Inconsistent Retirement Timing

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ABSTRACT

We study the effect of inconsistent time preferences on actual and planned retirement timing decisions in two independent data sets. Theory predicts that hyperbolic time preferences can lead to dynamically inconsistent retirement timing. In an online experiment with more than 2,000 participants, we find that time-inconsistent participants retire on average 1.75 years earlier than time-consistent participants do. The planned retirement age of nonretired participants decreases with age. This negative age effect is about twice as strong among time-inconsistent participants. The temptation of early retirement seems to rise in the final years of approaching retirement. Consequently, time-inconsistent participants have a higher probability of regretting their retirement decision. We find similar results for a representative household survey (German SAVE panel). Using smoking behavior and overdraft usage as time preference proxies, we confirm that time-inconsistent participants retire earlier and that nonretirees reduce their planned retirement age within the panel.

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I. Introduction

When to retire is one of the most important financial decisions in later life that almost everyone has to make. Income during retirement depends highly on retirement timing. In most countries, social security benefits are paid according to years of work and income during employment. In these systems, earlier retirement results in lower retirement benefits. The retirement timing decision becomes even more important as life expectancy increases. For example, the average number of years spent in retirement by men in the United States has increased from eight years in 1950 to almost 20 years in 2020. Accepting a reduction in retirement benefits, therefore, affects the financial well-being of a retiree for a substantial period of time.

Early retirement does not only have consequences on a personal level but also affects the pension system as a whole. Increasing life expectancy combined with low birth rates put the pay-as-you-go social security systems of many developed countries under pressure. Retirement timing is an important determinant of the ratio between contributors and recipients within the system. Policy attention to this issue has grown recently. In a white paper on adequate, safe, and sustainable pensions, the European Commission (2012) highlights the importance of creating an environment that encourages older workers to remain part of the workforce. To develop appropriate strategies in this regard, it is necessary to understand the drivers of individual retirement timing.

The retirement timing decision is an intertemporal consumption decision under uncertainty for which time preferences play an important role. These can be interpreted as individuals' valuation of a good at an earlier date compared to its valuation on a later date (Frederick, Loewenstein, and O'Donoghue 2002). A decision-maker with hyperbolic time preferences exhibits higher discount rates for the near future and lower rates for the more distant future. Such preferences can lead to dynamically inconsistent decisions. For example, DellaVigna and Malmendier (2006) analyze gym membership contracts and find that the majority of gym members plan to attend on a regular basis when signing the membership contract. However, actual attendance over the lifetime of the contract turns out to be much lower.

In the retirement context, time-inconsistent decision-makers schedule an optimal retirement age during work life. However, when the retirement age approaches, they reevaluate this plan and choose to retire earlier or later. We focus on the case of unplanned earlier retirement and, from now on, use the term "time-inconsistent preferences" synonymously with hyperbolic or present-biased preferences (excluding other forms of inconsistency, such as future bias). A preference revision may have undesirable financial consequences, in particular, if decision-makers are naive about it. As commonly defined, naive hyperbolic discounters overestimate their future self-control, while sophisticated hyperbolic discounters are aware of potential future preference reversals.

Theoretical studies model the savings and retirement timing decision of hyperbolic agents when retirement is endogenous (Diamond and Köszegi 2003; Zhang 2013; Findley and Caliendo 2015), which allows us to derive predictions for retirement timing. Hyperbolic discounting (in contrast to exponential discounting) can lead to dynamically inconsistent earlier retirement. The decision-maker initially plans to retire on a certain date, but by placing too much weight on the near future will prefer to retire early when the retirement date approaches. Future consumption is, in this case, traded against immediate leisure. However, hyperbolic discounting at the same time predicts undersaving. A hyperbolic decision-maker might not have accumulated sufficient wealth to afford early retirement and is forced to retire later (Diamond and Köszegi 2003). The direction of the total effect is, therefore, an empirical question.

We collect evidence from two independent data sets. We obtain the first data set in an online experiment in cooperation with a large German newspaper. We recruit more than 2,000 participants, who are classified as time consistent or time inconsistent based on an intertemporal choice task. Using the example of a tax refund, they are offered several choices of a smaller sooner or a later larger amount. Participants also answer a series of questions regarding their retirement plans and expectations. They indicate their planned retirement age if they are not yet retired or their actual retirement age if they are already retired. The experiment further includes questions on risk preferences, loss aversion, financial literacy, impatience, and subjective life expectancy.

For the subsample of retired participants, we find that retirees who can be classified as time inconsistent retired on average 1.75 years earlier than time-consistent participants. This demonstrates that inconsistent time preferences may have severe consequences for retirement timing. The result holds after controlling for impatience, which also predicts earlier retirement but does not imply time inconsistency. Moreover, we find that time-inconsistent participants are on average more than twice as likely to regret their retirement timing decision—34 percent of the time-inconsistent participants state that they would retire later if they could decide again.

For the larger subsample of not yet retired participants, we focus on the relation between time preferences and planned retirement age. Inconsistent time preferences may lead to a decreasing planned retirement age with advancing age of the decision-maker. The rationale is an increasing temptation to retire as the planned retirement date approaches. We find evidence for this prediction as participants' age has a significantly negative effect on planned retirement age. Time-inconsistent participants, on average, plan to retire up to one month earlier by each year they get older. This negative age effect is about twice as large as found for time-consistent participants and kicks in above age 50. The pattern of results is consistent with predictions of hyperbolic discounting, which provide evidence for the role of time preferences in adapting retirement plans.

We further explore the financial consequences of the dynamically inconsistent retirement decision. The German social security system allows contributors to retire earlier with reduced monthly benefits. We find that participants, who plan to retire early from a young age, compensate for this reduction by buying private pension insurance. However, earlier retirement is unplanned from the perspective of a young or middle-aged person with time-inconsistent preferences. Therefore, it does not increase the likelihood of owning private pension insurance for this group, and a reduction in social security benefits remains largely uncompensated. In the German social security system, our results imply, on average, a 10 percent lower level of monthly retirement benefits for time-inconsistent retirees. This suggests that the nature of individual time preferences strongly influences participants' financial budget in retirement.

As a second data set, we use a German household survey (SAVE panel) to corroborate the obtained results. It complements the experimental data as it provides a representative sample and the opportunity to analyze the dynamics of planned retirement with panel data. Specifically, the panel structure allows us to rule out possible cohort effects. While the SAVE household survey includes questions on planned and actual retirement, it lacks a direct measure of time preferences. Instead, we use smoking habits and bank account overdraft usage as proxies for time inconsistency.

With the help of these proxies, we can confirm the experimental results for planned and actual retirement age (controlling for health effects). Time-inconsistent participants retire significantly earlier, and the economic magnitude of the effect is comparable to the experimental results. The analysis of the panel shows that time-inconsistent nonretirees significantly decrease their planned retirement age over time. The fraction of participants who retire earlier than planned is also higher for time-inconsistent participants.

By measuring individuals' time preferences and analyzing their effect on retirement timing, we contribute to a growing literature in behavioral economics on retirement savings and planning (Benartzi and Thaler 2007). Framing and its impact on retirement timing is perhaps the phenomenon studied most extensively, with the common finding that the retirement decision is strongly affected by how information is presented (Fetherstonhaugh and Ross 1999; Brown, Kapteyn, and Mitchell 2013; Shu, Payne, and Sagara 2014; Merkle, Schreiber, and Weber 2017). Nonstandard time preferences, alongside affective forecasting and planning fallacy, fall into a category of issues in predicting future behavior and happiness (for an overview, see Knoll 2011). While altering decision frames in the form of nudging has prominently reached the policy debate, we point out how inconsistent time preferences interact with policy interventions. In particular, we discuss recent trends to increase flexibility in retirement systems and the potential creation of commitment devices.

II. Time Preferences and the Retirement Decision

A. Time Preferences: Hyperbolic Discounting

Discount functions are commonly used to formalize time preferences and to express how decision-makers value consumption or payments at different points in time. The strength of discounting hereby depends on the individual level of impatience, which is mostly considered a fixed characteristic of a person. A standard assumption for discount functions is stationarity, which implies that discount rates are the same for time periods of the same lengths (Halevy 2015). The only discount function fulfilling this assumption is the exponential discount function. However, empirical and experimental studies find that people often exhibit higher discount rates for outcomes in the near future and lower discount rates for outcomes in the more distant future (Thaler 1981; Frederick, Loewenstein, and O'Donoghue 2002). This pattern in time preferences can be described by a hyperbolic discount function.

