\%$)	taxable ($\tau_2 = 40\%$)
4	1 (by choice)	RA	taxable ($\tau_1 = 40\%$)	tax-free
		TA	tax-deductible ($\tau_1 = 40\%$)	taxable ($\tau_2 = 40\%$)

Notes: This table gives an overview of the second experiment. Depending on the round, either a traditional account (TA) and/or a Roth account (RA) is offered. The last two columns show the corresponding taxation of the savings contributions. τ_1 denotes the tax rate on income in period 1 and τ_2 is the (expected) pension tax rate in round 2. We denote random variables with a tilde.

To answer the second research question, we use descriptive analysis as well as multinomial logistic regression with robust standard errors to identify the factors influencing the choice of a particular savings plan.

3.4.2 Variable Measurement

Dependent Variables

As in Experiment 1, we use *Outcome Satisfaction* and *Effective Saving Rate* as dependent variables (see section 3.3.2). To further analyze individual preferences regarding the two savings plans, we employ the variable *Choice Account* as an additional dependent variable. This variable captures participants' choices among the following options: (1) choosing the RA, (2) choosing the TA, or (3) choosing both accounts (round 2) or being indifferent between the two savings plans (round 4).

Independent and Control Variables

In addition to the variable *Two Plans*, we consider the variable *Introduction* as an independent variable to examine the extent to which the effect of the social norm to save more with two savings accounts is moderated by the introduction of the savings account. *Introduction* is a binary variable equal to one if the additional savings account is introduced (Round 2 in Experiment 1) and zero otherwise.

To investigate the factors influencing the choice of a savings account, we identified several significant variables, including tax complexity. To assess the influence of tax complexity, we constructed the variable *Rel TA Tax Complexity*, which captures the perceived difference in complexity between the two savings plans. This was achieved by subtracting the perceived tax complexity of the TA from the perceived tax complexity of the RA (for details on the measurement of tax complexity, refer to section 3.3.2). Consequently, a positive difference indicates that the TA was perceived as more complex than the RA.

Additionally, we incorporated tax aversion as another influencing factor, as it represents a tendency among individuals to perceive a disutility associated with paying taxes (Blaufus and Möhlmann 2014). To measure tax aversion, we presented participants with a choice between investing money in a tax-free bond or a slightly more economically advantageous taxable bond (Sussman and Olivola 2011). The dummy variable *Tax Aversion* is assigned a value of one if the participant expresses a preference for the tax-free bond and zero otherwise.

Individuals could formulate taxes in intertemporal saving decisions in terms of an assumed time reference point, thereby offsetting tax payments and tax benefits (or tax refunds) (e.g., Loewenstein 1987, 1988; Loewenstein and Prelec 1992). Because losses are generally weighted more heavily than gains (Kahneman and Tversky 2013), a decision that represents a change in the timing of outcomes from the status quo can be expected to result in a net reduction in utility. The intertemporal framing effect should not play a role if savings are taxed immediately since income is currently taxed regardless of the amount saved, so there is no immediate loss that could be associated with future tax savings. Savings to a TA, on the other hand, can be framed as

an exchange of an immediate gain (current tax savings) for a future loss (future tax liability). Following Cuccia et al. (2022), we asked participants about this intertemporal framing effect after the savings decision for each of the two products (see Questions 8 and 9 in the section 3.9.2). We created a dummy variable called *Temp Frame Def* to capture the association of tax costs with savings in a TA compared to an RA. We hypothesize that individuals who perceive tax costs to be more strongly associated with savings in a TA than in an RA will have a positive correlation with preference for an RA.

Research shows that anticipating future aversive (pleasant) events has negative (positive) utility (e.g., Loewenstein 1987; Hardman 2009). Under certain circumstances, this dread can lead to a preference for accelerating undesirable outcomes, which is at conflict with traditional economic models of discounted utility. Since taxes are often perceived negatively (e.g., Hardisty et al. 2010), dread of future tax payments can significantly influence the choice between different taxed savings products: if taxpayers focus on pension taxes, they may prefer to avoid the dread of paying taxes on future pensions and "get it over with" by contributing to an RA. Consistent with Cuccia et al. (2022), we expect the dread of future tax payments to increase preferences for immediately taxed plans (RAs). To measure the level of dread associated with outstanding tax payments, following Loewenstein (1987), we asked participants the maximum amount they would currently pay to avoid a future tax payment of €5,000 at three points in the future (1 year, 10 years, and 20 years). We then subtracted the amount each participant would pay to avoid the payment if it were due in 1 year from the amount each participant would pay to avoid the payment if it were due in 10 [20] years, and divided the difference by the one-year amount.[19] Larger numbers indicate higher discounting of future payments (less dread). The variable *Low Dread* measures the mean level at the two future points in time: 10 and 20 years.

The preference for prepayment is an important factor associated with saving behavior in different retirement tax systems (Cuccia et al. 2022). To measure prepayment preferences, we ask participants to imagine that they plan to be unemployed for a fully predictable and short period of time in six months (based on Prelec and Loewenstein 1998; Patrick and Park 2006). They are then told that living expenses during this period can be financed in two ways: (1) by saving within six months before becoming unemployed, or (2) by taking out an interest-free loan to be repaid within six months after becoming unemployed. The variable *Preference for Prepayment* equals one if prepayment is chosen before scheduled unemployment, and zero otherwise.

We also investigate the impact of risk aversion, particularly in the context of the uncertain pension tax rate in the second round. We expect that the preference for a TA would decrease with increasing risk aversion. Descriptive statistics for the average sociodemographic characteristics of the participants in this experiment are presented in columns 3 and 4 of Table 3.2. To analyze potential systematic variations in sociodemographic characteristics across the two experiments,

[19] Note that the measure for subjects who positively discounted future payments ranges between 0 and 1. Conversely, the measure has no lower bound for those who may have negatively discounted future payments. For these subjects, the lower bound of the measure was set to -1.

we conducted a joint Chi^2 test employing a logit model. The objective of the test was to evaluate the null hypothesis stating that there are no differences between the experiments with respect to all control variables. The results demonstrate that our randomization process successfully achieved balanced socio-demographic characteristics across both experiments ($p = 0.725$).

3.4.3 Empirical Results

The Social Norm Effect

In section 3.3, we showed that subjects are more likely to save more when an additional savings account is introduced than when there is only one savings account. We suggest that this increased savings behavior is influenced by a social norm that signals the importance of saving when both accounts are available. However, the question remains whether the effect of the social norm is moderated by the introduction of a second savings plan. To address this question, we compare savings behavior between the first round of the second experiment and the second round of the first experiment. These two rounds differ only in that an additional savings account was introduced in the second round of the first experiment, while in Experiment 2, both savings accounts were offered from the beginning.

In Model 1 of Table 3.6, the results demonstrate that the savings rate is approximately 9.9 percentage points higher when both pension plans are offered from the beginning (Round 1, Experiment 2) compared to when only one account is offered (Round 1, Experiment 1). This indicates that the presence of both savings accounts from the outset leads to increased savings due to the influence of a social norm effect.

Furthermore, Model 2 in Table 3.6 reveals an additional positive effect on savings, amounting to 5.2 percentage points, when the second pension plan is explicitly introduced. This suggests that the explicit introduction of the second plan further enhances the savings behavior of participants.

Table 3.6: Random-Effects Regression Results

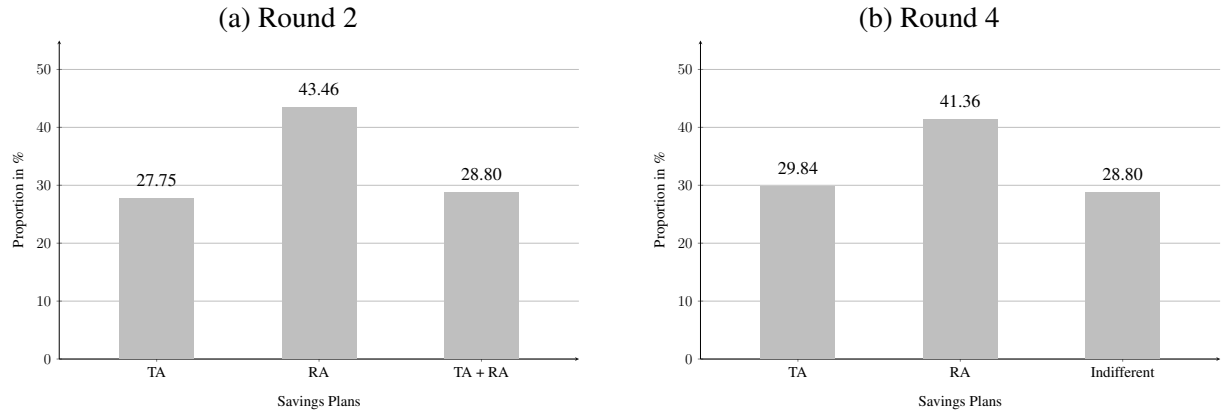
	(1)	(2)
	Savings Rate	
Two Plans	0.0998***	0.0994***
	(0.0229)	(0.0229)
Introduction		0.0516**
		(0.0229)
Observations	384	577
Number of ID	384	384
Controls	YES	YES
Adjusted R^2	0.063	0.104
F-Test/Chi^2	3.32***	112.25***

Notes: Model 1 shows the linear regression results with observations from the first round of Experiments 1 and 2. In the random-effects regression in Model 2, observations from the second round of Experiment 1 are also included. The dependent variable is the *Savings Rate*. The independent variable *Introduction* is a dummy variable equal to one if the additional savings account is introduced (Round 2 in Experiment 1). The independent variable *Two Plans* indicates whether one or two savings plans are offered. The models include control variables, which are described in detail in section 3.3.2. The standard errors are clustered at the level of the subjects and reported in parentheses. *, **, and *** indicate significance at the .10, .05, and .01 level, respectively.

Preferences for RAs, TAs, and the Simultaneous Offer

The second research question examines participants' preferences regarding the types of accounts they are offered: RAs only, TAs only, or both accounts simultaneously. Figure 3.2a illustrates that approximately 43.5% of participants opted for only an RA in the second round. This choice is noteworthy because, according to rational choice theory, it provided the lowest expected benefit for the majority of participants in our experiment (95.9% of the sample). Conversely, only 28.8% of participants chose the diversification option, despite it being optimal for individuals with an RRA greater than 0.5 (91.6% of the sample). This indicates that participants' choices deviate from the predictions of rational choice theory in terms of account preferences and diversification behavior.

Figure 3.2: Choice of Savings Accounts - Experiment 2



Notes: This graph shows the percentage of those who chose a Roth account (RA), a Traditional account (TA), both accounts (round 2) or were indifferent between both accounts (round 4).

To explore participants' preferences when there are only noneconomic differences between the two savings plans, they were asked in the fourth round to indicate their choice between the two products. The rational choice model suggests that participants should be indifferent between the two savings plans. However, Figure 3.2b shows that only approximately one in three participants selected the option of being indifferent. In contrast, a significantly higher proportion of participants (41.4%) chose the RA, while fewer participants (29.8%) selected the TA. These findings confirm the results of Cuccia et al. (2022), indicating a general preference for RAs even within a real choice environment. Thus, in addition to financial preferences, nonfinancial preferences play a role, which we further examine using multinomial logistic regression.

The results presented in Table 3.7 highlight several important findings. First, a higher perceived complexity of TAs compared to RAs significantly increases the preference for RAs. This suggests that participants tend to favor the savings plan that they perceive as less complex. In addition, our analysis indicates that as individuals' risk aversion increases, the likelihood of choosing an RA increases while the likelihood of choosing a TA decreases. Additionally, our findings align with our initial suggestions, as we observe that preferences for an RA are positively correlated with *Preferences for Prepayment*, *Tax Aversion*, and *Temp Frame Def*, and negatively correlated with *Low Dread*. Some of our findings, however, depend on whether the pension tax rate is uncertain (round 2) or not (round 4). For instance, tax aversion is positively correlated with the preference for an RA only when the uncertain tax rate in round 2 poses a potential high tax payment in the pension period.

Table 3.7: Multinomial Logistic Regression

	Round 2			Round 4		
	(1) RA	(2) TA	(3) RA + TA	(4) RA	(5) TA	(6) Indifferent
Rel TA Tax Complexity	0.0301**	-0.0367***	0.00666	0.0370**	-0.0354*	-0.00155
	(0.0136)	(0.0129)	(0.0124)	(0.0185)	(0.0191)	(0.0154)
Preference For Prepayment	-0.0609	-0.00375	0.0647	0.175*	-0.301***	0.127
	(0.104)	(0.0865)	(0.0912)	(0.0935)	(0.101)	(0.0840)
Tax Aversion	0.166**	-0.0910	-0.0747	0.0374	-0.0388	0.00132
	(0.0737)	(0.0653)	(0.0669)	(0.0727)	(0.0642)	(0.0680)
Temp Frame Def	0.139*	-0.0741	-0.0652	0.0286	0.00105	-0.0297
	(0.0729)	(0.0629)	(0.0667)	(0.0719)	(0.0648)	(0.0665)
Low Dread	-0.0609	0.106*	-0.0454	-0.112*	0.0627	0.0495
	(0.0617)	(0.0622)	(0.0593)	(0.0601)	(0.0631)	(0.0634)
Low Risk Aversion	-0.178**	0.198***	-0.0197			
	(0.0728)	(0.0688)	(0.0701)			
Low Loss Aversion	-0.0310	-0.0201	0.0511			
	(0.0786)	(0.0690)	(0.0713)			
Observations	191			191		
Chi^2	23.21*			18.06*		
$Pseudo - R^2$	0.068			0.049		
Controls	YES			YES		

Notes: This table shows the results of a multinomial logistic regression with the variable *Choice Account* as the dependent variable. This variable captures the subject's choice between (1) choosing an RA, (2) choosing a TA, or (3) choosing both accounts (round 2) or being indifferent between the two savings accounts (round 4). The variables *Rel TA Tax Complexity*, *Preference For Prepayment*, *Tax Aversion*, *Temp Frame Def*, *Low Dread*, *Low Risk Aversion*, and *Low Loss Aversion* and the control variables are described in section 3.3.2. Robust clustered standard errors are in parentheses. *, **, and *** indicate significance at the .10, .05, and .01 level, respectively.

In summary, our findings support the hypothesis that nonfinancial factors, including perceived complexity, dread of tax payments, and preference for prepayment, play a significant role in shaping individuals' preferences for RAs or TAs.

3.5 Additional Analyses

3.5.1 Savings Gap: TAs vs RAs

In section 3.3.3, we demonstrated a significant difference in savings behavior between the RA and the TA in the first round of Experiment 1 (p = 0.019). Specifically, participants significantly undersaved in the TA compared to the optimal benchmark, while their savings rate in the RA aligned with the optimal savings rate. This finding provides novel evidence suggesting that TAs not only result in lower savings compared to RAs but may also lead to overconsumption when compared to the rational choice benchmark.

In contrast to previous studies, our findings suggest that the savings gap between TAs and RAs is not solely attributable to tax misperceptions or tax neglect (Blaufus and Milde 2021; Beshears et al. 2017); other factors are likely at play. One potential explanation is complexity aversion, as participants perceive both the tax system and the decision-making process to be more complex for TAs than for RAs ($p < 0.001$). To further investigate this topic, we conducted a linear regression analysis that included two mediators, namely, *Tax Complexity* and *Complicated Decision* (untabulated). The results show that the savings gap is reduced by approximately 20% but remains statistically significant (p = 0.072). In this context, we have additionally scrutinized the impact of tax complexity on savings patterns. Our findings indicate a negative correlation between savings patterns and tax complexity exclusively for TAs (p = 0.051) but not for RAs (p = 0.830). Decision complexity, on the other hand, has no significant effect on saving behavior. In summary, complexity (aversion) has a small effect on the savings gap, but there are likely other factors contributing to the observed differences.

To investigate the role of different moderators, we included interaction terms between the savings account and variables such as *Preference For Prepayment*, *Tax Aversion*, *Temp Frame Def*, and *Low Dread* in our regression models (results not tabulated). This approach enables us to examine the savings behavior between the two differently taxed savings plans across various subgroups. Specifically, among subjects with low tax aversion, the savings gap between TAs and RAs almost disappears (p = 0.654). Conversely, individuals who are tax-averse tend to save significantly less in a TA than an RA due to the taxation of pensions. However, we did not find significant effects on the savings gap for the other moderators. These findings indicate that tax aversion plays a crucial role in driving the differences in savings behavior between TAs and RAs.

3.5.2 Individual Characteristics and the Social Norm Effect

We have already established that providing two savings plans increases savings behavior, likely due to the influence of a social norm. We now aim to investigate whether this effect is moderated by specific individual characteristics. To examine this, we include interaction terms between *Two Products* and variables such as *Cognitive Ability*, *High Financial and Tax Knowledge*[20], and *Pension Savings Experience* in our regression models in section 3.3.3 (untabulated). The results indicate that the impact of the social norm is weaker for individuals with higher cognitive ability and tax and financial knowledge. However, this effect is only significant for cognitive ability ($p = 0.090$) and not for financial and tax knowledge ($p = 0.145$).

3.6 Conclusion

This paper examines the economic effects of offering both immediately taxed pension plans (Roth accounts, RA) and tax-deferred pension plans (Traditional accounts, TA) simultaneously with two preregistered experiments. The findings reveal that the introduction of both an RA and a TA significantly increases retirement savings. Savings rates increase by 9.9 percentage points when both pension plans are available. The increase in savings is likely due to individuals perceiving the simultaneous offer of both pension plans as a social norm signaling the need for higher savings. Moreover, the positive effect on savings is further amplified by an additional 5.2 percentage points when the second pension plan is explicitly introduced.

One might argue that the experimental setting represents only a one-shot decision, and subjects may adjust their behavior in real-life, potentially diminishing the effect of the social norm signal. However, prior research indicates that people tend to exhibit inertia and rarely revise their retirement savings decisions (Cronqvist et al. 2018). Therefore, even a one-shot effect can have long-lasting implications.

Overall, the simultaneous offer of both a TA and an RA, which is not yet widely available in most countries, holds the potential to significantly alleviate the ”retirement savings crisis” (Benartzi and Thaler 2013, p. 1152). However, the simultaneous offer increases decision complexity, leading to a decrease in subjects' satisfaction. Thus, future research should focus on exploring methods to simplify retirement saving decisions. Interestingly, when subjects have a choice, a substantial portion of the sample (43.5%) prefers to be offered only an RA, despite the optimal strategy being tax risk diversification using both a TA and an RA. This preference for RAs over TAs further emphasizes the role of complexity, as subjects perceive the taxation of TAs as more intricate, driving their preference for RAs.

These findings have significant implications for policymakers and firms. The results suggest that

[20]The dummy variable *High Financial and Tax Knowledge* takes a value of one if an individual's tax knowledge or financial literacy is above the median of all participants. For the measurement of tax knowledge or financial literacy, see section 3.3.2.

countries should consider offering both Roth and Traditional accounts when their objective is to encourage higher retirement savings. Moreover, if governments grant firms the flexibility to choose between either of the tax options or offer both alternatives, firms aiming to attract and retain employees through appealing retirement plans may opt to provide only RAs, given their popularity among most individuals. To address this potential outcome, governments seeking to bolster the savings rate should consider implementing regulations that mandate firms always offer both types of plans. However, in doing so, it becomes crucial to address the complexities associated with multiple plan choices to enhance individuals' overall satisfaction.

3.7 Appendix A: Mathematical Appendix

3.7.1 Optimal pre-tax savings under one savings option available

Immediately taxed savings option

We assume that subjects choose their savings to maximize their lifetime wealth according to a simple two-period life-cycle model (Modigliani and Brumberg 1954):

$$U = u(C_1) + \frac{u(C_2)}{(1+\rho)}$$

with C_1 denoting consumption in the first and C_2 denoting consumption in the second period and $1+\rho$ denoting the subject's discount rate. Hereafter, we abstract from interest and discounting due to our experimental setting. Thus, simplifying yields to:

$$U = u(C_1) + u(C_2). \tag{3.10}$$

In general, consumption in the working period C_1 equals pre-tax income Y minus taxes and minus savings. In the pension period, there is no exogenous income received. Consumption in the pension period C_2 equals the savings minus taxes. We assume a positive decreasing marginal utility: $u'(C) > 0$, $u''(C) < 0$.
Under immediate taxation, retirement savings $S_I^{'}$ are paid out of net-income, future pensions are tax-free. Thus, we obtain:

$$C_1 = Y \cdot (1-\tau_1) - S_I^{'}, \tag{3.11}$$

$$C_2 = S_I^{'}, \tag{3.12}$$

with τ_1 denoting the tax rate on working income. To simplify comparisons with other tax regimes, we define $S_I = \frac{S_I^{'}}{1-\tau_1}$ as pre-tax savings under immediate taxation. Inserting in equations (3.11) and (3.12) yields:

$$C_1 = (Y - S_I) \cdot (1-\tau_1), \tag{3.13}$$

$$C_2 = S_I \cdot (1-\tau_1). \tag{3.14}$$

Maximizing (3.10) subject to (3.13) and (3.14) results in the optimal rule for allocating consumption (Euler rule):

$$u^{'}\big((Y - S_I) \cdot (1-\tau_1)\big) \cdot (1-\tau_1) = u^{'}\big(S_I \cdot (1-\tau_1)\big) \cdot (1-\tau_1). \tag{3.15}$$

Subjects choose pre-tax savings under immediate taxation such that the marginal utility of the consumption in the first period equals the marginal utility of consumption in the second period.

We obtain optimal pre-tax savings as:

$$S_I^* = \frac{Y}{2}. \tag{3.16}$$

As one can see from (3.16), the immediate pension taxation does not affect savings decisions, thus, leaving intertemporal consumption undistorted.

Deferred taxed savings option

Under deferred taxation, retirement savings S_D are tax deductible, future pensions are subject to taxes. Because future taxes can be uncertain, future consumption can also be uncertain.[21] We assume that subjects maximize their utility according to:

$$U = u(C_1) + E[u(\tilde{C_2})]. \tag{3.17}$$

Under deferred taxation, C_1 and C_2 are defined as follows:

$$C_1 = (Y - S_D) \cdot (1 - \tau_1), \tag{3.18}$$

$$\tilde{C_2} = S_D \cdot (1 - \tilde{\tau_2}), \tag{3.19}$$

with $\tilde{\tau_2}$ denoting the future tax rate on pension income that is uncertain with mean $\overline{\tau_2}$. Maximizing (3.17) subject to (3.18) and (3.19), results in:

$$u^{'}(C_1) \cdot (1 - \tau_1) = E[u^{'}(\tilde{C_2}) \cdot (1 - \tilde{\tau_2})]. \tag{3.20}$$

Equation (3.20) shows that deferred taxation affects optimal savings whenever the future tax rate is uncertain or (in case of tax certainty) if the future tax rate differs from the current tax rate on working income. If we assume $CRRA$ utility with $u = \frac{C^{1-r}}{1-r}$, with r, also referred to as RRA, denoting the constant relative risk aversion ($r > 0$ and $r \neq 1$), we obtain optimal savings under deferred taxation as follows:

$$S_D^* = \frac{Y}{1 + (\frac{1}{1-\tau_1})^{1-\frac{1}{r}} \cdot E[(1 - \tilde{\tau_2})^{1-r}]^{\frac{-1}{r}}}. \tag{3.21}$$

Comparison of pre-tax savings under immediately and deferred taxed savings options

From a comparison of equations (3.16) and (3.21) it follows that immediate and deferred taxation result in identical pre-tax retirement savings if the following condition holds:

$$E[(1 - \tilde{\tau_2})^{1-r}]^{\frac{-1}{r}} = (1 - \tau_1)^{1-\frac{1}{r}}.$$

[21] We denote random variables using a tilde.

This can be simplified to

$$E[(1-\tilde{\tau_2})^{1-r}] = (1-\tau_1)^{1-r}\,. \tag{3.22}$$

Obviously, this condition holds if the future tax rate is certain and equals the current tax rate on working income. In this case, immediate and deferred taxation result in identical savings. For our experimental setting of an uncertain future tax rate with mean smaller than the current tax rate, the effects are ambiguous. We explicitly describe them below, referring to our concrete experimental setting.

Due to identical savings under immediate and deferred taxation under the assumption of equal, certain current and future tax rates, equation (3.22) can also be used to explain the effects of tax rate uncertainty and deviating future tax rates on pre-tax savings in the deferred taxed pension product. If the LHS of equation (3.22) exceeds (is lower than) the RHS of equation (3.22), savings under deferred taxation under uncertainty are higher (lower) than savings under deferred taxation under certainty and identical current and future tax rates. For $r > 1$ ($r < 1$), x^{1-r} is convex (concave), such that due to Jensen's inequality $E[(1-\tilde{\tau_2})^{1-r}] \underset{(<)}{>} (1-\overline{\tau_2})^{1-r}$ holds. Hence, tax rate uncertainty increases (decreases) pre-tax savings for $r > 1$ ($r < 1$). Subjects with RRA greater than one who undertake additional, precautionary savings under such a multiplicative tax rate risk can be called multiplicative risk prudent (Wong et al. (2010)).[22] In contrast, under certainty, under declining future tax rates subjects with RRA greater than one (smaller than one) decrease (increase) pre-tax savings. For $\tau_2 < \tau_1$, if $r > 1$ ($r < 1$), $(1-\tau_2)^{1-r} \underset{(>)}{<} (1-\tau_1)^{1-r}$ holds.

Concrete experimental setting

In our experimental setting, we examine inter alia an uncertain future tax rate with mean smaller than the current tax rate ($\overline{\tau_2} < \tau_1$). Then, for $r > 1$, x^{1-r} is convex such that due to Jensen's inequality $E[(1-\tilde{\tau_2})^{1-r}] > (1-\overline{\tau_2})^{1-r}$ holds. Because of $(1-\overline{\tau_2})^{1-r} < (1-\tau_1)^{1-r}$ for $r > 1$, in general, this implies that both $E[(1-\tilde{\tau_2})^{1-r}] > (1-\tau_1)^{1-r}$ and $E[(1-\tilde{\tau_2})^{1-r}] < (1-\tau_1)^{1-r}$ are possible for $r > 1$. For $r < 1$, x^{1-r} is concave such that due to Jensen's inequality $E[(1-\tilde{\tau_2})^{1-r}] < (1-\overline{\tau_2})^{1-r}$ holds. Because of $(1-\overline{\tau_2})^{1-r} > (1-\tau_1)^{1-r}$ for $r < 1$, in general, this implies that both $E[(1-\tilde{\tau_2})^{1-r}] > (1-\tau_1)^{1-r}$ and $E[(1-\tilde{\tau_2})^{1-r}] < (1-\tau_1)^{1-r}$ are possible for $r < 1$. Thus, it is not clear-cut whether pre-tax savings in immediately or those in deferred taxed options are greater.

[22] See e.g. Leland (1968), Kimball (1990), Mirman (1971), Eisenhauer (2000) and Wong et al. (2010) for studies referring to multiplicative and additive risk prudence.

Specifically, in our experimental setting, we assume that $\tilde{\tau_2}$ is randomly distributed with

$$\tilde{\tau_2} = \begin{cases} \overline{\tau_2} + \delta, & p = 0.5 \\ \\ \overline{\tau_2} - \delta, & 1 - p \end{cases} \tag{3.23}$$

with $\delta > 0$. Rearranging (3.22) yields $\frac{1}{2} \cdot (\frac{1-(\overline{\tau_2}+\delta)}{1-\tau_1})^{1-r} + \frac{1}{2} \cdot (\frac{1-(\overline{\tau_2}-\delta)}{1-\tau_1})^{1-r} = 1$. Under our experimental conditions $\overline{\tau_2} = 0.35$, $\tau_1 = 0.4$ and $\delta = 0.25$, $0.5 \cdot (\frac{2}{3})^{1-r} + 0.5 \cdot (\frac{3}{2})^{1-r} > 1$ is valid for $r > 1$ and $r < 1$. In general, the effect of uncertainty and that of lower future tax rates are counteracting. In our setting, for subjects with RRA smaller than one, the effect of a lower future tax rate dominates and for subjects with RRA greater than one, the effect of uncertainty dominates. Thus, under one savings option available, theoretically, optimal savings in the deferred taxed product exceed those in the immediately taxed one, independently of the constant relative risk aversion, r.

3.7.2 Diversification

If subjects can choose among immediately taxed and deferred taxed pension products, let $S = S_I + S_D$ denote the total amount of pre-tax savings, f the share of pre-tax savings that is invested in the immediately taxed savings option and $1 - f$ the share of pre-tax savings that is invested in the deferred taxed savings option. Consumption is then defined as follows:

$$C_1 = (Y - S) \cdot (1 - \tau_1), \tag{3.24}$$

$$\tilde{C_2} = S \cdot f \cdot (1 - \tau_1) + S \cdot (1 - f) \cdot (1 - \tilde{\tau_2}). \tag{3.25}$$

Inserting (3.24) and (3.25) and maximizing (3.17) with respect to S yields:

$$U'(C_1) \cdot (1-\tau_1) = E\left[U'\Big(S \cdot \big(f \cdot (1-\tau_1) + (1-f) \cdot (1-\tilde{\tau_2})\big)\Big) \cdot \big((1-f) \cdot (1-\tilde{\tau_2}) + f \cdot (1-\tau_1)\big)\right]. \tag{3.26}$$

Maximizing (3.17) with respect to f yields:

$$E\big[u'\big(S \cdot f \cdot (1 - \tau_1) + S \cdot (1 - f) \cdot (1 - \tilde{\tau_2})\big) \cdot (\tau_1 - \tilde{\tau_2})\big] = 0. \tag{3.27}$$

For condition (3.27) to hold for a share of pre-tax savings smaller than one that is invested in the immediately taxed pension product, the mean of the future tax rate has to be lower than the current one. Under the realization of higher future tax rates, C_2 is lower than under lower future tax rates for f smaller than one. Due to $u''(C) < 0$, $u'(C_2)$ is higher than under lower future tax rates. Due to $u'(C) > 0$, the mean absolute value of the differences between the current and the possible lower future tax rates has to be higher than the mean absolute difference between the

current and the possible higher future tax rates for (3.27) to hold under f being smaller than one. Hence, a prerequisite for allocating savings to the deferred taxed option with an uncertain future tax rate is that the mean of the future tax rate is lower than the current one. Otherwise, subjects would only invest in the immediately taxed savings product.