A functional form of the hyperbolic discount factor is $DF(t) = (1 + \alpha t)^{-\frac{\gamma}{\alpha}}$ with parameters $\alpha, \gamma > 0$ (Loewenstein and Prelec 1992). Compared to the exponential function, the hyperbolic function discounts the immediate future more strongly and becomes rather flat for the distant future. Just as the exponential discounting function, it can encode different levels of individual impatience. Due to its functional form, the average hyperbolic discounter will be more impatient for the near future and more patient for the more distant future.

In many theoretical models, a quasi-hyperbolic discount function is used. The concept of quasi-hyperbolic discounting was introduced by Phelps and Pollak (1968) and formalized by Laibson (1997). The quasi-hyperbolic discount factor is a discrete-time function $DF(t) = \beta\delta^t$ and $DF(0) = 1$, with δ and β between 0 and 1. It combines most features of the hyperbolic discount function with good analytical tractability. In particular, the parameter β introduces present bias, as all future outcomes are additionally discounted relative to the present. However, a relevant feature of the general hyperbolic discount function is absent in quasi-hyperbolic discounting: the nonstationarity of time preferences for future outcomes.[1] While a hyperbolic discounter becomes gradually more impatient when outcomes get closer in time, for the quasi-hyperbolic discounter this is not the case as long as all outcomes remain in the future (sometimes called quasi-stationarity, Montiel Olea and Strzalecki 2014).

Hyperbolic (and quasi-hyperbolic) time preferences can lead to dynamically inconsistent decisions (Laibson 1997; O'Donoghue and Rabin 1999). For example, a worker might prefer a 20-minute break in 101 days over a 15-minute break in 100 days, but as time passes, might reverse the decision in favor of a 15-minute break today instead of a 20-minute break tomorrow (Laibson, Repetto, and Tobacman 1998). Dynamic inconsistency arises when a decision-maker chooses an optimal plan at a point in time t but reevaluates this plan at a later point in time $t+s$ and does not stick to it. Time inconsistencies arise by a change in the used discount factor when time progresses, not by a change of the discount function itself, which is assumed to be stable within person.

Experimental studies reveal such time inconsistencies by providing sets of choices between sooner smaller rewards and later larger rewards, with different delays for the sooner reward (Green, Fristoe, and Myerson 1994; Kirby and Herrnstein 1995; Ahlbrecht and Weber 1997; Coller and Williams 1999; Meier and Sprenger 2010). They show preference reversals, as with longer delays, the later larger reward typically becomes more attractive. Another approach is to follow participants longitudinally and let them take the same decision once ahead of time and once at the time of consumption (Ainslie and Haendel 1983; Read and van Leeuwen 1998; Sayman and Öncüler 2009; Halevy 2015). A common finding is that some (but not all participants) show time-inconsistent preferences. There is evidence for experimental measures of time preferences to predict behavior outside the laboratory (Meier and Sprenger 2010, 2012; Sutter et al. 2013), even though not all studies find such a link (Rohde 2019).[2] There is also evidence that empirically measured time preferences are to a similar degree stable, as other personality measures (Kirby 2009; Meier and Sprenger 2015; Falk et al. 2016).

An important distinction is whether a decision-maker is aware of time-inconsistent preferences or not (sophisticated vs. naive, O'Donoghue and Rabin 1999). A naive decision-maker does not anticipate the urge to change the original plan in later periods. In contrast, a sophisticated decision-maker anticipates a lack of self-control and tries to pre-commit to a course of action if possible (Strotz 1955; Thaler 1981). Commitment

1. For a detailed description of the differences between discount functions, see Online Appendix A.
2. It is beyond the scope of this paper to provide a complete summary of the large literature on time preferences (for critical reviews, see, for example, Frederick, Loewenstein, and O'Donoghue 2002; Sayman and Öncüler 2009; Sprenger 2015; and Rohde 2019). We will also mostly bypass a discussion of present bias, that is, the overvaluation of immediate rewards (see, for example, Lynch and Zauberman 2006; O'Donoghue and Rabin 2015).

devices can help a sophisticated decision-maker to stick to a plan identified as optimal. Examples for the real-world demand of commitment devices have been found in the financial and nonfinancial domain (Ashraf, Karlan, and Yin 2006; DellaVigna and Malmendier 2006).

B. The Retirement Decision

Hyperbolic decision-makers place more weight on the near future. In the retirement context, this can have two opposing effects. On the one hand, hyperbolic decision-makers prefer immediate consumption and save less during their work life. As a consequence, they might have to work longer before they can afford to retire than exponential decision-makers (Laibson 1997). On the other hand, the retirement timing decision itself represents a trade-off between immediate leisure and future consumption. Approaching retirement, hyperbolic decision-makers are tempted to retire earlier since they weight the utility gained from immediate leisure highly relative to the utility loss due to reduced future consumption. For a given level of savings, a hyperbolic decision-maker is thus more likely to retire early.

Diamond and Köszegi (2003) examine the effect of an endogenous retirement decision on savings behavior in a model with quasi-hyperbolic time preferences. In a three-period setting, an agent works in period -1, decides whether to work or to retire in period 0, and is retired in period 1. Working in period -1 provides income, which can be consumed or saved. As a result of saving, the agent holds wealth $W_0 \geq 0$ in period 0. Working in period 0 produces additional income of Δ, but costs effort of $e > 0$. In periods 0 and 1, the agent can thus consume W_0 if retiring or $W_0 + \Delta$ if working. Diamond and Köszegi (2003) show that there are wealth levels, W_0, for which the agent initially plans to retire late, but, as period 0 arrives, reevaluates this plan and chooses to retire earlier. Quasi-hyperbolic utility can thus produce dynamically inconsistent retirement timing.

Sophisticated agents anticipate their inconsistent future behavior and can devise two different strategies to prevent it. Either they reduce savings in period -1 such that wealth W_0 is sufficiently low to force the period-0-self to work ("strategic undersaving"), or they increase savings that both the self in period -1 and 0 prefer to retire early. Whether quasi-hyperbolic discounting leads to early retirement, therefore, depends on the level of accumulated savings.

Empirically, both undersaving and early retirement are observed. For example, in the United States, the majority of employees choose to retire earlier than the full retirement age (Gruber and Wise 2004; Behaghel and Blau 2012). Simultaneously, savings rates are declining, and many Americans report that they are saving too little for retirement (Choi et al. 2002; Benartzi and Thaler 2013).[3] Present-biased time preferences have been found to be a factor in lower retirement savings (Goda et al. 2019).

To explain these findings, Zhang (2013) studies a model that differs from Diamond and Köszegi (2003) in three major ways. First, the decision-maker chooses a continuous labor supply in period 0. Second, both naive and sophisticated agents are taken into

3. The common interpretation is that undersaving occurs because of limited self-control, inertia, or lack of means to save. The empirical relevance of strategic undersaving remains unclear.

account, and finally, early retirement and undersaving are defined relative to a decision-maker who discounts exponentially. She derives conditions under which quasi-hyperbolic discounting can lead to a coexistence of undersaving and early retirement. The result depends on utility functions and discounting parameters, and it holds for naive as well as for sophisticated agents.

Findley and Caliendo (2015) study the effect of hyperbolic discounting on savings behavior in a continuous-time model with endogenous retirement. They focus on naive decision-makers and compare them to exponential discounters. They find that hyperbolic discounters plan to retire early but then have to postpone retirement due to insufficient savings. The hyperbolic agent fails to stick to original retirement plans, but the resulting time inconsistency is different from the outcome of the other models. They document the possibility of delayed retirement arising from hyperbolic time preferences.

Besides these theoretical models, a broad literature studies structural life-cycle models and labor supply (see Blundell, French, and Tetlow 2016, for a review). As structural approaches can accommodate many features of social security systems, they are a powerful tool for policy analysis. However, these models are almost exclusively estimated with time-consistent preferences (an exception is Gustman and Steinmeier 2012), which is why we do not derive hypotheses from them. We will point out the potential effect of introducing inconsistent time preferences into such structural models in the discussion of policy measures.

C. The German Public Pension System in Brief

The German public pension system is one of the oldest in the world and was introduced in 1889. It covers private-sector employees and public-sector employees except for civil servants and self-employed persons. During the employment phase, employees, as well as employers, contribute to social security proportional to wage (with a cap). Employees accumulate earnings points that, together with their retirement age, determine the amount of retirement benefits. Unlike in the United States, all years of earnings count for retirement benefits.