Additionally, according to (3.27), it must be possible that the realization of the future tax rate can be smaller and greater than the current tax rate. Otherwise, the allocation to both savings products, referred to as diversification, cannot be optimal under the assumption of an uncertain future tax rate.

Concrete experimental setting

Including that $\tilde{\tau_2}$ is randomly distributed according to (3.23) and assuming $CRRA$ utility, (3.27) yields:

$$f^* = \frac{(1-\overline{\tau_2}+\delta)\cdot(\delta-\tau_1+\overline{\tau_2})^{\frac{1}{r}} + (\delta+\tau-\overline{\tau_2})^{\frac{1}{r}}\cdot(-1+\overline{\tau_2}+\delta)}{(\delta+\tau-\overline{\tau_2})\cdot(\delta-\tau+\overline{\tau_2})^{\frac{1}{r}} + (\delta+\tau-\overline{\tau_2})^{\frac{1}{r}}\cdot(\delta-\tau+\overline{\tau_2})}. \tag{3.28}$$

The expression (3.28) shows that f^* does not depend on the optimal pre-tax savings. Further, subjects have to be sufficiently risk-averse to allocate savings additionally to the immediately taxed savings option, not only to the deferred taxed one because f^* is only larger than zero when $r > \frac{ln\left(\frac{\overline{\tau_2}+\delta-\tau_1}{\tau_1-\overline{\tau_2}+\delta}\right)}{ln\left(\frac{1-\overline{\tau_2}-\delta}{1-\overline{\tau_2}+\delta}\right)}$. Otherwise, subjects would only allocate savings to the deferred taxed savings option. In our experimental setting, assuming $\overline{\tau_2} = 0.35$, $\tau_1 = 0.4$ and $\delta = 0.25$, diversification is optimal for a constant relative risk aversion, r, greater than 0.5.

Under the assumption of a random distribution of $\tilde{\tau_2}$ according to (3.23) and $CRRA$ utility, (3.26) yields:

$$S^* = \frac{Y}{A^{-\frac{1}{r}}\cdot(1-\tau)^{-1+\frac{1}{r}}+1} \tag{3.29}$$

with

$$A = E\left[\left(f^*\cdot(1-\tau_1)+(1-f^*)\cdot(1-\tilde{\tau_2})\right)^{-r}\cdot\left((1-f^*)\cdot(1-\tilde{\tau_2})+f^*\cdot(1-\tau_1)\right)\right]. \tag{3.30}$$

3.7.3 Comparison optimal pre-tax savings under diversification with optimal pre-tax savings under one savings option available

The preceding analysis followed previous research on retirement savings (see e.g. Dickson (2004)). We extend prior analyses by comparing savings when tax diversification is possible with savings when only one tax-advantaged pension plan exists. The technical procedure of comparing pre-tax savings under diversification with those under an immediately taxed option

is very similar to that of comparing pre-tax savings under diversification with those under a deferred taxed option. Thus, we will present the steps one after another, beginning with the comparison of pre-tax savings under diversification and immediate taxation and followed by the comparison of pre-tax savings under diversification and deferred taxation. We denote S_I^* as optimal pre-tax savings in the case that only the immediately taxed option is available and S_D^* as optimal pre-tax savings in the case that only the deferred taxed option is available. According to (3.26), if optimal pre-tax savings under the immediately taxed option are greater (smaller) than those under diversification, the following inequality has to be true:

$$U'\big(C_1\big)\cdot(1-\tau_1)\underset{(<)}{\overset{>}{}}E\Bigg[U'\Big(S_I^*\cdot\big(f\cdot(1-\tau_1)+(1-f)\cdot(1-\tilde{\tau_2})\big)\Big)\cdot\big((1-f)\cdot(1-\tilde{\tau_2})+f\cdot(1-\tau_1)\big)\Bigg]. \tag{3.31}$$

Inserting (3.15) into the LHS of (3.31) yields:

$$U'\big(S_I^*\cdot(1-\tau_1)\big)\cdot(1-\tau_1)\underset{(<)}{\overset{>}{}}E\Bigg[U'\Big(S_I^*\cdot\big(f\cdot(1-\tau_1)+(1-f)\cdot(1-\tilde{\tau_2})\big)\Big)\cdot\big((1-f)\cdot(1-\tilde{\tau_2})+f\cdot(1-\tau_1)\big)\Bigg]. \tag{3.32}$$

Similarly, according to (3.26), if pre-tax savings under deferred taxation are greater (smaller) than those under diversification, the following inequality has to hold:

$$U'(C_1)\cdot(1-\tau_1)\underset{(<)}{\overset{>}{}}E\Bigg[U'\Big(S_D^*\cdot\big(f\cdot(1-\tau_1)+(1-f)\cdot(1-\tilde{\tau_2})\big)\Big)\cdot\big((1-f)\cdot(1-\tilde{\tau_2})+f\cdot(1-\tau_1)\big)\Bigg]. \tag{3.33}$$

Inserting (3.20) into the LHS of (3.33)yields:

$$E\Big[U'\big(S_D^*\cdot(1-\tilde{\tau_2})\big)\cdot(1-\tilde{\tau_2})\Big]\underset{(<)}{\overset{>}{}}E\Bigg[U'\Big(S_D^*\cdot\big(f\cdot(1-\tau_1)+(1-f)\cdot(1-\tilde{\tau_2})\big)\Big)\cdot\big((1-f)\cdot(1-\tilde{\tau_2})+f\cdot(1-\tau_1)\big)\Bigg]. \tag{3.34}$$

If we assume $CRRA$ utility with $u=\frac{C^{1-r}}{1-r}$, with $r>0$ and $r\neq 1$, considering the comparison with the immediately taxed option, we obtain:

$$\big(S_I^*\cdot(1-\tau_1)\big)^{-r}\cdot(1-\tau_1)\underset{(<)}{\overset{>}{}}E\Bigg[\Big(S_I^*\cdot\big(f\cdot(1-\tau_1)+(1-f)\cdot(1-\tilde{\tau_2})\big)\Big)^{-r}\cdot\big((1-f)\cdot(1-\tilde{\tau_2})+f\cdot(1-\tau_1)\big)\Bigg]. \tag{3.35}$$

Correspondingly, considering the comparison with the deferred taxed option, we get:

$$E\Big[\big(S_D^* \cdot (1-\tilde{\tau}_2)\big)^{-r} \cdot (1-\tilde{\tau}_2)\Big] \underset{(<)}{>} E\Big[\Big(S_D^* \cdot \big(f \cdot (1-\tau_1) + (1-f) \cdot (1-\tilde{\tau}_2)\big)\Big)^{-r} \cdot \big((1-f) \cdot (1-\tilde{\tau}_2) + f \cdot (1-\tau_1)\big)\Big]. \tag{3.36}$$

Assuming optimal pre-tax savings greater than zero, yields, comparing the immediately taxed option:

$$(1-\tau_1)^{1-r} \underset{(<)}{>} E\Big[\big((1-f) \cdot (1-\tilde{\tau}_2) + f \cdot (1-\tau_1)\big)^{1-r}\Big] \tag{3.37}$$

and similarly comparing the deferred taxed option:

$$E\big[(1-\tilde{\tau}_2)^{1-r}\big] \underset{(<)}{>} E\Big[\big((1-f) \cdot (1-\tilde{\tau}_2) + f \cdot (1-\tau_1)\big)^{1-r}\Big]. \tag{3.38}$$

Condition (3.37) [(3.38)] holds if optimal pre-tax savings in the immediately [deferred] taxed option are greater (smaller) than those under diversification.

If diversification is optimal, assuming equally high savings under one savings option available and diversification, utility of the latter is higher. When comparing with the immediately taxed option, we obtain:

$$U\big(S_I^* \cdot (1-\tau_1)\big) < E\Big[U\big(S_I^* \cdot f \cdot (1-\tau_1) + S_I^* \cdot (1-f) \cdot (1-\tilde{\tau}_2)\big)\Big] \tag{3.39}$$

and similarly, when comparing with the deferred taxed option:

$$E\Big[U\big(S_D^* \cdot (1-\tilde{\tau}_2)\big)\Big] < E\Big[U\big(S_D^* \cdot f \cdot (1-\tau_1) + S_D^* \cdot (1-f) \cdot (1-\tilde{\tau}_2)\big)\Big]. \tag{3.40}$$

If we assume $CRRA$ utility with $u = \frac{C^{1-r}}{1-r}$, with $r > 0$ and $r \neq 1$, we get

$$\frac{\big(S_I^* \cdot (1-\tau_1)\big)^{1-r}}{1-r} < E\Big[\frac{\big(S_I^* \cdot f \cdot (1-\tau_1) + S_I^* \cdot (1-f) \cdot (1-\tilde{\tau}_2)\big)^{1-r}}{1-r}\Big] \tag{3.41}$$

and

$$E\Big[\frac{\big(S_D^* \cdot (1-\tilde{\tau}_2)\big)^{1-r}}{1-r}\Big] < E\Big[\frac{\big(S_D^* \cdot f \cdot (1-\tau_1) + S_D^* \cdot (1-f) \cdot (1-\tilde{\tau}_2)\big)^{1-r}}{1-r}\Big]. \tag{3.42}$$

Assuming positive pre-tax savings, $r > 1$ ($r < 1$) yields

$$(1-\tau_1)^{1-r} \underset{(<)}{>} E\Big[\big(f \cdot (1-\tau_1) + (1-f) \cdot (1-\tilde{\tau}_2)\big)^{1-r}\Big] \tag{3.43}$$

and

$$E\Big[(1-\tilde{\tau}_2)^{1-r}\Big] \underset{(<)}{>} E\Big[\big(f\cdot(1-\tau_1)+(1-f)\cdot(1-\tilde{\tau}_2)\big)^{1-r}\Big]. \tag{3.44}$$

Inequality (3.43) matches with (3.37), inequality (3.44) with (3.38). Thus, under the assumption of diversification being optimal, optimal pre-tax savings are smaller (greater) than under an immediately [deferred] taxed option if $r > 1$ ($r < 1$).[23]

Taken together, diversification is optimal for individuals being sufficiently risk-averse (for subjects with RRA greater than approximately 0.5) if the mean of the future tax rate is smaller than the current tax rate and if the realization of the future tax rate can be greater than the current tax rate. Under diversification being optimal, compared to the deferred taxed savings option alone, uncertainty can be reduced by also allocating savings to the immediately taxed product. Additionally, under diversification being optimal, compared to the immediately taxed option alone, advantageous lower future tax rates can be achieved by also allocating savings to the deferred taxed option. Under certainty compared to uncertainty and under a future tax rate falling below the current one compared to a future tax rate equaling the current one, in each case subjects with RRA greater than one (smaller than one) reduce (raise) pre-tax savings (see section 3.7.1). Under diversification being optimal, pre-tax savings of subjects with RRA greater than one (smaller than one) are lower (higher) than pre-tax savings under only one savings option available.

[23] This main result also remains valid under the inclusion of interest and discounting. Then, the discount rate and the interest rate on savings cancel out.

3.8 Appendix B: Experiment Instructions

3.8.1 Experiment 1

Welcome Page

Welcome to our Study

Thank you for participating in this study. Before the study begins, please read the following carefully.

1. Procedure and Duration
In this study, several savings decisions have to be made. There are also some questions about savings behavior and other socio-demographic characteristics. Please answer all questions carefully and pay attention to the control questions, which are designed to focus your attention. The study should take approximately 30 minutes to complete.

Participation in this study is completely voluntary. You will not be penalized for dropping out of the study, but you will not receive any compensation.

2. Purpose of this Research Study
This study examines your overall savings behavior.

3. Compensation
You will receive a fixed compensation of 200 mingle points for completing the study. In addition, you will receive a variable compensation. The amount depends on your decisions and your luck. In the following instructions, you will learn how your variable compensation is calculated. The average variable compensation is 310 mingle points.

Please note the following: It is very important to us that you complete this study conscientiously and answer the questions honestly. Therefore, we will pay you a reasonable compensation. We will not pay you in the following cases:

- **You do not read the instructions carefully.**
- **You do not read the questions carefully or answer not conscientiously.**

4. Benefit of the Study
This study will help the research team to learn more about human behavior. We hope that in the future, other people can benefit from this study through a better understanding of savings behavior.

5. Possible Risks of the Study
In this study, no risks or adverse effects beyond those normally experienced in daily life are expected.

6. Confidentiality

The information you provide is kept strictly confidential. Only the principal investigator and his or her staff will have access to the raw data. Anonymized data from this study may be shared with qualified researchers or research institutions as deemed appropriate in accordance with the policies of the academic association, journal, or university. All reports from this study will be at an aggregate level and/or with individual information anonymized or masked so that participants cannot be identified. We will not share personally identifiable information with others unless required to do so by law.

7. Declaration of Consent
By clicking on *Next* you confirm that you have read the points above and that you agree to participate in the study.

Instructions - Round 1

[Before the experiment, each participant was randomly assigned to one of the two differently taxed savings products (Product I or Product D). The differences between the two products are shown in square brackets.]

Structure and Compensation

1. Structure of the Study:

The study consists of a **comprehension test**, **four independent decision rounds**, and a subsequent **questionnaire**.

2. Fictitious currency

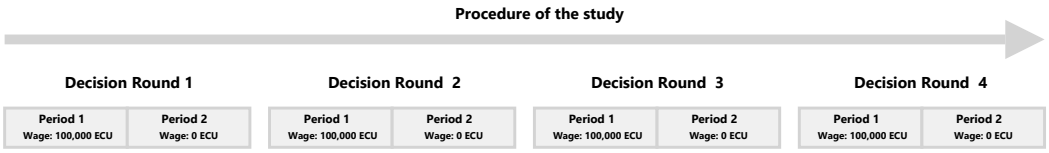
You will receive a payoff in each decision round. The payoffs are denominated in a **fictitious currency** we call **"ECU"**. 1,000 ECU equals 8 mingle points. Your actual payout is calculated at the end of the study from the "earned ECU" and then converted into mingle points.

Your Savings Decision

1. Procedure of the Study

Each of the 4 rounds consists of **2 periods**. In the first period you will receive an **income** from us. This is always 100,000 ECU. In the second period, you will not receive an income from us. **To receive a payoff in the second period, you must save (see point 2)**. Since each of the 4 decision rounds consists of 2 periods, there are a total of **8 periods**. One of these 8 periods will be randomly selected for your compensation at the end of the study.

In the following figures you can see again the procedure of the study as well as your incomes:



2. Your Savings Decision

From your salary (100,000 ECU), you can save an amount for the second period in a savings product in the first period.

Your Income

1. Amount of the Gross Income

In each of the following four decision rounds, we will pay you a **gross income of 100,000 ECU** in period 1.

2. Taxation of the Gross Income

Your gross income is subject to a **40% tax**. The taxes in this study are levies that we use for further scientific research as well as for the fees incurred for this study.

Your Savings Product I

1. Your Savings Product

In each decision round, you must decide how much of your after-tax income you want to save for the second period. For this purpose, you have a savings product at your disposal - **Savings Product I (immediately taxed)** [**Product D (deferred taxed)**].

2. Taxation of Savings Contributions

[Participants with Product I:]

Period 1: The savings contributions to this savings product are not tax deductible. This means that your savings contributions do not reduce the tax paid in period 1 (40%).

Period 2: The income from this savings product is tax-free in the second period. This means that you pay no tax on the income from this savings product.

In summary, this savings product has both advantages and disadvantages from a tax point of view:

Advantage: The income from the savings contributions in period 2 is tax-free and the tax rate in period 1 is certain.

Disadvantage: The savings contributions in period 1 do not reduce the tax paid (40%), since they are not deductible.

[Participants with Product D:]

Period 1: Contributions to this savings product are tax deductible. This means that you save 40% of the tax on your savings contributions.

Period 2: The income from this savings product is subject to tax in the second period. However, the amount of tax is uncertain. The tax rate is either 10% or 60%, each with a probability of 50%. Therefore, the average tax rate can be assumed to be 35%. The actual tax rate is determined at the end of the study by a random generator.

In summary, this savings product has both advantages and disadvantages from a tax point of view:

Advantage: The savings contributions save you 40% tax in period 1. The resulting income in the second period is subject to an average tax rate of only 35%.

Disadvantage: The tax rate in period 2 is uncertain. The tax rate could be either very low (10%) or very high (60%).

Your Savings Product II

1. Graphical Representation

The payoffs that you will be compensated for in a period are shown in the decision rounds as follows:

[see Figure 3.3 for Product I and Figure 3.4 for Product D]

2. Save for the Second Period

To save money for the second period, simply move the slider. You will then see in the graph how much your payoffs are affected by the savings decision.

Tip: You can click on the slider and then use the arrow keys to move it.

Become familiar with the slider and try a few different savings amounts. Then click Next.

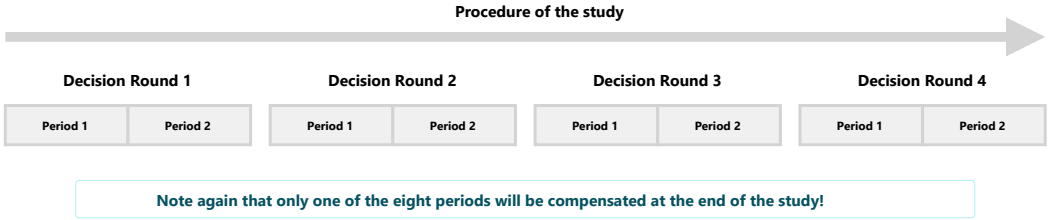
Your Remuneration

1. Fixed Remuneration

You will receive a fixed compensation of 200 mingle points.

2. Variable Remuneration

Depending on how you distributed your income, you will be paid accordingly. A random generator first determines which of the two periods of a decision round is relevant for the compensation. At the end of the study, you will be compensated for one of the four decision rounds. You will then receive the payment for that period as compensation.



You can also earn some extra money later in the questionnaire.

Comprehension Test

Before you begin the actual study, we would like you to answer the following comprehension questions. If you have any questions, please feel free to review the instructions at any time.

Please note that we will not compensate you if you do not read the instructions carefully and therefore do not answer the following questions conscientiously.

Question 1: Which of the following statements is true about compensation at the end of the study?

- ☐ The average payoff amount of all periods is compensated at the end of the study.
- ☐ The average payoff amount of all decision rounds is compensated at the end of the study.
- ☐ Only one of the total of eight periods is compensated at the end of the study.

Question 2: How is the gross income taxed in the first period?

- ☐ The gross income is subject to a tax of 40%.
- ☐ The gross income is subject to a tax of 15%.
- ☐ The gross income is tax-free.

Question 3: How will the savings contributions be taxed in the **first period**?

- ☐ All savings contributions are tax deductible.
- ☐ All savings contributions are not tax-deductible.

Question 4: How will the income resulting from the savings contributions be taxed in the **second period**?

- ☐ The income resulting from the savings contributions is tax-free.
- ☐ The income resulting from the savings contributions is subject to tax. However, the tax rate is uncertain.
- ☐ The income resulting from the savings contributions is taxed at a rate of 40%.

Question 5: Suppose you save nothing in the first period of a decision round and at the end of the study the second period of that decision round is paid out. What is your variable compensation?

- ☐ 0 ECU.
- ☐ The average payoff of the two periods.

Instructions - Round 2

Instructions

1. Additional Savings Product

[Participants with Product I in the first round: In this decision round, an **additional Savings Product D (deferred tax)** is available to you. The only difference between this and Product I (immediately taxed) is the taxation.]

[Participants with Product D in the first round: In this decision round, an **additional Savings Product I (immediately taxed)** is available to you. The only difference between this and Product D (deferred tax) is the taxation.]

2. Taxation of Savings Contributions in Savings Product D [Savings Product I]

[see the tax rules in section 3.8.1]

3. Reminder: Your Savings Product I [Savings Product D]

In addition to the new Savings Product D [Savings Product I], Savings Product I [Savings Product D] is still available to you in this decision round. As a reminder, you will find below the information you already know about the taxation of savings contributions in Savings Product I [Savings Product D]:

[see the tax rules in section 3.8.1]

4. Graphical Representation

The payoffs are presented in the decision rounds as follows:

[see Figure 3.5]

Comprehension Test

Before you begin the actual study, we would like you to answer the following comprehension questions. If you have any questions, please feel free to review the instructions at any time.

Question 1: How will the savings contributions of the new **Savings Product D** [**Savings Product I**] be taxed in the **first period?**

☐ All savings contributions are tax-deductible.
☐ All savings contributions are not tax-deductible.

Question 2: How will the income resulting from the savings contributions of the new **Savings Product D** [**Savings Product I**] be taxed in the **second period**?

- ☐ The income resulting from the savings contributions is tax-free.
- ☐ The income resulting from the savings contributions is subject to tax. However, the tax rate is uncertain.
- ☐ The income resulting from the savings contributions is taxed at a rate of 40%.

Instructions - Round 3

1. Tax Rate for Savings Product D (deferred tax)

As in the last decision round, the tax rate in period 2 for Savings Product D (deferred tax) is uncertain. However, the tax rate is now either 20% or 60% with a probability of 50%.

Otherwise, this decision round is identical to the last decision round

2. Your Savings Products

Here is an overview of the two savings products and the corresponding taxation:

Savings Product I (immediately taxed):

Period 1: The savings contributions to this savings product are not tax deductible. This means that your savings contributions do not reduce the tax paid in period 1 (40%).

Period 2: The income from this savings product is tax-free in the second period. This means that you pay no tax on the income from this savings product.

In summary, this savings product has both advantages and disadvantages from a tax point of view:

Advantage: The income from the savings contributions in period 2 is tax-free and the tax rate in period 1 is certain.

Disadvantage: The savings contributions in period 1 do not reduce the tax paid (40%), since they are not deductible.

Savings Product D (deferred tax):

Period 1: Contributions to this savings product are tax deductible. This means that you save 40% of the tax on your savings contributions.

Period 2: The income from this savings product is subject to tax in the second period. However, the amount of tax is uncertain. The tax rate is either 20% or 60%, each with a probability

of 50%. Therefore, the average tax rate can be assumed to be 40%. The actual tax rate is determined at the end of the study by a random generator.

In summary, this savings product has both advantages and disadvantages from a tax point of view:

Advantage: The savings contributions save you 40% tax in period 1.

Disadvantage: The tax rate in period 2 is uncertain. The tax rate could be either very low (20%) or very high (60%).

Instructions - Round 4

1. Certain Tax Rate for Savings Product D (deferred tax)

In this last decision round, the tax rate in period 2 for Savings Product D (taxed in arrears) is certain and is 35%. Otherwise, this decision round is identical to the last decision round.

Here is an overview of the two savings products and the corresponding taxation:

Savings Product I (immediately taxed):

Period 1: The savings contributions to this savings product are not tax deductible. This means that your savings contributions do not reduce the tax paid in period 1 (40%).

Period 2: The income from this savings product is tax-free in the second period. This means that you pay no tax on the income from this savings product.

Savings Product D (deferred tax):

Period 1: Contributions to this savings product are tax deductible. This means that you save 40% of the tax on your savings contributions.

Period 2: The income from this savings product is subject to a tax of 35% in the second period.

3.8.2 Experiment 2

[Since this experiment is largely identical to Experiment 1, only the differences will be presented in this chapter, and where the content is the same, reference will be made to section 3.8.1 accordingly.]

Welcome Page

Welcome to our Study

[see Chapter 3.8.1]

Instructions - Round 1

Structure and Compensation

[see Chapter 3.8.1]

Your Savings Decision

[see Chapter 3.8.1]

Your Income

[see Chapter 3.8.1]

Your Savings Products I

1. Your Savings Products

In each decision round, you must decide how much of your after-tax income you want to save for the second period. For this purpose, you have two savings products at your disposal - **Savings Product I (immediately taxed)** and **Product D (deferred taxed)**. The two savings products differ only in terms of taxation.

2. Taxation of Savings Contributions

Savings Product I:

Period 1: The savings contributions to this savings product are not tax deductible. This means that your savings contributions do not reduce the tax paid in period 1 (40%).

Period 2: The income from this savings product is tax-free in the second period. This means that you pay no tax on the income from this savings product.

In summary, this savings product has both advantages and disadvantages from a tax point of view:

Advantage: The income from the savings contributions in period 2 is tax-free and the tax rate in period 1 is certain.

Disadvantage: The savings contributions in period 1 do not reduce the tax paid (40%), since they are not deductible.

Savings Product D:

Period 1: Contributions to this savings product are tax deductible. This means that you save 40% of the tax on your savings contributions.

Period 2: The income from this savings product is subject to tax in the second period. However, the amount of tax is uncertain. The tax rate is either 10% or 60%, each with a probability of 50%. Therefore, the average tax rate can be assumed to be 35%. The actual tax rate is determined at the end of the study by a random generator.

In summary, this savings product has both advantages and disadvantages from a tax point of view:

Advantage: The savings contributions save you 40% tax in period 1. The resulting income in the second period is subject to an average tax rate of only 35%.

Disadvantage: The tax rate in period 2 is uncertain. The tax rate could be either very low (10%) or very high (60%).

Your Savings Products II

1. Graphical Representation

The payoffs that you will be compensated for in a period are shown in the decision rounds as follows:

[see Figure 3.5]

2. Save for the Second Period

To save money for the second period, simply move the sliders. You will then see in the graph how much your payoffs are affected by the savings decision.

Tip: You can click on the slider and then use the arrow keys to move it.

Become familiar with the sliders and try a few different savings amounts. Then click Next.

Your Remuneration

[see Chapter 3.8.1]

Comprehension Test

[see Chapter 3.8.1]

Instructions - Round 2

This decision round is identical to the previous decision round, except that you must decide at the beginning of the decision round whether you want both savings products or only one of them.

Instructions - Round 3

1. Savings Products in this decision round In this decision round, as in the first decision round, both savings products I and D are offered.

In this decision round, however, the tax rate in period 2 for savings product D (deferred tax) is certain and is 40%. Otherwise, this decision round is the same as the last decision round.

2. Your Savings Products

Here is an overview of the two savings products and the corresponding taxation:

Savings Product I (immediately taxed):

Period 1: The savings contributions to this savings product are not tax deductible. This means that your savings contributions do not reduce the tax paid in period 1 (40%).

Period 2: The income from this savings product is tax-free in the second period. This means that you pay no tax on the income from this savings product.

In summary, this savings product has both advantages and disadvantages from a tax point of view:

Advantage: The income from the savings contributions in period 2 is tax-free and the tax rate in period 1 is certain.

Disadvantage: The savings contributions in period 1 do not reduce the tax paid (40%), since they are not deductible.

Savings Product D (deferred tax):

Period 1: Contributions to this savings product are tax deductible. This means that you save 40% of the tax on your savings contributions.

Period 2: The income from this savings product is subject to a tax of 40% in the second period.

In summary, this savings product has both advantages and disadvantages from a tax point of view:

Advantage: The savings contributions save you 40% tax in period 1. The tax rate in period 2 is certain

Disadvantage: The income resulting from the savings contributions is subject to tax at a rate of 40% in period 2.

Instructions - Round 4

This decision round is identical to the previous decision round, except that you must now **choose one of the two savings products**.

3.9 Appendix C: Questionnaire (translated from German)

3.9.1 Questions before the Experiment

Question 1: Are you female, male or non-binary?

☐ female
☐ male
☐ non-binary

Question 2: How old are you?

☐

Question 3: How do you rate yourself personally: Are you generally a person who is willing to take risks or do you try to avoid taking risks?

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

Question 4: Did you file a tax return in the last year?

☐ Yes
☐ No

Question 5: Are you currently paying contributions in a so-called Riester or Rürup pension plan?

☐ Yes
☐ No

Question 6: Are you currently paying contributions to a company pension plan?

☐ Yes
☐ No

Question 7: What do you estimate will be your average tax burden (in %) when you retire (excluding social contributions such as health and long-term care insurance)?

What do you think your average **minimum** tax rate will be in retirement?

☐ %

What do you think your average **maximum** tax rate will be in retirement?

☐ %

3.9.2 Questions after each decision round

Question 1: How satisfied are you with the payoff in the **first period**?

not at all satisfied ☐—☐—☐—☐—☐—☐—☐ very satisfied

Question 2: How satisfied are you with the payoff in the **second period**?

not at all satisfied ☐—☐—☐—☐—☐—☐—☐ very satisfied

Question 3: How did you feel during this round about your decision to save?

discontented	☐	☐	☐	☐	☐	☐	☐	☐	☐	contented
bad	☐	☐	☐	☐	☐	☐	☐	☐	☐	good
not annoyed	☐	☐	☐	☐	☐	☐	☐	☐	☐	annoyed
unhappy	☐	☐	☐	☐	☐	☐	☐	☐	☐	happy
not overwhelmed	☐	☐	☐	☐	☐	☐	☐	☐	☐	overwhelmed

Question 4: How much do you agree with the following statement? I felt that I could optimize my payoffs well.

do not agree at all ☐—☐—☐—☐—☐—☐—☐—☐—☐—☐ fully agree

Question 5: How difficult was it for you to make a savings decision?

very easy □—□—□—□—□—□—□—□—□—□ very difficult

[If two savings products were offered, the following question was asked for both products:]

Question 6: How complicated did you find the taxation of **Savings Product I (immediately taxed)** [**Savings Product D (deferred taxed)**]?

very easy □—□—□—□—□—□—□—□—□—□ very difficult

[Only after the second decision round in Experiment 1 and after the first round in Experiment 2:]

Question 7: How much do you agree with the following statement? I liked the choice of two savings products.

do not agree at all □—□—□—□—□—□—□—□—□—□ fully agree

Question 8: Which best describes your view of Savings Product I (taxed immediately)?
A: The tax exemption of my income in period 2 directly increases the taxes I have to pay in period 1.
B: The tax exemption of my income in period 2 does not directly affect the taxes I have to pay in period 1.

totally A □—□—□—□—□—□—□ totally B

Question 9: Which best describes your view of Savings Product D (deferred taxed)?
A: The tax savings due to the deductibility of my savings contributions in period 1 directly increases the taxes I have to pay in period 2.
B: The tax savings due to the deductibility of my savings contributions in period 1 has no direct impact on the taxes I have to pay in period 2.

totally A ☐—☐—☐—☐—☐—☐—☐ totally B

Question 10: This question is to check your attention. Please click here on the last answer option (= perfect).

not at all ☐—☐—☐—☐—☐—☐—☐ perfect

Question 11: Think about your last savings decision. How much do you agree with the following statements regarding your last savings decision?