The German social security system stipulates a regular or full retirement age (FRA), as well as an early retirement age. A reform in 2007 shifted the FRA from 65 to 67, which is implemented gradually depending on birth year. The replacement rate at FRA was around 50 percent (before taxes) during the survey period. Early retirement is possible up to four years before the full retirement age, with a 3.6 percent per year reduction of retirement benefits.[4] Late retirement is also possible, with a 6 percent per year premium on retirement benefits. Besides the regular old-age pension, social security covers disability pension and survivors' pension.

D. Hypotheses

According to the presented theory, hyperbolic discounting can have a direct and an indirect effect on retirement timing. The direct effect predicts earlier than planned retirement, as hyperbolic discounters are tempted to trade future consumption against immediate leisure. Approaching retirement, it becomes more attractive to avoid the additional effort costs associated with working. The indirect effect, however, goes in

4. For a detailed calculation of financial losses associated with early retirement, see Online Appendix B.

the opposite direction, as hyperbolic time preferences increase the utility of immediate consumption relative to saving for future consumption. Hyperbolic discounters might not have accumulated sufficient savings to finance early retirement and therefore need to work longer.

We study the empirical relation between inconsistent time preferences and the retirement decision in Germany. The social security system functions as a commitment device by forcing employees to save a relatively high share of their income. As a result, German retirees heavily rely on retirement benefits and regard private savings rather as an add-on (70 percent of retirement income in Germany comes from public transfers, OECD 2017). We can confirm in the data that participants expect to obtain a relatively high level of retirement benefits. This mitigates at least to some extent the problem of undersaving. We thus hypothesize that the direct effect will dominate in societies with a strong social security system:

Hypothesis 1: Time-inconsistent decision-makers will retire *earlier* than time-consistent decision-makers.

It is important to distinguish the effect of time-inconsistent preferences from mere impatience. Impatience implies a higher discount rate and is compatible with both exponential discounting and hyperbolic discounting. More impatient decision-makers are likewise predicted to retire earlier. However, the two effects should be independent, as inconsistent time preferences rely on the specific significance of the present and near-future relative to the more distant future.

Hypothesis 1a: Higher impatience will result in earlier retirement, but its impact is distinct from the effect of time inconsistency.

In particular, more impatient but time-consistent decision-makers will not regret their decision, as their perspective on the decision is stationary when time progresses. On the other hand, time-inconsistent preferences might lead to a later reevaluation of the decision with a different outcome. This allows us to sharpen the distinction between time-inconsistent preferences and the degree of impatience.

Hypothesis 2: Time-inconsistent decision-makers are more likely to regret their decision than time-consistent decision-makers.

Hypothesis 2a: The degree of impatience has no impact on decision regret.

Inconsistent time preferences do not only influence the final retirement decision but ongoing retirement plans as well. When coming closer to retirement, a hyperbolic agent approaches the steeper part of the discount function and will feel increasingly tempted to retire earlier and may reduce the planned retirement age. This results in our third hypothesis:

Hypothesis 3: The planned retirement age of time-inconsistent decision-makers will *decrease* with increasing age.

Notably, this age effect is absent for consistent time preferences due to stationarity. Impatience per se does not produce such an effect. Likewise, the quasi-hyperbolic model does not predict a decrease in planned retirement age since time preferences are stationary except for period 0 (Online Appendix A). However, a number of other factors might induce a revision of one's planned retirement age. For example, older individuals have less uncertainty about their future life expectancy. In the empirical analysis, we control for subjective life expectancy and impatience. We further control for demographics, risk aversion, loss aversion, and many other variables.

The idea of time-inconsistent retirement plans is supported by Bidewell, Griffin, and Hesketh (2006), who conduct an experiment in which participants choose between early and late retirement depending on hypothetical savings, enjoyment of retirement, and chances of good health during retirement. They find that participants who are closer to their planned or expected retirement age are more tempted and are willing to give up more of their future retirement income in order to retire early. They attribute this finding to stronger discounting, however, not explicitly to hyperbolic discounting. Yet this is in line with hyperbolic time preferences, as the functional form of the discount factor predicts stronger discounting and increasing temptation as an event draws closer. For the observed age effect, we thus formulate as an additional hypothesis:

Hypothesis 3a: The negative effect of age on planned retirement age is more pronounced for decision-makers closer to retirement.

A final question is whether decision-makers are sophisticated about this gradual reduction in planned retirement age. If so, they might buy additional pension insurance to compensate for the expected loss in benefits. In contrast, if decision-makers are naive, the reduction in planned retirement age will come as a surprise and find them unprepared. While this is ultimately an empirical question, we give participants the benefit of the doubt and assume sophistication:

Hypothesis 4: Time-inconsistent decision-makers anticipate earlier retirement and increase their retirement provisions already when young.

III. Experimental Design and Data

A. Experimental Design

We conduct an online experiment in cooperation with a large and well-circulated German newspaper, the *Frankfurter Allgemeine Zeitung* (FAZ). Participants were recruited via a link on the newspaper's website and two announcements in the print edition. In total, 3,077 participants completed the experiment, which took them on average 11 minutes. Participants answered questions about retirement planning, time preferences, risk preferences, financial literacy, and demographics. Some participants are assigned to different branches of the experiment, which are analyzed in two papers that use data from the same survey (Schreiber and Weber 2016; Merkle, Schreiber, and Weber 2017). Therefore, the initial sample for this study consists of 256 retired participants and 2,173 nonretired participants.

The main dependent variables are actual or planned retirement age. First, participants were asked whether or not they have already retired. Depending on their response, we asked participants "At what age did you retire?" or "At what age do you plan to retire?", respectively. The question for actual retirement age does not specify whether participants retired to receive regular old-age pension or disability pension (which covers about 10 percent of retirees). It is plausible that retirement due to illness or disability is less or not at all affected by time preferences. Not being able to exclude these cases will most likely weaken our results.

The following questions are about your personal preference. There are no right or wrong answers.

Suppose you receive a tax refund. You are given two options regarding the point in time when the payment is transferred to you. If you choose option A the money is transferred to you earlier compared to option B. If you choose option B you will receive the money later. Please indicate for all six situations which option you would prefer.

A: you receive 1,100 € **immediately**
B: you receive 1,130 € **in 10 months**

A: you receive 1,100 € **in 18 months**
B: you receive 1,130 € **in 28 months**

A: you receive 1,100 € **immediately**
B: you receive 1,200 € **in 10 months**

A: you receive 1,100 € **in 18 months**
B: you receive 1,200 € **in 28 months**

A: you receive 1,100 € **immediately**
B: you receive 1,380 € **in 10 months**

A: you receive 1,100 € **in 18 months**
B: you receive 1,380 € **in 28 months**

Figure 1
Time Preference Survey Questions
Notes: Screenshot of the survey question used to elicit time preferences. Displayed are six choices between a smaller sooner amount and a later larger amount. Time consistency requires the same choice (A or B) on the right and the left.

To distinguish between time-inconsistent and time-consistent participants, we use decisions between an earlier and a later monetary reward, which is a standard elicitation procedure in economics at least since Thaler (1981). According to a recent review, 60 percent of all empirical articles in the time preference literature use a version of the money earlier or later design (Cohen et al. 2020). Participants in our survey made six choices about when to receive a tax refund, which are displayed in Figure 1. The choices always offer a smaller sooner refund and a later larger refund. Decisions with similar stakes and time delays have been introduced in broad population surveys (Harrison, Lau, and Williams 2002; Andersen et al. 2008). To measure time inconsistency, each choice is paired with a time-delayed version of the same choice (Sayman and Öncüler 2009; Meier and Sprenger 2010). For this reason, half of the choices involve decisions between a refund today and in ten months, while the other half are between a refund in 18 months and 28 months. The three questions within each set differ in the annual interest rate i, which takes the values 3.3 percent, 11.3 percent, and 31.3 percent.

If participants had time-consistent preferences, only the time difference between the two options would matter, which is the same for all questions (ten months). Time-consistent participants make the same decision (earlier or later payment) independent of whether the earlier payment takes place today or in 18 months. Hyperbolic decision-makers, however, value the immediate payment more highly relative to the payment in ten months than they do if all payments are delayed by 18 months. It is likely that a hyperbolic discounter will switch decisions for at least one interest rate level.[5] Participants' choices are classified as inconsistent if they prefer the earlier payment in the choice involving the immediate payment and the later payment in the delayed choice. We define a measure for time-inconsistent preferences that counts the number of inconsistent answers ranging from zero to three.