When making my savings decision, it was important to me that ...	not important at all							very important
... the tax rate on Savings Product I (immediately taxed) was certain.	☐	☐	☐	☐	☐	☐	☐	☐
... with Savings Product D (deferred tax), there was a chance of a lower tax rate (10%) in the second period.	☐	☐	☐	☐	☐	☐	☐	☐
... the savings contributions in Savings Product D (deferred tax) were tax-deductible.	☐	☐	☐	☐	☐	☐	☐	☐
... I have approximately the same payoffs in both periods.	☐	☐	☐	☐	☐	☐	☐	☐
... the payoffs in Savings Product I (immediately taxed) were tax-free in the second period.	☐	☐	☐	☐	☐	☐	☐	☐
... the tax rate for Savings Product D (deferred tax) was only 35% on average in the second period.	☐	☐	☐	☐	☐	☐	☐	☐

[Only after Round 2 in Experiment 1:]

Question 12: In this decision round, you had two savings products to choose from. Looking back, would you have preferred the option of saving in more than one savings product, or would the option of saving in one of the two savings products have been sufficient for you?

- ☐ I would have preferred to save in both savings products.
- ☐ Savings Product D (deferred tax) would have been sufficient for me.
- ☐ Savings Product I (immediately taxed) would have been sufficient for me.
- ☐ For me, one of the two savings products would have been sufficient, be it Savings Product I or Savings Product D.

3.9.3 Question before the second decision round in Experiment 1

Question 1: However, if you had a choice, would you prefer to be able to save in more than one savings product, or would the ability to save in your current savings product be sufficient for you?

- ☐ For me, the current savings product would be sufficient.
- ☐ I would like to have several savings products to choose from.

3.9.4 Questionnaire at the end of the experiment

Question 1: What year were you born (e.g. 1962)?

Question 2: What is your current employment status?

- ☐ Pupil
- ☐ University student
- ☐ Employee
- ☐ Public official
- ☐ Freelancer
- ☐ Homemaker
- ☐ Unemployed/job-seeking
- ☐ No longer working (e.g. retired)

Question 3: What is your highest educational qualification?

- ☐ secondary modern school (”Hauptschulabschluss”)
- ☐ middle school qualification (”Realschulabschluss”)
- ☐ High-school diploma (”Abitur”)
- ☐ Applied science university diploma (”Fachhochschulabschluss”)
- ☐ University degree
- ☐ Dual university degree
- ☐ Doctorate

Question 4: What is your marital status?

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

Question 5: What is your personal net monthly income after taxes and social security?

- ☐ less than €500
- ☐ €500-€1,000
- ☐ €1,000-€1,500
- ☐ €1,500-€2,000
- ☐ €2,000-€2,500
- ☐ €2,500-€3,000
- ☐ €3,000-€3,500
- ☐ €3,500-€4,000
- ☐ €4,000-€4,500
- ☐ €4,500-€5,000
- ☐ €5,000-€5,500
- ☐ €5,500-€6,000
- ☐ €6,000 and more

Question 6: How would you rate your own tax law knowledge?

no knowledge at all ☐—☐—☐—☐—☐—☐—☐—☐—☐—☐ tax expert/consultant

Question 7: Suppose you received a tax refund of 1,000 EUR after filing your next tax return. How would you spend it? (multiple answers possible)

- ☐ Saving for a special purpose (e.g. vacation)
- ☐ For current expenses (e.g. groceries, rent)
- ☐ Pay off debts (e.g. credit)
- ☐ Saving for retirement
- ☐ Make a large purchase (e.g., TV)

Question 8: Now imagine that you plan to be unemployed for a short period of time in six months. You can cover various living expenses during this period by saving within six months before becoming unemployed or by taking out an interest-free loan to be repaid within six months after becoming unemployed. Which of these options would you choose?

☐ Saving within six months before unemployment.
☐ Interest-free loan with repayment within 6 months after the unemployment.

Question 9: Imagine that you have just inherited some money that you want to invest. You are deciding between two different bond options. Both have the same risk and a maturity of 10 years. The first bond is expected to pay €401 per year, but you will also be taxed €100 on that income each year. The second bond has a lower yield of $300 per year, but it will not be taxed. Which bond would you invest in?

☐ I would put the money in the first bond.
☐ I would put the money in the second bond.

Question 10: To what extent do you agree with the following statements?

	do not agree at all							fully agree
With a large variety of food at an all-you-can-eat buffet, I am tempted to eat more than with a small variety of food at an all-you-can-eat buffet.	☐	☐	☐	☐	☐	☐	☐	☐
In stores with a large assortment, I feel tempted to buy more than in stores with a small assortment.	☐	☐	☐	☐	☐	☐	☐	☐
With a large number of investment options (for example, the number of funds in a retirement plan), I am tempted to invest more money than with a small number of investment options.	☐	☐	☐	☐	☐	☐	☐	☐

Question 11: What is the maximum amount you would be willing to pay now to avoid a €5,000 tax liability in the future?

I would be willing to pay € [ ] now in order to avoid paying €5,000 in taxes in one year.

I would be willing to pay € [ ] now in order to avoid paying €5,000 in taxes in 10 years.

I would be willing to pay € [ ] now in order to avoid paying €5,000 in taxes in 20 years.

Question 12: Suppose you had €100 in a savings account and the interest rate was 2% per year. After 5 years, how much do you think you would have in the account if you left the money to grow: more than €102, exactly €102, less than €102?

☐ More than €102
☐ Exactly €102
☐ Less than €102

Question 13: Imagine that the interest rate on your savings account was 1% per year and inflation was 2% per year. After 1 year, would you be able to buy more than, exactly the same as, or less than today with the money in this account?

☐ More than today
☐ The same as today
☐ Less than today

Question 14: Do you think that the following statement is true or false? "Buying a single company stock usually provides a safer return than a stock mutual fund."

☐ True
☐ False

Question 15: A bat and a ball cost €22. The bat costs €20 more than the ball. How much does the ball cost (in €)?

€ ☐

Question 16: A farmer has 15 sheep and all but 8 die. How many are left?

☐ sheep

Question 17: If you are in a race and you pass the person in second place, what is your position?

Position ☐

3.9.5 Task: Risk Aversion

In this task you can earn **more money**. Below you will see 22 choices on the screen. Each decision consists of a choice between ”Option A” and ”Option B”.

- **Option A:** Certain payoff which increases with each decision.
- **Option B:** Two fixed payoffs. The probability of receiving either the high or low payoff is 50%.

After you have made all your selections, one of the 22 options will be randomly selected for your compensation. If the selected option is ”Option B”, the low or high amount of your payoff will be randomly selected based on the respective probabilities. If it is ”Option A”, you will receive the certain amount.

Option A			Option B
3.100 ECU certain	☐	☐	3.000 ECU with a probability of 50%, 7.000 ECU otherwise
3.200 ECU certain	☐	☐	3.000 ECU with a probability of 50%, 7.000 ECU otherwise
3.300 ECU certain	☐	☐	3.000 ECU with a probability of 50%, 7.000 ECU otherwise
3.400 ECU certain	☐	☐	3.000 ECU with a probability of 50%, 7.000 ECU otherwise
3.500 ECU certain	☐	☐	3.000 ECU with a probability of 50%, 7.000 ECU otherwise
3.600 ECU certain	☐	☐	3.000 ECU with a probability of 50%, 7.000 ECU otherwise
3.700 ECU certain	☐	☐	3.000 ECU with a probability of 50%, 7.000 ECU otherwise
3.800 ECU certain	☐	☐	3.000 ECU with a probability of 50%, 7.000 ECU otherwise
3.900 ECU certain	☐	☐	3.000 ECU with a probability of 50%, 7.000 ECU otherwise
4.000 ECU certain	☐	☐	3.000 ECU with a probability of 50%, 7.000 ECU otherwise
4.100 ECU certain	☐	☐	3.000 ECU with a probability of 50%, 7.000 ECU otherwise
4.200 ECU certain	☐	☐	3.000 ECU with a probability of 50%, 7.000 ECU otherwise
4.300 ECU certain	☐	☐	3.000 ECU with a probability of 50%, 7.000 ECU otherwise
4.400 ECU certain	☐	☐	3.000 ECU with a probability of 50%, 7.000 ECU otherwise
4.500 ECU certain	☐	☐	3.000 ECU with a probability of 50%, 7.000 ECU otherwise
4.600 ECU certain	☐	☐	3.000 ECU with a probability of 50%, 7.000 ECU otherwise
4.700 ECU certain	☐	☐	3.000 ECU with a probability of 50%, 7.000 ECU otherwise
4.800 ECU certain	☐	☐	3.000 ECU with a probability of 50%, 7.000 ECU otherwise
4.900 ECU certain	☐	☐	3.000 ECU with a probability of 50%, 7.000 ECU otherwise
5.000 ECU certain	☐	☐	3.000 ECU with a probability of 50%, 7.000 ECU otherwise
5.100 ECU certain	☐	☐	3.000 ECU with a probability of 50%, 7.000 ECU otherwise
5.200 ECU certain	☐	☐	3.000 ECU with a probability of 50%, 7.000 ECU otherwise

3.9.6 Task: Loss Aversion

And now to our final task, where you can earn **more money** again.

Below you will see 6 lotteries. For each of these lotteries, you can choose whether or not to participate. If you participate in the lottery, a random number generator will decide whether you win or lose the lottery.

The profit or loss is then as follows:

- **Profit:** You will receive an additional payoff of €1,20.
- **Loss:** Your compensation will be reduced by a given amount (see below).

The probability of winning or losing is 50% in each case.

After you have made all of your decisions, one of the 6 lotteries will be randomly selected. If you entered the selected lottery, a random number generator will determine whether you won or lost the lottery.

Please decide now which lotteries you would like to participate in.

Lotteries (probability 50% / 50%)	**Participate**	**Do not participate**
Profit = €1,20 / Loss = €-0,40	☐	☐
Profit = €1,20 / Loss = €-0,60	☐	☐
Profit = €1,20 / Loss = €-0,80	☐	☐
Profit = €1,20 / Loss = €-1,00	☐	☐
Profit = €1,20 / Loss = €-1,20	☐	☐
Profit = €1,20 / Loss = €-1,40	☐	☐

3.10 Appendix D: Screenshots of oTree (translated from German)

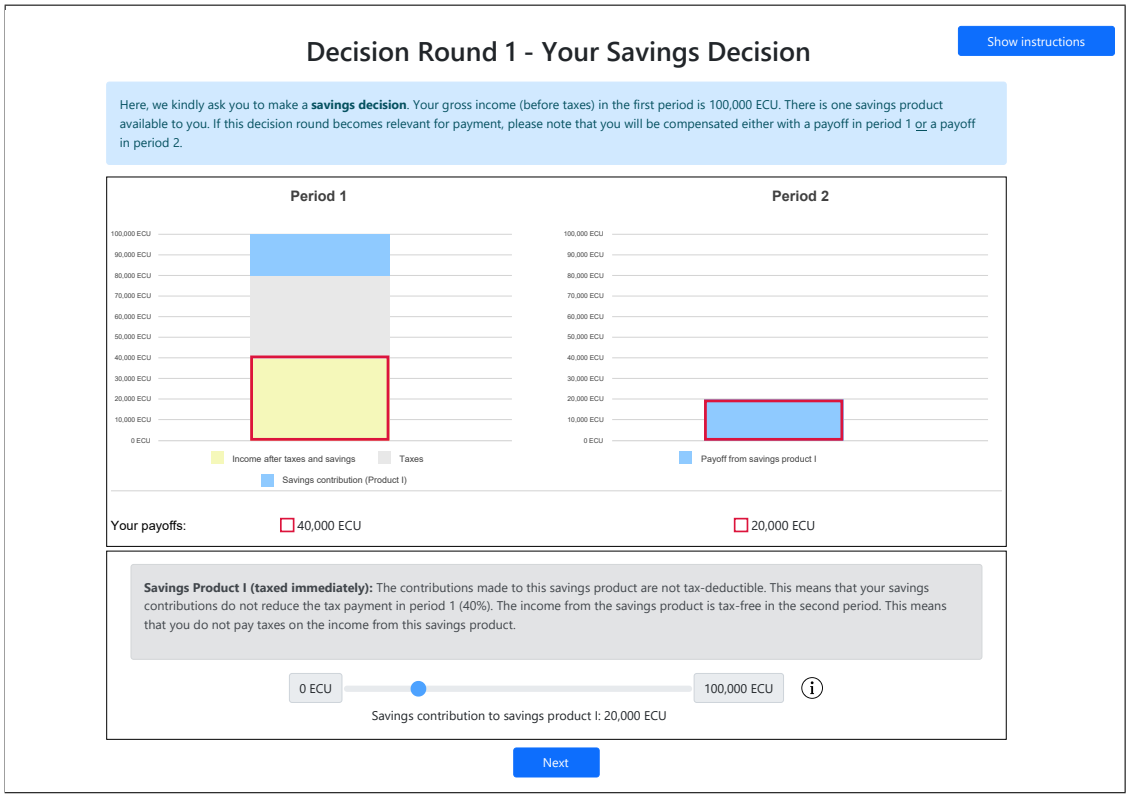


Figure 3.3: Savings Decision: RA

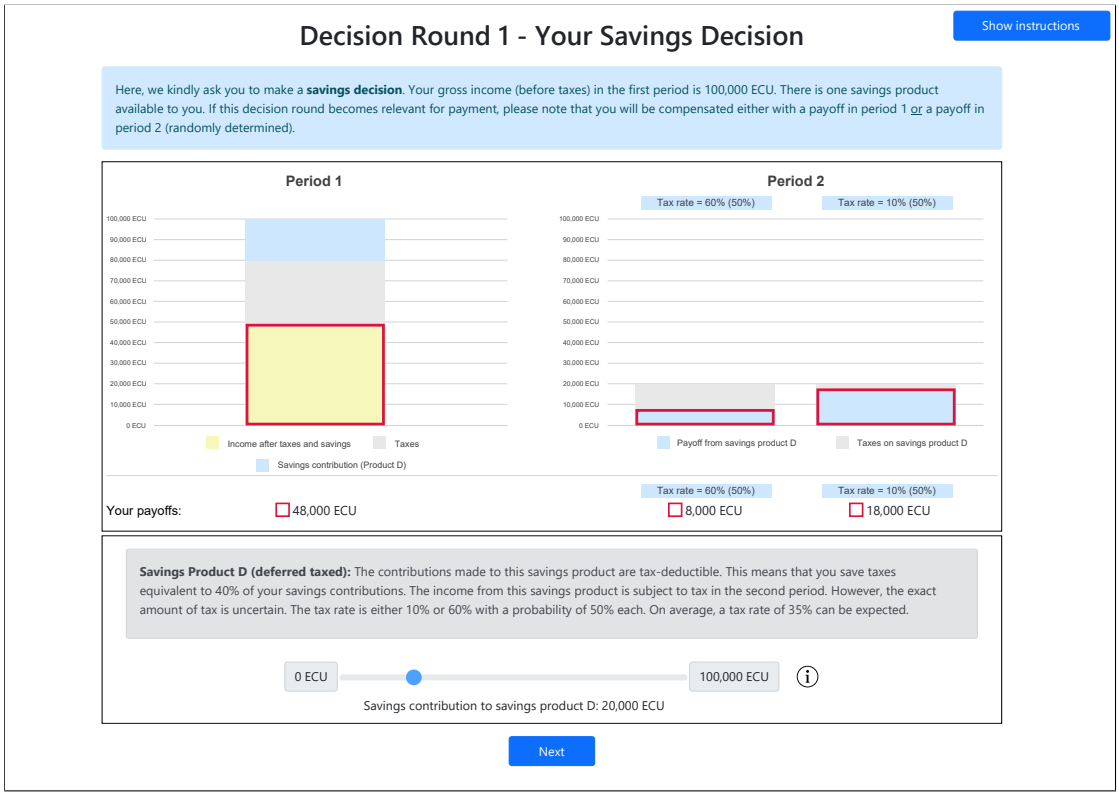


Figure 3.4: Savings Decision: TA

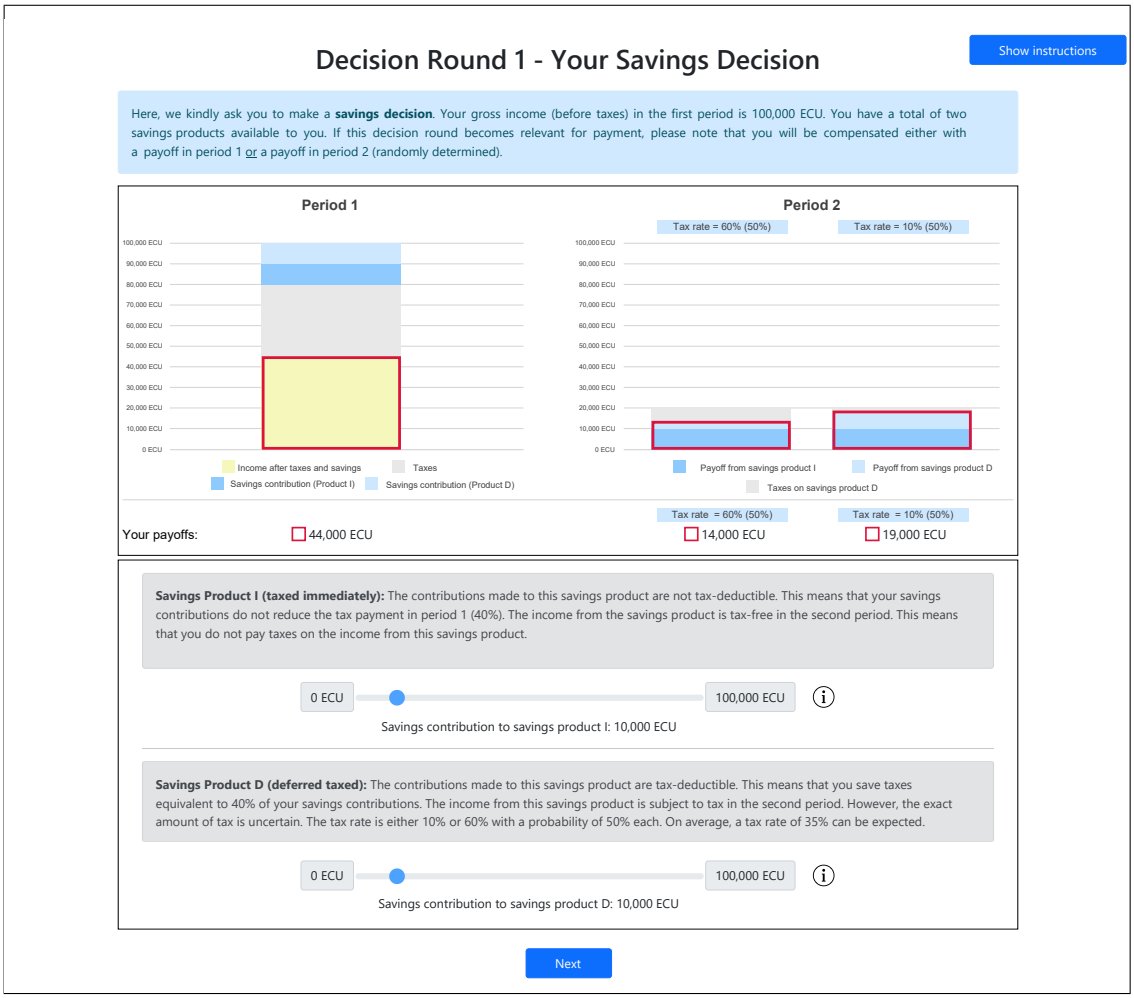


Figure 3.5: Savings Decision: RA + TA

Chapter 4

The effect of tax policy uncertainty on effort and implications for welfare

This paper examines the effect of tax policy uncertainty on effort in an agency model with risk-averse principal and agent. If the agent's effort is unobservable, the agent's variable share of profit acts as a risk sharing and incentivizing instrument. Then, a counter-cyclical tax base policy at the level of the agent or a pro-cyclical one at the level of the principal can raise the agent's variable share of profit, whose increase raises the effort of the agent. This theoretical finding supports a pro-cyclical tax policy at company level (principal) and a counter-cyclical one at employee level (agent). Tax policy uncertainty in the sense of tax base risk makes possible this increase in effort and strengthens the effects. Additionally, under a counter-cyclical tax base policy at the level of the agent, tax base risk at the level of the agent up to a certain level increases overall utility and therefore welfare.

Keywords: agency model · tax base risk · tax policy uncertainty · pro-cyclical · counter-cyclical

4.1 Introduction

The corona pandemic led to tax base changes worldwide. In Germany, tax base reductions were implemented by means of the Corona Tax Assistance Act. At the level of private individuals, for example the relief amount for single parents was raised and a lump sum for working from home was introduced. At the company level, for example the duration of using investment deductions was extended and the amount of degressive depreciations increased. Other countries also provided such counter-cyclical tax policy measures, inter alia at the level of corporations, to reduce the tax base in the time of the crisis (Alm et al. (2020)). To name just a few, the United States enlarged allowances for interest deductions of the taxable income, South Africa delayed the limitation of interest expense deductions to 30 percent of taxable income and deferred a reform of enlarging the corporate tax base and the Czech Republic enabled immediate depreciation for specific investments (OECD 2021, pp. 40, 42). In contrast, France temporarily introduced a tax for private healthcare suppliers and Hungary implemented a retail surtax. These are examples for pro-cyclical measures at the level of companies (OECD 2021, p. 44). At the level of individuals, Canada broadened the alternative minimum tax base for individuals with high income (Government of Canada (2023)). Reasons for a reduction of taxes are to increase liquidity, support recovery, (OECD 2021, p. 41), increase consumption, output and investment (Blanchard 2020, pp. 116, 117) and thus counteract a recession. In contrast, an important reason for an opposite pro-cyclical tax policy is to avoid enlargement of budget deficits (Blanchard 2020, p. 139).

I derive a counter-cyclical tax base policy at employee level (agent) and a pro-cyclical one at company level (principal) as possible determinants of increasing effort. By the hedging properties of a counter-cyclical tax base policy at employee level, the variable share of profit of the risk-averse employee can be increased. Under unobservable effort of the employee, the employee's work effort increases. The same result of an increasing variable share of profit of the employee and hence increased effort of the agent under unobservable effort can be obtained by a pro-cyclical tax policy at company level. In contrast, a widespread counter-cyclical tax policy at company level is in danger to restrict effort.

By varying the tax base pro- or counter-cyclically, the tax law is not static but flexible. This flexibility of tax policy can be referred to as tax policy uncertainty, quite exposed to criticism. Skinner (1988) estimates the welfare loss from tax policy uncertainty at 15 billion dollars in 1986 and Adam Smith states:

"The certainty of what each individual ought to pay is, in taxation, a matter of so great importance that a very considerable degree of inequality, it appears, I believe, from the experience of all nations, is not so great an evil as a very small degree of uncertainty." (Smith 1776, Book 5)

In contrast, the present paper highlights tax policy uncertainty in the sense of tax base risk as the tax policy's scope of action. Tax policy uncertainty strengthens and enables the increase in effort

by a counter-cyclical tax base policy at employee and a pro-cyclical one at company level.

Section 4.2 places this paper in the context of the existing literature. Then the underlying model assumptions are described (see section 4.3). Subsequently, the first- (see section 4.4) and the second-best solution (see section 4.5) of the model are presented. Section 4.6 additionally focuses on utilities of principal and agent in the case of a pro-cyclical tax policy with respect to the tax base of the principal and a counter-cyclical one with respect to the tax base of the agent. At the end, section 4.7 concludes.

4.2 Literature

The effects of tax uncertainty on decision making are extensive and ambiguous. I subsequently especially focus on the effects of uncertainty on effort.[1] Eaton and Rosen (1980) examine the impact of wage uncertainty on labor supply. Focusing only on the employee's utility maximization problem without involving an offered employment contract, they show the ambiguous effects of wage taxation dependent on the income and substitution effect. Effort can be increased to self-secure against future uncertainty. Parker et al. (2005) demonstrate this effect of self-securing empirically, showing that self-employed males work longer hours responding to greater uncertainty. Flodén (2006) expands the model of Eaton and Rosen (1980) by including endogenous savings. He shows that including savings, the reduction of future labor supply assuming wage uncertainty is stronger. I derive tax policy uncertainty as possible determinant to increase an employee's effort.

In contrast to these contributions, I focus on an agency model. An agent exerts effort to generate profit for the principal. The profit is also determined by an uncertain factor. The agent is risk- averse, does not want to bear risk and prefers a fixed remuneration. But when the principal in addition cannot observe the effort of the agent, a fixed remuneration of the agent would not incentivize the agent to exert effort. Thus, there exists a trade-off between risk and incentive (Shavell (1979) and Holmström (1979)). The present paper focuses particularly on the variable share of profit as part of the variable remuneration of the agent and its risk sharing and incentivizing effects. A higher variable share of profit of the agent shifts more risk to the agent, also influencing the agent's effort in the second-best solution. Lukas et al. (2019) also analyze risk and incentives in an agency model. They focus on risk-neutral principal and agent and assume that the agent does not only exert effort but also chooses projects. Additionally, they include accountability of the agent's choice and effort in their model. To compensate the agent for the pressure of accountability and prevent the agent from choosing projects with low risk and return, the principal eventually has to increase the variable share of profit of the agent.

[1] For papers studying the impact of tax uncertainty on investment see e.g. Alvarez et al. (1998), Auerbach and Hines (1988), Hassett and Metcalf (1999), Niemann (2004), Niemann (2011), Fedele et al. (2011) and Niemann and Sureth-Sloane (2016).

Amihud and Lev (1981) also focus on risk in an agency model. They consider the stockholders of a company as principal, diversified by portfolios in the capital market, and the manager as risk-averse party, whose income risk is strongly related to that of the company. They suppose that managers engage in conglomerate mergers to diversify, possibly in contradiction to the interest of the principal. In contrast, I stress the role of a counter-cyclical tax policy at the level of the agent as a measure to minimize the agent's uncertainty. Like the present paper, Hofmann and Hofmann (2013) also focus on risk-averse principal and agent and in particular on the uncertainty of the profit parameter. In distinction to the present paper, they include divergent perceptions of the fluctuation of the company result by principal and agent as symbol of deviating corporate culture of corporate mergers and assume that the perceived uncertainty enters the agent's variable share of profit. They highlight the variable share of profit of the agent (dependent of the degree of risk aversion of principal and agent and the perception of the fluctuation of the company result) as a possibility to split the risk between the two parties and under unobservable effort additionally as instrument to incentivize. They show that employees of the leading company should be given stronger incentives than employees of the acquired company. Empirically, Prendergast (2002) finds a positive relationship between risk and incentives. She points out that in common agency models (referring to a risk-neutral principal), theoretically, there exists a negative relationship between incentives and uncertainty. She explains the positive relationship found with increased delegation in an environment with greater uncertainty, leading to higher variable remuneration. In the group that should provide the strongest evidence for the theory, this cannot be shown empirically, so Prendergast (2002) considers the possibility of other potential explanations. Such an explanation could be the raise of the variable share of profit for risk sharing purposes that I illustrate.

Ewert and Niemann (2014) include tax risk, comprising for example tax reforms and uncertain results of audits, in an agency model and study tax avoidance. They consider a multi-task agency model with an agent who can engage in tax planning and operational effort. The depending tax liability and operational cash flow of the company are additionally influenced by the random variables tax risk and operational risk and their correlation. By embedding tax risk and operational risk and their correlation in the model, I follow Ewert and Niemann (2014) (see section 4.3). Ewert and Niemann (2014) show paradoxical results like a possibly decreasing effort of tax planning in the company's tax rate and derive operational and tax planning productivity of the agent, tax risk and operational risk and their correlation as determinants of tax avoidance.[2] Bauer et al. (2018) derive deviating tax bases in the sense of profit shifting incentives as interesting topic for future research. I close the research gap of considering deviating tax bases but in the sense of tax base risks.

[2]See further e.g. Scotchmer and Slemrod (1989), Beck and Jung (1989) and Diller and Lorenz (2015) for the effect of tax uncertainty on tax avoidance and evasion.

4.3 Model assumptions

The company (principal) provides the employee (agent) with a production technology to work with. The company's gross profit x is a function of the agent's effort a, the agent's productivity b and a random variable ϵ. I follow Ewert and Niemann (2014) and refer to the random variable ϵ as operational company risk. The random variable is normally distributed with variance σ^2 and zero mean and represents for example the impact of global crises and firm specific risks that cannot be influenced by the agent. All operational company risks are summed up in σ^2. Let σ denote operational company risk. The gross profit can be stated as:

$$x = a \cdot b + \epsilon. \tag{4.1}$$

The agent is compensated by a linear compensation contract, comprising a fixed remuneration f and a variable remuneration w_v. The variable remuneration, w_v, consists of a share of profit v of the gross profit, x:[3]

$$\begin{aligned} w_v &= v \cdot x \\ &= v \cdot (a \cdot b + \epsilon). \end{aligned} \tag{4.2}$$

The agent also faces tax base risk that is not shared with the principal. It is represented by the random variable k_{A_Z}, which is normally distributed with mean k_A and variance $\sigma^2_{k_A}$. All tax base risks of the agent are summed up in $\sigma^2_{k_A}$. Let σ_{k_A} denote tax base risk at the level of the agent. The random variables ϵ and k_{A_Z} are assumed to be jointly normally distributed. Thus, the marginal distributions are normal and the sum of the random variables is normally distributed. I assume a tax rate of the agent $t_A \in (0, 1)$. The agent's after-tax remuneration w takes the following form:

$$\begin{aligned} w &= f + w_v - (f + w_v - k_{A_Z}) \cdot t_A \\ &= \big(f + v \cdot (a \cdot b + \epsilon)\big) \cdot (1 - t_A) + k_{A_Z} \cdot t_A. \end{aligned} \tag{4.3}$$

The agent dislikes hard work, exerting effort causes costs $C(a)$:

$$C(a) = \frac{1}{2} \cdot a^2. \tag{4.4}$$

[3] I follow Voßmerbäumer (2012) and Bauer and Kourouxous (2017) and use a pre-tax base of variable remuneration of the agent. Ewert and Niemann (2012) use a so-called hybrid base of variable remuneration of the agent that includes after-tax values but not the remuneration's reduction of its own tax base. The main theoretical results for a hybrid after-tax base of variable compensation of the agent that does not include the remuneration's reduction of its own tax base and integrates the mean of the principal's tax base risk are presented in the Appendix. The main theoretical results remain valid, even overall utilities in the optimum are equal. Hence, a remuneration contract with an after-tax base of variable remuneration does not increase welfare compared to a contract with a pre-tax base of variable remuneration. See e.g. Attwood et al. (1998) for an empirical investigation of reasons for a pre- or after-tax base of variable remuneration.