B. Control Variables

We carefully select control variables consulting the broad literature on retirement timing and factors that delay or accelerate retirement.[6] Among analyzed factors that influence retirement timing are health (Bazzoli 1985; McGarry 2004; van Rijn et al. 2013), economic status (Kim and Feldman 1998; Madero-Cabib, Gauthier, and Le Goff 2015), gender (Finch 2014), age (Kim and Feldman 1998), education (DePreter, Looy, and Mortelmans 2015; Woehrmann, Brauner, and Michel 2020), subjective life expectancy (Griffin, Hesketh, and Loh 2012; Heimer, Myrseth and Schoenle 2019), marital status (Gustman and Steinmeier 2000), and childbearing (Hank 2004). We thus collect information about gender, age, marital status, number of children, subjective life expectancy, and education. Economic status is captured by income for nonretirees and retirement benefits for retirees. For exact definitions of the variables, see the Appendix below.

We lack information on health and wealth, as these were considered sensitive in the context of a voluntary survey. Due to limited survey length, we also do not have detailed data on job characteristics (Wang and Shultz 2010; Earl and Taylor 2015) or spousal labor and retirement choices (Schirle 2008). It is thus possible that our regression analysis suffers from some degree of omitted variable bias. To get an indication of the severity of the problem, we will use the methodology introduced by Oster (2019).

The set of control variables further includes measures of impatience, risk and loss aversion, and financial literacy. Impatience is measured as agreement with the statement "I am an impatient person" on a seven-point Likert scale. Risk and loss aversion are both self-reported and elicited on seven-point Likert scales as well. Participants indicate whether they agree with the statements "I am a risk-averse person" and "I am very afraid of losses," respectively. There is evidence that self-reported preferences are good predictors of choices (Nosić and Weber 2010; van Rooij, Lusardi, and Alessie 2011; Merkle, Schreiber, and Weber 2017).

Participants further answered a set of six financial literacy questions. Since the FAZ newspaper has a sophisticated readership, only one of the basic questions and three of the advanced questions by van Rooij, Lusardi, and Alessie (2011) are used. We introduce two even more advanced questions (Online Appendix D).

The experiment uses hypothetical choices, which allows us to recruit a large sample of participants, including employees of all ages and retirees. The decision when to retire lies in the nearer future for many participants, and we expect relevant answers to retirement-related questions. Rubinstein (2001) replicates more than 40 experiments without monetary rewards and, in almost all cases, finds no qualitative differences in

5. In Online Appendix C, we discuss the occurrence of such switches depending on the discount function.
6. For detailed reviews of this literature, see Beehr and Bennett (2015) and Fisher, Chaffee, and Sonnega (2016).

results compared to incentivized experiments. For time preferences in particular, it has been found that hypothetical and real rewards usually produce similar responses (Cohen et al. 2020).

In addition, using real incentives in intertemporal choice can provoke participants to view future payments as uncertain, in particular, when the distance in time between the experiment and the actual payoff is large (for example, up to 28 months in our survey). Therefore, a present-biased or hyperbolic discounting pattern can be generated even for participants with time-consistent preferences (Read 2005; Sutter et al. 2013). Secondly, monetary payments can create a self-selection problem by attracting participants who are in immediate need of money. This could also introduce a bias in the direction of hyperbolic discounting (Noor 2009; Sutter et al. 2013).

C. Summary Statistics

We begin with a detailed description of participants' time preferences. As the final measure will be constructed by combining all six time-preference questions, we exclude observations with missing values ($n = 104$).[7] Table 1 shows the responses of the remaining 2,325 participants separately for the subsamples of retirees and nonretirees. Panel A shows how many participants choose the sooner smaller refund or the later larger refund for each question. As expected, the fraction of participants choosing the sooner refund decreases with the implicit interest rate. Furthermore, in all three decisions involving the immediate refund, the percentage of participants choosing sooner is higher than in the corresponding decisions with a time delay. This finding already suggests that some degree of present bias exists in both subsamples.

Panel B summarizes results on the participant level. Around 60 percent answer time-consistently in all three questions, while the remaining participants are mostly time-inconsistent in the direction of present bias or hyperbolic discounting. This means that they prefer the sooner refund in the decision without delay and the later refund in the decision with delay. We distinguish participants with one, two, or three inconsistent answers and find that one inconsistent answer is most common in both subsamples.

There are rare cases of time inconsistencies in the other direction ($n = 21$), which can be labeled "future bias" or "reverse time inconsistency" (Sayman and Öncüler 2009). As these observations account for less than 1 percent of the sample, they are excluded, and we do not analyze them any further. Even though other studies find higher rates of future bias (Takeuchi 2011; Montiel Olea and Strzalecki 2014), it remains unclear whether such findings robustly correlate with behavioral outcomes (Stango and Zinman 2023). Finally, some participants show both behaviors, present bias in one question and future bias in another ($n = 6$). These observations are also excluded. The low rate of mixed bias and high sensitivity to interest rates suggests that participants answer the questions diligently, which should reduce measurement error. The final sample consists of 187 retirees and 2,111 nonretirees.

For further analysis, we capture time inconsistency in two variables: an inconsistency indicator that takes a value of one if at least one question is answered inconsistently and

7. Missing values are more frequent in the sample of retirees. One reason might be that the time preference questions were asked at a later point in the survey for this group. Additionally, retirees might regard a tax refund as irrelevant to them as, until recently, most retirees did not pay taxes on social security benefits in Germany.

Table 1
Detailed Summary Statistics for Time Preferences

Panel A	Retirees			Nonretirees		
	Sooner	Later	% Sooner	Sooner	Later	% Sooner
Immediate tax refund (low interest rate)	154	39	80	1,723	409	81
Immediate tax refund (medium interest rate)	112	81	58	946	1,186	44
Immediate tax refund (high interest rate)	104	89	54	535	1,597	25
Delayed tax refund (low interest rate)	116	77	60	1,278	854	60
Delayed tax refund (medium interest rate)	73	120	38	393	1,739	18
Delayed tax refund (high interest rate)	79	114	41	157	1,975	7

Panel B	Retirees		Nonretirees	
Observations Included in Analysis	*n*	%	*n*	%
Time consistent				
# inconsistent answers = 0	122	63.2	1,257	59.0
Present biased				
# inconsistent answers = 1	38	19.7	490	23.0
# inconsistent answers = 2	13	6.7	185	8.7
# inconsistent answers = 3	14	7.3	179	8.4
Total	187	96.9	2,111	99.0
Observations excluded from analysis	*n*	%	*n*	%
Future biased	4	2.1	17	0.8
Mixed biased	2	1.0	4	0.2
Total	6	3.1	21	1.0

Notes: The table presents detailed summary statistics of the time preference measure used in the survey (see Figure 1). Panel A shows choices of participants (sooner or later tax refund) in each of the six questions separately for the subsamples of retirees and nonretirees. Panel B specifies time-consistent responses, present-biased responses, and other response patterns.

the number of inconsistent answers ranging from zero to three. The three pairs of questions cannot perfectly identify time-inconsistent preferences, as there are some parameter combinations for hyperbolic and quasi-hyperbolic discount functions that produce zero switching (Online Appendix C). The indicator may thus understate the prevalence of time-inconsistent preferences. Such measurement error is inevitable when eliciting continuous preference parameters using a discrete grid of choices (Falk et al. 2016). Misclassifications will add noise to the analysis and can lead to attenuation bias. As displayed in Table 2, the average number of inconsistent answers is around 0.6 in both samples (and around 1.6

Table 2
Summary Statistics

	Retirees ($n = 187$)		Nonretirees ($n = 2{,}111$)	
	Mean	SD	Mean	SD
Panel A: Retirement Timing				
Planned retirement age			64.97	3.81
Actual retirement age	61.54	4.64		
Full retirement age	65.14	0.25	66.72	0.52
Retirement regret	0.22	0.41		
Panel B: Time Preferences				
Inconsistency indicator	0.35	0.48	0.40	0.49
Number inconsistent answers [0–3]	0.57	0.92	0.66	0.95
Impatience [1–7]	3.85	1.77	3.88	1.62
Panel C: Demographics				
Age	66.66	5.70	40.10	12.10
Gender [male = 1]	0.88	0.33	0.85	0.36
Income			3,411.73	3,125.81
Retirement benefits	3,157.41	4,639.30		
Satisfaction with benefits [1–7]	5.00	1.83		
Number of children	1.64	1.19	0.78	1.19
Education [0–2]	1.44	0.78	1.61	0.62
Married	0.82	0.39	0.47	0.50
Panel D: Additional Controls				
Risk aversion [1–7]	4.02	1.51	3.89	1.46
Loss aversion [1–7]	4.67	1.59	4.22	1.59
Financial literacy [0–6]	3.98	0.93	4.15	1.13
Subjective life expectancy	84.35	6.45	83.53	7.78
Private pension insurance	0.36	0.48	0.65	0.48

Notes: The table shows summary statistics for the FAZ survey separately for the subsamples of retired and nonretired participants. Variables are as defined in the Appendix.

conditional on being time inconsistent). We interpret this count of inconsistent answers as a measure for the strength of time inconsistency because a higher number of inconsistent choices requires more pronounced (quasi) hyperbolic discounting. Participants are moderately impatient, and impatience is only weakly correlated with the number of inconsistent answers given (0.20 for retirees [n.s.], 0.03 for nonretirees [n.s.]).