At the level of the principal, in addition to the gross profit, the agent's remuneration and some additional tax base risk are integrated into the tax base. The additional tax base risk is presented by the random variable k_{P_Z}, which is normally distributed with mean k_P and variance $\sigma^2_{k_P}$. All tax base risks of the principal are summed up in $\sigma^2_{k_P}$. Let σ_{k_P} denote tax base risk at the level of the principal. The random variables ϵ and k_{P_Z} are assumed to be jointly normally distributed. Therefore, the marginal distributions are normal and the sum of the random variables is normally distributed. The tax rate amounts to $t_P \in (0, 1)$. The principal's profit after taxation and remuneration π can be stated as:

$$\begin{aligned} \pi &= x - f - w_v - t_P \cdot (x - f - w_v - k_{P_Z}) \\ &= \big((a \cdot b + \epsilon) \cdot (1 - v) - f\big) \cdot (1 - t_P) + k_{P_Z} \cdot t_P. \end{aligned} \tag{4.5}$$

The utilities of agent U_A and principal U_P are represented by negative exponential utility functions:[4]

$$U_A = -e^{-r_A \cdot \left(w - C(a)\right)}, \tag{4.6}$$

$$U_P = -e^{-r_P \cdot \pi}. \tag{4.7}$$

with the constant absolute risk aversion of the agent $r_A > 0$ and the constant absolute risk aversion of the principal $r_P > 0$. The analysis is based on the so called LEN model (Spremann (1987) and Holmstrom and Milgrom (1987)). Under the LEN assumptions, explicit solutions by using certainty equivalents are obtained.[5] In distinction to the standard agency models with a risk-neutral principal, I assume that principal and agent are risk-averse. An example for a risk-averse principal are family businesses, which cannot diversify company-specific risks (Hofmann and Hofmann (2013)). The certainty equivalent of the agent CE_A is composed of the expected remuneration after tax $E[w]$, the cost of effort $C(a)$, and the risk premium RP_A:

$$CE_A = E[w] - \frac{1}{2} \cdot a^2 - \frac{r_A}{2} \cdot Var[w] \tag{4.8}$$

with

$$\frac{r_A}{2} \cdot Var[w] = RP_A \tag{4.9}$$

with

$$Var[w] = \sigma^2_{k_A} \cdot t^2_A + \sigma^2 \cdot (1 - t_A)^2 \cdot v^2 + 2 \cdot \rho_A \cdot \sigma_{k_A} \cdot \sigma \cdot t_A \cdot v \cdot (1 - t_A). \tag{4.10}$$

[4]The presentation of the following equations is based on Voßmerbäumer (2012).

[5]For a detailed formal derivation see Schöndube (2006), pages 31-34 and Appendix A.1.

Assuming that the operational company risk, ϵ, and the agent's tax base risk, k_{A_Z}, are correlated in the sense of a pro-cyclical tax policy, a positive correlation, ρ_A, raises the risk premium.[6] In contrast, a negative correlation in the sense of a counter-cyclical tax policy reduces it. Thus, tax policy uncertainty functions as an instrument to influence the general perception of uncertainty of the agent and thus the agent's certainty equivalent.

The certainty equivalent of the principal CE_P consists of the expected profit after taxation and remuneration $E[\pi]$ minus the risk premium of the principal RP_P:

$$CE_P = E[\pi] - \frac{r_P}{2} \cdot Var[\pi] \tag{4.11}$$

with

$$\frac{r_P}{2} \cdot Var[\pi] = RP_P \tag{4.12}$$

with

$$\begin{aligned} Var[\pi] = \sigma_{k_P}^2 \cdot t_P^2 + \sigma^2 \cdot (1 - t_P - v + t_P \cdot v)^2 \\ + 2 \cdot \rho_P \cdot \sigma_{k_P} \cdot \sigma \cdot t_P \cdot (1 - t_P - v + t_P \cdot v). \end{aligned} \tag{4.13}$$

The correlation coefficient ρ_P between the principal's tax base risk, k_{P_Z}, and the operational company risk, ϵ, also enters the risk premium of the principal, the interpretation is similar to that of the correlation coefficient ρ_A above.[7]

The agent only accepts the remuneration contract if it does not fall below the reservation utility u.[8] In the optimum, the principal pays the agent such that the agent receives the reservation utility and barely accepts the remuneration contract. The certainty equivalent of the agent always equals the reservation utility. Equation (4.14) denotes the agent's participation constraint:

$$(f + E[w_v]) \cdot (1 - t_A) + k_A \cdot t_A - \frac{1}{2} \cdot a^2 - \frac{1}{2} \cdot r_A \cdot Var[w] = u. \tag{4.14}$$

Reshaping (4.14) yields the fixed part of remuneration:

$$f = \frac{1}{1 - t_A} \cdot \big(\frac{a^2}{2} - k_A \cdot t_A + u - E[w_v] + t_A \cdot E[w_v] + \frac{1}{2} \cdot r_A \cdot Var[w]\big). \tag{4.15}$$

[6] The correlation coefficient ρ_A is determined by:

$$\rho_A = \frac{Cov[\epsilon, k_{A_Z}]}{\sigma \cdot \sigma_{k_A}}.$$

[7] The correlation coefficient ρ_P is determined by:

$$\rho_P = \frac{Cov[\epsilon, k_{P_Z}]}{\sigma \cdot \sigma_{k_P}}.$$

[8] The underlying assumption that taxation and uncertainty do not affect the reservation utility is widespread (Bauer et al. (2018), see e.g. Voßmerbäumer (2012), Göx (2008) and Niemann (2008)).

4.4 First-best solution

Assuming that the principal can observe the effort of the agent, the variable part of the remuneration is used to spread the risk between the two risk-averse parties. Plugging the agent's participation constraint (4.14) in the certainty equivalent of the principal (4.11) and then maximizing it with respect to v yields the agent's optimal variable share of profit, v^*.[9]

Observation 1 *The agent's optimal variable share of profit is determined by:*

$$v^* = \frac{-\sigma_{k_A} \cdot \rho_A \cdot r_A \cdot t_A + \sigma_{k_P} \cdot \rho_P \cdot r_P \cdot t_P + \sigma \cdot r_P \cdot (1 - t_P)}{\sigma \cdot \big(r_A \cdot (1 - t_A) + r_P \cdot (1 - t_P)\big)}. \tag{4.16}$$

In addition to the degree of risk aversion of principal and agent, the agent's variable share of profit is influenced by the degree of tax base risk of principal and agent and pro- or counter-cyclical tax policy. A positive correlation $\rho_P > 0$ between the principal's tax base risk, k_{P_Z}, and the operational company risk, ϵ, or a negative correlation $\rho_A < 0$ between the agent's tax base risk, k_{A_Z}, and the operational company risk, ϵ, increase the agent's variable share of profit compared to the case without tax base risks. Tax base risks of principal and agent, σ_{k_P} and σ_{k_A}, make the effects possible and strengthen them. Inserting the agent's participation constraint (4.14) in the certainty equivalent of the principal (4.11) and then maximizing it with respect to a and solving for a yields:

$$a^* = b \cdot (1 - t_A). \tag{4.17}$$

The optimal effort, a^*, does not depend on the variable part of the remuneration. In this first-best case, tax policy uncertainty and a pro- or counter-cyclical tax policy influence the agent's variable share of profit and do not have an impact on the agent's effort. The variable payment only acts as a risk sharing instrument.

4.5 Second-best solution

Assuming that the principal cannot observe the effort of the agent, the agent's variable share of profit is not only an instrument for sharing risk but also for enhancing incentives to work.

Lemma 1 *The optimal effort, $a^\dagger$, and the agent's optimal variable share of profit, $v^\dagger$, are determined by:*

$$a^\dagger = b \cdot (1 - t_A) \cdot v^\dagger, \tag{4.18}$$

$$v^\dagger = \frac{b^2 \cdot (1 - t_A) + \sigma \cdot \big(-\sigma_{k_A} \cdot \rho_A \cdot r_A \cdot t_A + \sigma_{k_P} \cdot \rho_P \cdot r_P \cdot t_P + \sigma \cdot r_P \cdot (1 - t_P)\big)}{b^2 \cdot (1 - t_A) + \sigma^2 \cdot \big(r_A \cdot (1 - t_A) + r_P \cdot (1 - t_P)\big)}. \tag{4.19}$$

Proof: See Appendix.

[9] The symbol '$*$' ('$\dagger$') denotes the optimal solution in the first-best (second-best) case.

Equation (4.18) shows that an increasing variable share of profit of the agent, $v^{\dagger}$, raises the effort of the agent.

Corollary 1 *An increase in the agent's variable share of profit, $v^{\dagger}$, raises the agent's effort, $a^{\dagger}$.*
Proof: See (4.18).

Compared to the agent's variable share of profit in the first-best case (4.16), the one in the second-best case (4.19) depends on the productivity of the agent, b, and now additionally acts as instrument to incentivize work because the effort of the agent is not observable. Under the realistic assumption of a first-best variable share of profit smaller than one, the agent's variable share of profit in the second-best case is greater than the agent's variable share of profit in the first-best case.

Proposition 1 *The agent's second-best variable share of profit, $v^{\dagger}$, exceeds the first-best one v^{*} under the assumption of a first-best variable share of profit smaller than one.*
Proof: See Appendix.

The agent's variable share of profit, $v^{\dagger}$, can be divided into three parts.
The base case without tax base uncertainty:

$$\frac{b^2 \cdot (1 - t_A) + \sigma^2 \cdot r_P \cdot (1 - t_P)}{b^2 \cdot (1 - t_A) + \sigma^2 \cdot \big(r_A \cdot (1 - t_A) + r_P \cdot (1 - t_P)\big)}, \tag{4.20}$$

the part, influenced by the principal's tax base risk

$$\frac{\sigma \cdot (\sigma_{k_P} \cdot \rho_P \cdot r_P \cdot t_P)}{b^2 \cdot (1 - t_A) + \sigma^2 \cdot \big(r_A \cdot (1 - t_A) + r_P \cdot (1 - t_P)\big)}, \tag{4.21}$$

and the part dependent on the agent's tax base risk

$$\frac{\sigma \cdot (-\sigma_{k_A} \cdot \rho_A \cdot r_A \cdot t_A)}{b^2 \cdot (1 - t_A) + \sigma^2 \cdot \big(r_A \cdot (1 - t_A) + r_P \cdot (1 - t_P)\big)}. \tag{4.22}$$

The correlation coefficients ρ_P and ρ_A of the tax base risks of principal and agent and the operational company risk, ϵ, (see (4.21) and (4.22)) affect whether the agent's variable share of profit is greater or smaller than the agent's variable share of profit without tax base risks of principal and agent (see (4.20)).

According to (4.21), a positive correlation between the principal's tax base risk and the operational company risk, $\rho_P > 0$, leads to a higher variable share of profit of the agent than in the base case. The principal wishes to pass some of the risk to the agent. A negative correlation, $\rho_P < 0$, hedges the principal, so that the desire of sharing risk is smaller than in the base case without tax base risk. In this case, the agent's variable share of profit is smaller.

The term (4.22) reveals that a positive correlation, $\rho_A > 0$, between the agent's tax base risk and the operational company risk, ϵ, aggravates the agent's risk. The agent's variable share of profit

is smaller than that in the case without tax base uncertainty. The other way round, a negative correlation, $\rho_A < 0$, hedges the agent such that the agent is able to bear more risk, the agent's variable share of profit is greater than in the base case without tax base uncertainty. Proposition (2) summarizes the results.

Proposition 2 *Compared to the second-best solution without tax base risks,*

(i) a positive (negative) correlation, $\rho_P > 0$ ($\rho_P < 0$), between the principal's tax base risk, k_{P_Z}, and the operational company risk, ϵ, increases (decreases) the agent's variable share of profit and hence the agent's effort.

(ii) a negative (positive) correlation, $\rho_A < 0$ ($\rho_A > 0$), between the agent's tax base risk, k_{A_Z}, and the operational company risk, ϵ, increases (decreases) the agent's variable share of profit and hence the agent's effort.

(iii) a positive tax base risk at the level of the principal, σ_{k_P}, makes possible (i). An increase in σ_{k_P} dependent on the correlation, ρ_P, either increases (if $\rho_P > 0$) or decreases (if $\rho_P < 0$) the agent's variable share of profit and thus the agent's effort. A positive tax base risk at the level of the agent, σ_{k_A}, makes possible (ii). A raise in σ_{k_A}, dependent on the correlation, ρ_A, either increases (if $\rho_A < 0$) or decreases (if $\rho_A > 0$) the agent's variable share of profit and thus the agent's effort.

Proof: See the decomposition of the variable share of profit $v^\dagger$ ((4.20), (4.21) and (4.22)) and Corollary 1.

Tax base risk is not based on risk in the sense of insecure audits alone but especially in the sense of flexible tax policy. The possibility of being able to react to mitigate or amplify current crises is especially expressed by the interaction of correlation coefficients ρ_P and ρ_A with tax base risks, σ_{k_P} and σ_{k_A}. Tax base risks of principal and agent interact as levers that strengthen and make possible the effects of pro- and counter-cyclical tax policy.

4.6 Additional analysis

The main analysis points out that increasing tax base risk can increase effort as objective measure. Prerequisites are a not observable effort of the agent and a pro-cyclical tax policy at the level of the principal or a counter-cyclical tax policy at the level of the agent. Additionally, this section examines the utilities of principal and agent in this setting. In general, increasing risk reduces utility of risk-averse individuals. I find that under a counter-cyclical tax base policy at the agent's level, tax base risk up to a certain level increases overall utility and therefore welfare.

As mentioned above, in the optimum, the agent always receives exactly the reservation utility to accept the contract, referred to as the agent's participation constraint, (4.14). Thus, the following analysis focuses on the utility of the principal and therefore the principal's certainty equivalent.

Differentiating the principal's certainty equivalent (4.11) with respect to the standard deviation σ_{k_P}, as measure of the principal's tax base risk in the optimum, the Envelope Theorem yields:

$$\begin{aligned} \frac{dCE_P^\dagger}{d\sigma_{k_P}} &= \frac{\partial CE_P^\dagger}{\partial v^\dagger} \cdot \frac{\partial v^\dagger}{\partial \sigma_{k_P}} + \frac{\partial CE_P^\dagger}{\partial \sigma_{k_P}} = \frac{\partial CE_P^\dagger}{\partial \sigma_{k_P}} \\ &= -\frac{1}{2} \cdot r_P \cdot \left(2 \cdot \sigma_{k_P} \cdot t_P^2 + 2 \cdot \rho_P \cdot \sigma \cdot t_P \cdot (1 - t_P) \cdot (1 - v^\dagger)\right). \end{aligned} \tag{4.23}$$

Under the realistic assumptions of a variable share of profit of the agent, $v^\dagger$, greater than zero and smaller than one, if the correlation $\rho_P > 0$ between the principal's tax base risk, k_{P_Z}, and the operational company risk, ϵ, is positive, an increased tax base risk always reduces the certainty equivalent of the principal. In this case, the tax policy does not hedge but raise the uncertainty of the risk-averse principal in the optimum.[10]

Differentiating the principal's certainty equivalent (4.11) in the optimum with respect to the standard deviation σ_{k_A}, as measure of tax base risk at the level of the agent, the Envelope Theorem yields:

$$\frac{\partial CE_P^\dagger}{\partial \sigma_{k_A}} = -\frac{1}{1 - t_A} \cdot \frac{1}{2} \cdot r_A \cdot (1 - t_P) \cdot \left(t_A^2 \cdot \sigma_{k_A} \cdot 2 + 2 \cdot \rho_A \cdot \sigma \cdot t_A \cdot v^\dagger \cdot (1 - t_A)\right). \tag{4.24}$$

Maximizing (4.24) with respect to σ_{k_A} and solving for σ_{k_A} yields the level of tax base risk at the level of the agent that maximizes the utility:[11]

$$\sigma_{k_A}^\dagger = -\frac{\sigma \cdot \rho_A \cdot (1 - t_A) \cdot \left(b^2 \cdot (1 - t_A) + \sigma^2 \cdot r_P \cdot (1 - t_P) + \sigma \cdot r_P \cdot \sigma_{k_P} \cdot p_P \cdot t_P\right)}{t_A \cdot \left(b^2 \cdot (1 - t_A) + \sigma^2 \cdot \left(r_P + (1 - \rho_A^2) \cdot (1 - t_A) \cdot r_A - r_P \cdot t_P\right)\right)}. \tag{4.26}$$

An increase in tax base risk at the level of the principal, σ_{k_P}, decreases overall utility and thus counteracts a potential increase in utility by a raise in tax base risk at the level of the agent, σ_{k_A}. Hence, I analyze the effects of tax base risk at the level of the agent on overall utility under the assumption of no tax base risk at the level of the principal, $\sigma_{k_P} = 0$. If the correlation ρ_A between the agent's tax base risk, k_{A_Z}, and the operational company risk, ϵ, is negative, there exists a positive optimal level of tax base risk, $\sigma_{k_A}^\dagger$. Thus, tax base risk at the level of the agent up to a certain level increases overall utility and therefore welfare.

[10] The standard deviations σ_{k_P} and below σ_{k_A} influence the certainty equivalent of the principal in the first-best solution the same way. Then, only v^* would substitute $v^\dagger$. Technically, the second-best solution differs from the first-best only in the inclusion of the optimal effort. According to the Envelope Theorem, these indirect effects can be neglected.

[11] The second derivative of the principal's certainty equivalent with respect to the agent's tax base risk amounts to:

$$\frac{\partial^2 CE_P^\dagger}{\partial \sigma_{k_A}} = -\frac{r_A \cdot t_A^2 \cdot (1 - t_P) \cdot \left(b^2 \cdot (1 - t_A) + \sigma^2 \cdot \left(r_P + (1 - \rho_A^2) \cdot r_A \cdot (1 - t_A) - r_P \cdot t_P\right)\right)}{(1 - t_A) \cdot \left(b^2 \cdot (1 - t_A) + \sigma^2 \cdot \left(r_A \cdot (1 - t_A) + r_P \cdot (1 - t_P)\right)\right)}. \tag{4.25}$$

The derivative is negative under realistic assumptions. Thus, the principal's certainty equivalent is strictly concave in σ_{k_A} in the optimum.

Proposition 3 *Assuming a variable share of profit of the agent, $v^{\dagger}$, greater than zero and smaller than one and a positive correlation between the principal's tax base risk and the operational company risk, $\rho_P > 0$, an increase in the tax base risk at the level of the principal always reduces overall utility. In contrast, under a counter-cyclical tax base policy at the level of the agent, $\rho_A < 0$, tax base risk at the level of the agent, σ_{k_A}, up to a certain level increases overall utility and therefore welfare.*
Proof: See (4.23) and (4.26).

4.7 Conclusion

This analysis is based on an agency model with risk-averse principal and agent. The company (principal) provides the employee (agent) with a production technology to work with. The earned gross profit is uncertain, it is not only influenced by the effort and the productivity of the agent but also by a random factor, inter alia comprising global crises and referred to as operational company risk. The agent is compensated by a linear compensation contract, comprising a fixed remuneration and a share of the gross profit. Both individuals face tax base risks, referred to as tax policy uncertainty. The tax policy can influence the utility of the risk-averse individuals by acting pro- or counter-cyclically. A pro-cyclical tax policy increases the uncertainty, a counter-cyclical one hedges. In the case of an observable effort of the agent (first-best) a pro-cyclical tax policy at the level of the principal increases the principal's uncertainty. The risk-averse principal wants to share some of the uncertainty not comprised in the base of variable remuneration of the agent. Thus, the agent's variable share of profit is raised. This is also achieved if the tax policy acts counter-cyclically at the level of the agent. The risk-averse individual is hedged and accepts a higher variable share of profit. The variable share of profit acts as a risk sharing instrument of the two risk-averse individuals. The tax base risks symbolize the scope of action of the tax policy. The tax base risks act as a lever, they strengthen and make possible the effects.

In case of unobservable effort of the agent (second-best), the agent's variable share of profit does not only act as a risk sharing but also as an incentivizing instrument. It now influences the optimal effort of the agent. As above, a pro-cyclical tax base policy at the level of the principal and a counter-cyclical tax base policy at the level of the agent raise the agent's variable share of profit. Hence, in the second-best case, on top of that, the effort of the agent increases.

Moreover, the effects of tax policy uncertainty in the case of a pro-cyclical tax policy at the level of the principal and a counter-cyclical tax policy at the level of the agent on the utilities of principal and agent are examined. The agent receives the reservation utility as condition of participation. Thus, the utility of the principal is focused. Assuming a pro-cyclical tax policy at the level of the principal, increased tax base risk cannot raise the utility of the principal. In contrast, under a counter-cyclical tax base policy at the level of the agent, tax base risk at the level of the agent up to a certain level increases overall utility and therefore welfare.

4.8 Appendix

Proof of Lemma 1: Maximizing the certainty equivalent of the agent (4.8) with respect to a yields:

$$\frac{\partial CE_A}{\partial a} = -a + b \cdot (1 - t_A) \cdot v = 0. \tag{4.27}$$

Solving for a yields the optimal effort (4.18). Plugging the optimal effort of the agent (4.18) and the agent's participation constraint (4.14) in the certainty equivalent of the principal (4.11), maximizing it with respect to v yields:

$$\begin{aligned}\frac{\partial CE_P}{\partial v} = (1 - t_P) \cdot \Big(b^2 \cdot (1 - t_A) \cdot (1 - v) + \sigma \cdot \big(-\sigma_{k_A} \cdot \rho_A \cdot t_A + \sigma_{k_P} \cdot \rho_P \cdot r_P \cdot t_P \\ + \sigma \cdot r_P \cdot (1 - t_P) \cdot (1 - v) - \sigma \cdot r_A \cdot v \cdot (1 - t_A)\big)\Big) = 0.\end{aligned} \tag{4.28}$$

Solving for v yields (4.19).

Proof of Proposition 1: According to (4.16) and (4.19), the second-best variable share of profit, $v^\dagger$, is received from the first-best one by adding the term $b^2 \cdot (1 - t_A)$ in the nominator and the term $b^2 \cdot (1 - t_A)$ in the denominator. To show that the agent's optimal second best variable share of profit exceeds the first best one, the variable share of profit in the second best case can be stated as follows:

$$v^\dagger = \frac{Y + m}{Y + n}$$

with $Y = b^2 \cdot (1 - t_A)$,
$m = \sigma \cdot \Big(-\sigma_{k_A} \cdot \rho_A \cdot r_A \cdot t_A + \sigma_{k_P} \cdot \rho_P \cdot r_P \cdot t_P + \sigma \cdot r_P \cdot (1 - t_P)\Big)$ and
$n = \sigma^2 \cdot \Big(r_A \cdot (1 - t_A) + r_P \cdot (1 - t_P)\Big)$.
The optimal first best variable share of profit is defined as $v^* = \frac{m}{n}$. Assuming that $Y + n$ and n are each greater than 0, simplifying

$$\frac{Y + m}{Y + n} > \frac{m}{n}$$

yields:

$$Y > \frac{m}{n} \cdot Y.$$

The inequality holds if the first best variable share of profit, $v^* = \frac{m}{n}$, is smaller than one.

Main results for an after-tax base of variable remuneration of the agent

Subsequently, the basic model and the main theoretical results for a hybrid after-tax base of variable remuneration of the agent that does not integrate the remuneration's reduction of its own tax base and that includes the mean of the principal's tax base risk are presented:

$$CE_{P_{\text{after-tax}}} = E[\pi_{\text{after-tax}}] - \frac{r_P}{2} \cdot Var[\pi_{\text{after-tax}}] \tag{4.29}$$

and

$$CE_{A_{\text{after-tax}}} = E[w_{\text{after-tax}}] - \frac{1}{2} \cdot a^2_{\text{after-tax}} - \frac{r_A}{2} \cdot Var[w_{\text{after-tax}}] \tag{4.30}$$

with

$$\pi_{\text{after-tax}} = x_{\text{after-tax}} - f_{\text{after-tax}} - w_{v_{\text{after-tax}}} - t_P \cdot (x_{\text{after-tax}} - f_{\text{after-tax}} - w_{v_{\text{after-tax}}} - k_{P_Z}) \tag{4.31}$$

with

$$x_{\text{after-tax}} = a_{\text{after-tax}} \cdot b + \epsilon \tag{4.32}$$

with

$$w_{\text{after-tax}} = f_{\text{after-tax}} + w_{v_{\text{after-tax}}} - (f_{\text{after-tax}} + w_{v_{\text{after-tax}}} - k_{A_Z}) \cdot t_A \tag{4.33}$$

with

$$\begin{aligned} w_{v_{\text{after-tax}}} &= v_{\text{after-tax}} \cdot \big(x_{\text{after-tax}} - t_P \cdot (x_{\text{after-tax}} - k_P)\big) \\ &= v_{\text{after-tax}} \cdot \big(a_{\text{after-tax}} \cdot b + \epsilon - t_P \cdot (a_{\text{after-tax}} \cdot b + \epsilon - k_P)\big) \end{aligned}$$

with

$$\begin{aligned} f_{\text{after-tax}} = \frac{1}{1-t_A} \cdot \big(&\frac{a^2_{\text{after-tax}}}{2} - k_A \cdot t_A + u - E[w_{v_{\text{after-tax}}}] + t_A \cdot E[w_{v_{\text{after-tax}}}] \\ &+ \frac{1}{2} \cdot r_A \cdot Var[w_{\text{after-tax}}]\big) \end{aligned} \tag{4.34}$$

with

$$\begin{aligned} Var[\pi_{\text{after-tax}}] = \sigma^2_{k_P} \cdot t_P^2 + \sigma^2 \cdot \big(1 - t_P - v_{\text{after-tax}} \cdot (1-t_P) + t_P \cdot v_{\text{after-tax}} \cdot (1-t_P)\big)^2 \\ + 2 \cdot \rho_P \cdot \sigma_{k_P} \cdot \sigma \cdot t_P \cdot \big(1 - t_P - v_{\text{after-tax}} \cdot (1-t_P) + t_P \cdot v_{\text{after-tax}} \cdot (1-t_P)\big) \end{aligned} \tag{4.35}$$

and with

$$\begin{aligned} Var[w_{\text{after-tax}}] = \sigma^2_{k_A} \cdot t_A^2 + \sigma^2 \cdot (1-t_A)^2 \cdot (1-t_P)^2 \cdot v^2_{\text{after-tax}} \\ + 2 \cdot \rho_A \cdot \sigma_{k_A} \cdot \sigma \cdot t_A \cdot v_{\text{after-tax}} \cdot (1-t_A) \cdot (1-t_P). \end{aligned} \tag{4.36}$$

Then, the optimal effort $a^{\dagger}_{\text{after-tax}}$ and the second-best variable share of profit $v^{\dagger}_{\text{after-tax}}$ and the

first-best variable share of profit $v^*_{\text{after-tax}}$ are:

$$a^\dagger_{\text{after-tax}} = b \cdot (1 - t_A) \cdot (1 - t_P) \cdot v_{\text{after-tax}}, \tag{4.37}$$

$$\begin{aligned} v^\dagger_{\text{after-tax}} &= v^\dagger \cdot \frac{1}{1 - t_P} \\ &= \frac{b^2 \cdot (1 - t_A) + \sigma \cdot \big(-\sigma_{k_A} \cdot \rho_A \cdot r_A \cdot t_A + \sigma_{k_P} \cdot \rho_P \cdot r_P \cdot t_P + \sigma \cdot r_P \cdot (1 - t_P)\big)}{\Big(b^2 \cdot (1 - t_A) + \sigma^2 \cdot \big(r_A \cdot (1 - t_A) + r_P \cdot (1 - t_P)\big)\Big) \cdot (1 - t_P)}, \end{aligned} \tag{4.38}$$

$$\begin{aligned} v^*_{\text{after-tax}} &= v^* \cdot \frac{1}{1 - t_P} \\ &= \frac{-\sigma_{k_A} \cdot \rho_A \cdot r_A \cdot t_A + \sigma_{k_P} \cdot \rho_P \cdot r_P \cdot t_P + \sigma \cdot r_P \cdot (1 - t_P)}{\sigma \cdot \big(r_A \cdot (1 - t_A) + r_P \cdot (1 - t_P)\big) \cdot (1 - t_P)}. \end{aligned} \tag{4.39}$$

The utilities in the second-best case under such a remuneration contract coincide with those under a pre-tax base of variable remuneration of the agent. The formulas of the fixed remuneration in both models only vary by the subscripts (see (4.15) and (4.34)). Plugging the fixed remuneration, f, into the principal's certainty equivalent (4.11), the variable remuneration of the agent, w_v, cancels out and simplifying yields:

$$CE_P = (1 - t_P) \cdot \big(a \cdot b - \frac{1}{1 - t_A} \cdot (\frac{a^2}{2} - k_A \cdot t_A + u + \frac{1}{2} \cdot r_A \cdot Var[w])\big) + t_P \cdot k_P - \frac{r_P}{2} \cdot Var[\pi].$$

The variance $Var[w]^\dagger$ coincides with $Var[w_{\text{after-tax}}]^\dagger$ and the variance $Var[\pi]^\dagger$ with $Var[\pi_{\text{after-tax}}]^\dagger$ in the optimum because $v^\dagger \cdot \frac{1}{1-t_P} = v^\dagger_{\text{after-tax}}$. The agent's effort level is lower for an after-tax base of variable remuneration of the agent (see (4.18) and (4.37)), the variable share of profit higher in the optimum. The effects offset one another such that the optimal effort of the agent is the same ($a^\dagger = a^\dagger_{\text{after-tax}}$).[12] Therefore, the principal's certainty equivalents are equal in the optimum. A remuneration contract with an after-tax base of variable remuneration presented here does not increase welfare compared to a contract with a pre-tax base of variable remuneration.

[12] See Bauer et al. (2018).

Chapter 5

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