The average planned retirement age is close to the former full retirement age in Germany (65). The actual retirement age of retirees in the survey is 61.8, which is not significantly different from the average retirement age in Germany at the time of the survey.[8] The difference between the planned and actual retirement age may indicate that employees adjust their plans downward when approaching retirement. To some extent, it may also represent a cohort effect. Twenty-one percent of retired participants believe that they retired too early.

The average age in the sample is 40 years. Men are overrepresented (85 percent male), reflecting the fact that the majority of FAZ readers are male. Moreover, the FAZ sample can be classified as educated and high income. Participants report an average monthly net income of EUR 3,410, which is about the German average *gross* income at the time of the survey.[9] Ninety-one percent of participants received the German equivalent of a high school diploma, and 66 percent graduated from a university. About half of the participants are married.

Table 2 also includes the additional control variables. The questions for risk aversion and loss aversion reveal that participants judge themselves as somewhat more loss averse than risk averse. As expected, participants do well in the financial literacy task, with an average of four correct answers (out of six). Participants estimate their life expectancy on average to be close to 84 years, and about 66 percent (of nonretirees) own private pension insurance. We run regressions of time preference measures on demographic variables and controls to identify correlations (Online Appendix C). We find an increase in time-inconsistent responses with age and a decrease in inconsistent responses with education and financial literacy. However, the economic magnitude of these effects is rather small.

IV. Results

A. Results for Actual Retirement Age

We first examine the relation between time preferences and the actual retirement age. Time-consistent participants in our sample retired at 62.2 years on average (Figure 2). The number of inconsistent answers in the time preference questions turns out to be related to retirement timing—answering all three questions inconsistently is associated with significantly lower actual retirement age. The effect size is economically meaningful. While mildly time-inconsistent retirees retired on average one year earlier than time-consistent retirees, participants who answer all three questions inconsistently retired a staggeringly 3.8 years earlier (statistically significant at the 1 percent level).

Table 3 reports results for actual retirement age in a multivariate setting. Column 1 includes an inconsistency indicator as the single explanatory variable. Time inconsistent participants retired 1.76 years earlier than time-consistent participants, which represents an average of the magnitudes displayed in Figure 2. As the figure shows an increase of the effect with the number of inconsistent answers, we switch to the count of inconsistent answers in Column 2. An additional inconsistent answer implies earlier retirement of

8. Average age at which a person first received an old-age pension: 61.1. Source: Eurostat https://ec.europa.eu/eurostat/databrowser/view/lfso_12agepens/default/table?lang=en (accessed November 20, 2023).

9. Source: German Federal Statistical Office (www.destatis.de/DE/ZahlenFakten/GesamtwirtschaftUmwelt/VerdiensteArbeitskosten/VerdiensteVerdienstunterschiede/Tabellen/Bruttomonatsverdienste.html, accessed November 17, 2023).

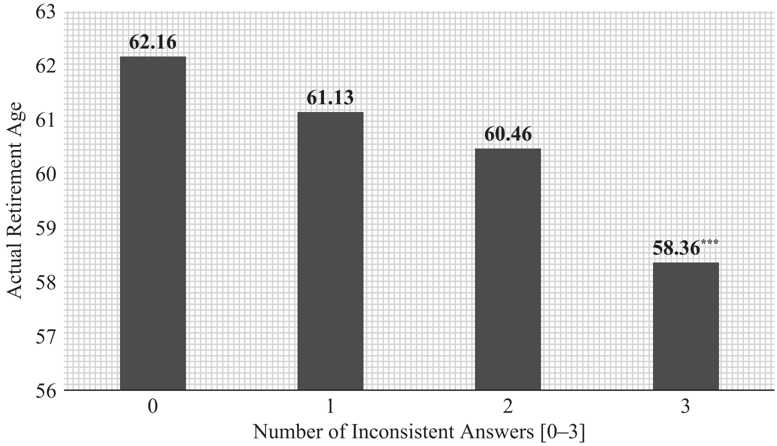

Figure 2

Average Actual Retirement Age by Number of Inconsistent Answers

Notes: The bars show the average actual retirement age for participants with zero, one, two, or three inconsistent answers. Significance: $^{*}p<0.1$, $^{**}p<0.05$, $^{***}p<0.01$, relative to the group with zero inconsistent answers.

about 1.1 years. The effect decreases slightly with the inclusion of further control variables in Columns 3–5 but remains robust, with a coefficient between −0.98 and −1.03.

Adding impatience in Column 3 is of particular interest from the perspective of time preferences. Impatience has a negative effect on actual retirement age, with one point on the scale accounting for an earlier retirement of about one-third of a year. As expected, more impatient participants retire earlier and trade off immediate leisure against future consumption. A jump from the middle to the end of the impatience scale has an effect of about the size of one additional time-inconsistent answer. However, impatience does not crowd out the effect of inconsistent time preferences, as both measures represent different aspects of time preferences. We can, therefore, simultaneously confirm Hypotheses 1 and 1a.

The earlier retirement of time-inconsistent participants suggests that an indirect effect on retirement timing due to undersaving, if present, seems to be dominated by the direct effect. We explain this by the nature of the German social security system. Given the high mandatory contributions, there is less room for undersaving within the system. Social security benefits still represent the main source of retirement income (about 75 percent according to a report of the German government),[10] and undersaving outside the system may be of limited consequence. Time-inconsistent employees are in general able to afford earlier retirement. One can interpret the social security system as a commitment device for these people. In Online Appendix E, we provide additional tests for civil

10. Source: Alterssicherungsbericht 2012, Bundesministerium für Arbeit und Soziales (report on retirement provision by the federal ministry of labour and social affairs), https://www.bmas.de/DE/Soziales/Rente-und-Altersvorsorge/rentenversicherungsbericht-art.html (accessed November 20, 2023).

Table 3
Effect of Time Preferences on Actual Retirement Age

	Actual Retirement Age				
	(1)	(2)	(3)	(4)	(5)
Inconsistency indicator	−1.758 (0.80)**				
Number inconsistent answers		−1.142 (0.46)**	−1.028 (0.43)**	−1.026 (0.41)**	−0.978 (0.41)**
Impatience			−0.330 (0.20)*	−0.443 (0.19)**	−0.538 (0.21)**
Age				0.321 (0.07)***	0.301 (0.07)***
Gender				1.507 (1.29)	2.305 (1.35)*
Married				−0.348 (0.90)	−0.781 (1.02)
Number of children				−0.247 (0.28)	−0.311 (0.30)
Education				0.851 (0.48)*	0.681 (0.51)
Retirement benefits [log]				−0.556 (0.30)*	−0.458 (0.27)*
Satisfaction retirement benefits				−0.070 (0.17)	−0.039 (0.18)
Risk aversion					−0.349 (0.25)
Loss aversion					−0.026 (0.23)
Financial literacy					−0.980 (0.41)**
Life expectancy					−0.022 (0.05)
Private pension insurance					0.113 (0.60)
Constant	62.158 (0.34)***	62.195 (0.34)***	63.401 (0.76)***	45.331 (4.66)***	53.353 (7.72)***
R^2	0.028	0.046	0.056	0.250	0.278
Observations	185	185	185	169	160

Notes: The table shows the results of five OLS regressions with actual retirement age in years as the dependent variable. Independent variables are as defined in the Appendix. Robust standard errors are displayed in parentheses. Significance: $*p<0.1$, $**p<0.05$, $***p<0.01$.

servants who receive more generous pensions. They tend to retire earlier and to follow their inconsistent time preferences more strongly.

In addition to time preferences, age, gender, retirement benefits, risk aversion, and financial literacy are (in some cases weakly) significant predictors of retirement age. The age effect is a mechanical effect as younger participants are only in the sample of retirees if they retired early. This does not imply that the younger cohort retires earlier in general. Participants who earn higher income retire earlier. Male participants retire 2.36 years later on average compared to female participants. These patterns have been previously observed in the literature (van Solinge and Henkens 2010; Moen and Flood 2013). In addition, we find that higher risk aversion leads to earlier retirement, and financial literacy, measured by the number of correct responses to the financial literacy questions, reduces the actual retirement age. This effect is not intuitive but is mainly driven by few retirees who answer only one or two out of the six questions correctly.

While coefficient stability after including controls is a common approach to evaluate robustness to omitted variable bias, Oster (2019) suggests a more formal approach. If the increase in the explained variation (R^2) is large relative to the change in effect size, it is unlikely that omitted variable bias is large. The test needs an assumption about the attainable R^2, which we set at 1.5 times the R^2 of the specification with all controls. Our criterion is stricter than the 1.3 times R^2 threshold applied by Oster (2019), which already more than 40 percent of results from observational data do not survive. The measure δ for the effect of the number of inconsistent answers on actual retirement age is 4.2 in the specification with all controls (Column 5 in Table 3). This means that the selection on unobservables would have to be more than 4.2 times larger than what we capture with the included controls for the effect of inconsistent answers to disappear. This is highly unlikely, as the suggested cutoff is $\delta = 1$.

B. Retirement Regret

When people follow their preferences, it is not obvious whether their behavior is harmful, even if these preferences are time-inconsistent. A criterion might be whether participants are satisfied with their retirement timing ex post. Overweighting immediate leisure relative to future consumption could give rise to decision regret. We ask retired participants how they would decide if they could make the retirement timing decision again. They can choose whether they would retire later with higher social security benefits, retire earlier with reduced social security benefits, or make the same retirement decision again. To analyze retirement regret, we create an indicator variable *Retirement Regret*. It equals one if participants indicate that they retired too early and would retire later from today's perspective and zero for participants who would not change their decision or would retire earlier.

Figure 3 shows a cross-tabulation of results for the number of inconsistent answers and the fraction of participants who indicate that they retired too early. Time consistency seems to matter. The fraction of participants stating they retired too early is significantly increasing with the number of inconsistent answers. In the group of retirees who are classified as time consistent, only 15 percent indicate that they would, in hindsight, choose to retire later. This fraction doubles for participants with one or two inconsistent answers and increases to 43 percent in the group with three inconsistent answers.

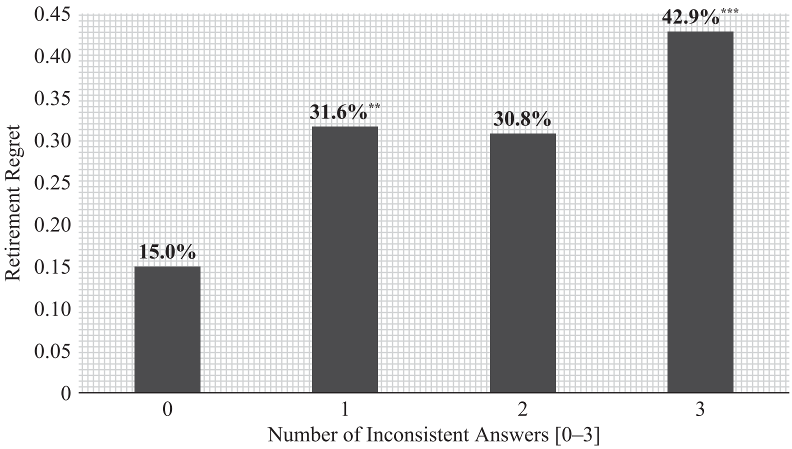

Figure 3

Fraction of Participants Stating They Retired Too Early

Notes: The bars show the fraction of participants who state they retired too early for participants with zero, one, two, or three inconsistent answers. Significance: $*p<0.1$, $**p<0.05$, $***p<0.01$, relative to the group with zero inconsistent answers.

To substantiate these results, we run a linear probability model with retirement regret as the dependent variable. Table 4 presents the results of this analysis. In the first column, we again include time inconsistency as an indicator, which raises the propensity to regret retirement timing by about 19 percentage points up from a baseline of 15 percent. Each time-inconsistent answer has an effect of about ten percentage points (Columns 2–5). The effect is robust to the inclusion of impatience and further control variables. We confirm all results using logistic regressions, which are econometrically more appropriate but less easy to interpret (Online Appendix F). In line with Hypothesis 2, we find a significant and economically strong effect of inconsistent time preferences on decision regret. It can be a result of an unplanned decision that is inconsistent with prior as well as subsequent preferences.

In contrast, the effect of impatience is insignificant in all regression specifications. The coefficient is close to zero and even switches signs when adding controls. While more impatient participants have been shown to retire earlier, they are not more likely to regret this decision. If participants are impatient but consistently so, they have no reason to change their minds about retiring early. This confirms the arguments brought forward for Hypothesis 2a. None of the remaining control variables have a significant effect on retirement regret. This suggests that no specific sociodemographic group is per se more likely to regret retirement timing. The measure for omitted variable bias is $\delta = 2.9$ for inconsistent answers in the regression specification with all control variables.

C. Results for Planned Retirement Age

We next examine the planned retirement age of participants who are not yet retired. With a total of 1,974 observations, this subsample is much larger than the sample of retired

Table 4
Ex Post Evaluation of the Retirement Decision

	Retirement Regret				
	(1)	(2)	(3)	(4)	(5)
Inconsistency indicator	0.188 (0.07)***				
Number inconsistent answers		0.097 (0.04)***	0.097 (0.04)**	0.097 (0.04)**	0.079 (0.04)**
Impatience			0.001 (0.02)	–0.005 (0.02)	–0.006 (0.02)
Actual retirement age				0.000 (0.01)	–0.002 (0.01)
Age				–0.001 (0.01)	–0.000 (0.01)
Gender				–0.100 (0.13)	–0.061 (0.14)
Married				–0.037 (0.10)	–0.088 (0.11)
Number of children				0.004 (0.03)	0.000 (0.03)
Education				–0.018 (0.04)	0.016 (0.04)
Retirement benefits [log]				0.030 (0.02)	0.025 (0.02)
Satisfaction retirement benefits				–0.059 (0.02)***	–0.072 (0.02)***
Risk aversion					0.019 (0.02)
Loss aversion					0.002 (0.02)
Financial literacy					–0.046 (0.04)
Life expectancy					0.003 (0.00)
Private pension insurance					–0.048 (0.07)
Constant	0.150 (0.03)***	0.161 (0.03)***	0.156 (0.07)**	0.412 (0.57)	0.506 (0.74)
R^2	0.043	0.042	0.036	0.082	0.099
Observations	185	185	185	167	158

Notes: The table shows the results of five linear probability models (OLS) with the indicator retirement regret as the dependent variable. Robust standard errors are displayed in parentheses. Significance: $*p<0.1$, $**p<0.05$, $***p<0.01$.

participants. We use this sample to test Hypotheses 3 and 4 on how planned retirement evolves during one's work life. A univariate comparison reveals that participants with time-inconsistent preferences plan to retire on average about four months earlier than time-consistent participants ($p < 0.05$). However, this overall effect deserves further scrutiny, as hyperbolic discounting predicts a reduction of planned retirement age over time rather than a lower planned retirement age in general.

Table 5 shows the multivariate relation between time preferences and planned retirement age. Columns 1 and 2 confirm an earlier planned retirement for time-inconsistent participants. Unsurprisingly, impatient participants also plan to retire earlier. Similar to the results for actual retirement age, the influences of time inconsistency and impatience coexist. They comprise different aspects of time preferences. The result for time inconsistency is robust to using the number of inconsistent answers as an alternative measure (Columns 3 and 4). In this case, the effect size is close to three months for each additional inconsistent answer. Stronger statistical significance implies that additional explanatory power comes from the extent of the inconsistency.

In Column 5, we introduce age and the interaction between age and time inconsistency. Age has a negative effect on planned retirement age, which suggests that when employees get older, they reduce their planned retirement age. At least part of this result can be attributed to a cohort effect, as younger participants might reasonably expect they have to work longer given recent changes in the social security system.[11] The interaction suggests that time-inconsistent participants reduce their planned retirement age even more than time-consistent participants. The total effect on planned retirement age for this group is about one month for each year of age. Importantly, the interaction captures a good part of the main effect, which is no longer significant. This means that the effect of time inconsistency is not static but sets in and increases with advancing age.

Besides time preferences, coefficients for income and education are statistically highly significant. Participants with a higher income plan to retire earlier, which is in line with findings by Munnell, Triest, and Jivan (2004) and Li, Hurd, and Loughran (2008). Participants with higher education plan to retire later, probably driven by higher job satisfaction (Helman, Copeland, and VanDerhei 2008). Additionally, education might enable a better understanding of the impact of retirement age on social security benefits, which could motivate a later planned retirement age (Coile et al. 2002). Quite intuitively, participants who buy private pension insurance plan to retire earlier.

In sum, we provide evidence for Hypothesis 3 that time-inconsistent participants decrease their planned retirement age when getting older. We now intend to trace this age effect more closely. Figure 4 shows planned retirement age over different age groups. For most of the age groups, there is little difference between the average planned retirement age of time-consistent and time-inconsistent participants.[12] However, after age 50, a gap between the two curves opens up, which is highly significant for the groups of

11. Cohort effects should matter less for the comparison between time-consistent and time-inconsistent participants, as it mainly involves people of the same age. Nonetheless, any inference drawn from a cross-section of behavior over time needs to be interpreted with caution.

12. If anything, planned retirement age is higher for time-inconsistent participants when young. This would be consistent with the flatter discount function of hyperbolic discounters for outcomes far away in time. However, the difference is insignificant.

Table 5
Effect of Time Preferences on Planned Retirement Age

	Planned Retirement Age					
	(1)	(2)	(3)	(4)	(5)	(6)
Inconsistency indicator	–0.365 (0.17)**	–0.327 (0.17)*			–0.141 (0.16)	–0.206 (0.16)
Impatience		–0.172 (0.05)***		–0.172 (0.05)***	–0.181 (0.05)***	–0.158 (0.05)***
Number inconsistent answers			–0.236 (0.08)***	–0.221 (0.08)***		
Age					–0.053 (0.01)***	–0.026 (0.01)*
Age × Incon. indicator					–0.034 (0.01)***	–0.032 (0.01)**
Gender						–0.038 (0.23)
Married						–0.395 (0.21)*
Number of children						0.051 (0.14)
Education						0.495 (0.13)***
Income [log]						–0.447 (0.13)***
Risk aversion						0.091 (0.08)
Loss aversion						–0.127 (0.07)*
Financial literacy						–0.122 (0.08)
Life expectancy						0.042 (0.02)**
Private pension insurance						–0.552 (0.17)***
Constant	65.114 (0.11)***	65.763 (0.22)***	65.123 (0.10)***	65.780 (0.22)***	67.862 (0.45)***	67.155 (2.19)***
R^2	0.002	0.006	0.003	0.008	0.057	0.074
Observations	2,111	2,104	2,111	2,104	2,104	2,046

Notes: The table shows the results of six OLS regressions with planned retirement age as the dependent variable. All variables are as defined in the Appendix. Age × Incon. indicator is the interaction between age and the inconsistency indicator. Robust standard errors are displayed in parentheses. Significance: *$p < 0.1$, **$p < 0.05$, ***$p < 0.01$.

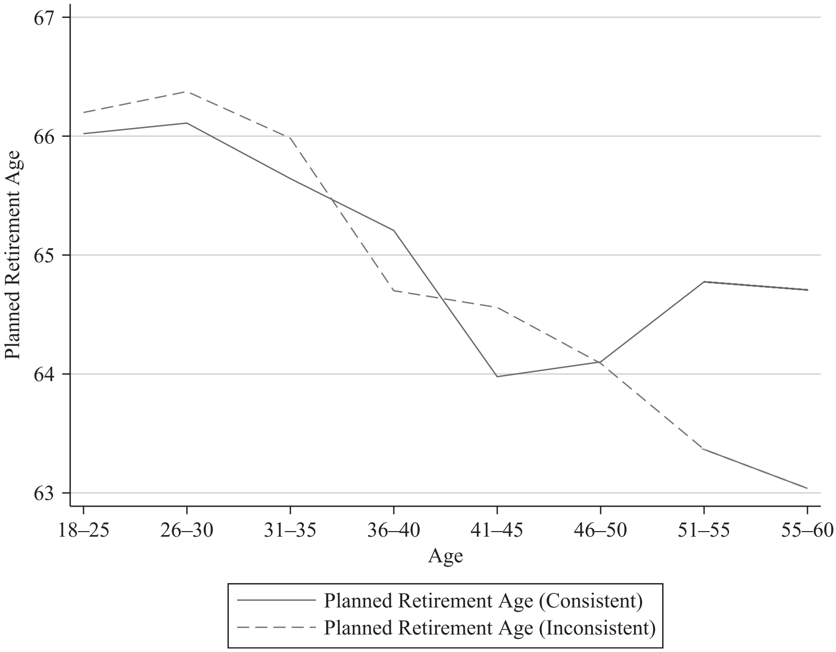

Figure 4

Planned Retirement Age by Age Group and Time Preferences

Notes: The figure shows the average planned retirement age depending on current age for time-consistent participants (solid line) and for time-inconsistent participants (dashed line).

age 51–55 (1.48 years, $p < 0.01$) and age 56–60 (1.71 years, $p < 0.001$). When time-inconsistent participants are close to retirement, they are tempted to retire earlier, just as hyperbolic discounting predicts.

For example, Laibson (1997) proposes hyperbolic discounting functions that intersect with exponential discounting 25 years ahead of an outcome (see his Figure 1). If we assume that retirement income is an income stream centered around age 75, then 50 would be about the age when hyperbolic discounters start to discount retirement income more strongly than exponential discounters. The difference between the discount functions increases with age, which could explain the widening gap between the groups. While the trend continues in our data for the age group above 60, we omit this group from the graph, as from this age, people start to retire in higher numbers, which introduces a selection effect.

We verify the result in a regression framework (Table 6). We split the sample at median age (40) and run regressions for the resulting age groups separately. To complement the figure, we now employ the number of inconsistent answers as a more precise measure of time preferences. The first two columns show the results for younger participants. The effect of time inconsistency is hardly significant and slightly positive, which means that, when young, time-inconsistent participants plan to retire slightly

Table 6
Effect of Time Preferences on Planned Retirement Age—Sample Split

	Planned Retirement Age					
	Age ≤ Median		Age > Median		Age > 50	Age > 55
	(1)	(2)	(3)	(4)	(5)	(6)
Number inconsistent answers	0.201 (0.12)*	0.125 (0.12)	−0.458 (0.14)***	−0.446 (0.14)***	−0.774 (0.18)***	−0.988 (0.29)***
Impatience	−0.286 (0.07)***	−0.246 (0.07)***	−0.124 (0.08)	−0.127 (0.08)	−0.114 (0.10)	−0.243 (0.15)
Age		0.021 (0.04)		−0.011 (0.02)	−0.049 (0.06)	−0.175 (0.20)
Gender		0.054 (0.31)		−0.288 (0.36)	−0.808 (0.54)	−1.022 (0.73)
Married		0.244 (0.41)		−0.739 (0.28)***	−0.747 (0.39)*	−0.494 (0.55)
Number of children		−0.325 (0.46)		0.239 (0.08)***	0.085 (0.16)	0.259 (0.21)
Education		0.827 (0.25)***		0.225 (0.16)	0.700 (0.21)***	0.548 (0.29)*
Income [log]		−0.848 (0.20)***		−0.181 (0.17)	−0.159 (0.22)	0.223 (0.22)
Risk aversion		0.096 (0.11)		0.086 (0.10)	−0.179 (0.15)	−0.258 (0.19)
Loss aversion		−0.225 (0.11)**		−0.039 (0.09)	0.008 (0.13)	0.198 (0.17)
Financial literacy		−0.151 (0.11)		−0.113 (0.14)	−0.049 (0.19)	0.274 (0.28)
Life expectancy		0.016 (0.03)		0.076 (0.02)***	0.046 (0.03)	0.089 (0.04)**
Private pension insurance		−0.737 (0.24)***		−0.441 (0.28)	−0.553 (0.38)	−0.614 (0.54)
Constant	66.810 (0.31)***	71.423 (2.80)***	64.881 (0.32)***	61.319 (2.62)***	66.565 (4.69)***	65.873 (12.28)***
R^2	0.014	0.058	0.013	0.041	0.074	0.139
Observations	1,071	1,043	922	897	375	151

Notes: The table shows six OLS regressions with planned retirement age as the dependent variable. The columns show results for different subsamples by age (participants aged 60 or above are excluded). All variables are as defined in the Appendix. Robust standard errors are displayed in parentheses. Significance: $*p < 0.1$, $**p < 0.05$, $***p < 0.01$.

later than time-consistent participants. This turns around for older participants (Columns 3 and 4), who plan to retire earlier by around four months per inconsistent answer. When we restrict the age range further (to above 50 or 55 years), the impact of time-inconsistent preferences increases in line with Hypothesis 3a. The δ measure suggested by Oster (2019) is well above one (>6) for all subsamples, suggesting a low risk of omitted variable bias.[13]

D. Sophisticated vs. Naive Hyperbolic Decision-Makers

We already introduced the important distinction between sophisticated and naive hyperbolic discounters (Laibson 1997; Diamond and Köszegi 2003). Sophisticated hyperbolic discounters are aware of their time preferences and anticipate that they might revise their planned retirement timing in the future. To prevent time inconsistency, they would seek to commit to a late retirement decision when young. However, in the German and most other social security systems, a commitment device allowing for a binding decision is not available. While, in theory, strategic undersaving has been proposed as a commitment device, mandatory contributions to social security provide retirement income sufficient to retire regardless (even if not maintaining prior living standards).

Results so far suggest that early retirement and downward revision of retirement plans are widespread among participants. Either participants are predominantly naive, or they are sophisticated without access to a commitment device. In the latter case, they would at least try to cushion the consequences of anticipated early retirement by additional retirement provisions. Therefore, we analyze whether time-inconsistent participants buy private pension insurance to compensate for an anticipated reduction in social security benefits due to early retirement. While there are other means of saving for retirement, private pension insurance uptake provides indicative evidence on Hypothesis 4.

Results in Tables 5 and 6 revealed that owning private pension insurance is negatively related to planned retirement age. The motivation to purchase private pension insurance might thus be to afford earlier retirement. To find out who owns private pension insurance, we regress a pension insurance indicator on time preferences in a linear probability model (Table 7). As Columns 1 and 2 reveal, time-inconsistent participants are less likely to purchase private pension insurance. From a base level of 65 percent, they are 4.5 percentage points less likely to do so, or two percentage points for each time-inconsistent answer. This effect is robust to the inclusion of impatience and further control variables (Columns 3–5) and also holds in a logistic regression (Online Appendix Table F.2). The result is unlikely to be affected by omitted variable bias ($\delta = 9.7$). As the effect is opposite to what Hypothesis 4 suggests, we interpret it as evidence against Hypothesis 4.

Participants seem not to be sophisticated in the sense that they anticipate their earlier retirement and provide for it. Instead, the present-biased nature of their time preferences seems to result in a lower propensity for private pension savings. Retiring early without sufficient replacement by other means of savings has severe financial consequences. Not only do retirees incur a deduction from their social security benefits for each month they

13. There is no established procedure to compute δ for interaction terms, which is why we do not report a value for Table 5. However, the nature of the subsample analysis is very similar.

Table 7
Effect of Time Preferences on Owning Private Pension Insurance

	Private Pension Insurance Indicator				
	(1)	(2)	(3)	(4)	(5)
Inconsistency indicator	–0.045 (0.02)**				
Number inconsistent answers		–0.020 (0.01)*	–0.020 (0.01)*	–0.025 (0.01)**	–0.025 (0.01)**
Impatience			–0.007 (0.01)	–0.005 (0.01)	–0.005 (0.01)
Age				–0.000 (0.00)	–0.000 (0.00)
Gender				–0.004 (0.03)	–0.016 (0.03)
Married				0.063 (0.03)**	0.062 (0.03)**
Number of children				–0.007 (0.01)	–0.010 (0.01)
Education				0.018 (0.02)	0.016 (0.02)
Income [log]				0.069 (0.01)***	0.068 (0.01)***
Risk aversion					–0.019 (0.01)**
Loss aversion					–0.005 (0.01)
Financial literacy					–0.006 (0.01)
Life expectancy					0.003 (0.00)**
Constant	0.649 (0.01)***	0.644 (0.01)***	0.671 (0.03)***	0.099 (0.10)	0.002 (0.17)
R^2	0.002	0.001	0.001	0.025	0.030
Observations	2,277	2,277	2,270	2,072	2,046

Notes: The table shows the results of five linear probability models with the indicator private pension insurance as the dependent variable. All variables are as defined in the Appendix. Robust standard errors are displayed in parentheses. Significance: $^*p<0.1$, $^{**}p<0.05$, $^{***}p<0.01$.

retire earlier, but they also forgo additional contributions they would be making when retiring later. In Online Appendix B, we provide a calculation of the financial impact of on average 1.75 years of earlier retirement we observe for time-inconsistent participants (actual retirement age, see Table 3). In the German social security system, this would lead to a reduction in retirement benefits of about 10 percent (see also Engelhardt, Gruber, and Kumar 2022).

V. Evidence from a Representative Household Survey

A. The SAVE Data Set

For complementary evidence, we use a representative German household panel (SAVE). The SAVE panel survey has been conducted between 2001 and 2013 by the Munich Center for the Economics of Aging (MEA). It focuses on savings behavior, financial assets, and old-age provision (for a detailed description, see Börsch-Supan et al. 2009). We use the four survey waves of 2008, 2009, 2010, and 2011 in the following analyses. Waves before 2008 are excluded because, in a reform of the German pension system, the full retirement age was raised to 67 in 2007. In line with Behaghel and Blau (2012), we find that participants use the full retirement age as an anchor for their planned retirement age. Therefore, a change of the full retirement age represents a structural break in the data. The wave of 2013 is excluded due to a shorter questionnaire that misses key variables.

The main dependent variables, planned retirement age and actual retirement age, as well as the control variables, are similar to those used in the FAZ experiment. The two data sets are complements, as the SAVE survey provides a more diverse sample of respondents and, due to its panel structure, allows studying changes within person. However, none of the survey waves in the SAVE panel include an explicit measure for inconsistent time preferences. Instead, we use participants' cigarette smoking habits and their use of bank account overdrafts as proxies.

In the medical and psychological literature, smoking has been frequently related to impulsivity, lack of self-control, and hyperbolic discounting (Bickel, Odum, and Madden 1999; Krishnan-Sarin et al. 2007; Reynolds and Fields 2012; Stillwell and Tunney 2012; Daly, Delaney, and Baumeister 2015). The empirical link between hyperbolic discounting and smoking has been mostly confirmed in economics (Kan 2007; Grignon 2009; Ida 2014; Kang and Ikeda 2014), even though some studies find mixed evidence (Khwajaa, Silverman, and Sloan 2007; Harrison, Lau, and Rutström 2010). Gruber and Köszegi (2004) formulate a theoretical model of inconsistent time preferences and smoking behavior, which they believe describes smoking decisions better than an exponential model.

Within this literature, several studies explicitly relate smoking behavior to monetary measures of time preferences similar to the one used in the FAZ experiment. Bickel, Odum, and Madden (1999) find higher discount rates and a better fit of the hyperbolic discounting model for smokers. Stillwell and Tunney (2012) likewise report steeper discounting by smokers within a hyperbolic model. Grignon (2009) shows that present-biased respondents find it harder to quit smoking, while Ida (2014) and Kang and Ikeda (2014) find that both present bias and impatience predict smoking behavior. Harrison, Lau, and Rutström (2010) find only a slightly higher prevalence of time-inconsistent preferences among smokers, which is not statistically significant.

Smoking behavior has been used before as a proxy for inconsistent time preferences in the financial domain. Most closely related to our study, Finke and Huston (2013) find a negative relation between smoking and the perceived importance of saving for retirement. Uhr, Meyer, and Hackethal (2021) report that smokers among brokerage clients are prone to excessive trading behavior. Smokers also show a higher demand for savings plans (presumably as a commitment device), but they are less likely to maintain the savings plan over longer time horizons. Based on the strong link between smoking and inconsistent time preferences and its availability in the SAVE survey, we opt to use it as a time preference proxy.

Smoking as a time inconsistency proxy has the disadvantage that it might influence retirement timing due to health effects since nonsmokers are on average in better health than smokers. We thus have to control for health to overcome omitted variable bias. In the analysis, we include three variables measuring the health status of SAVE participants: (i) self-assessed health status on a five-point scale, (ii) satisfaction with the current health status on a ten-point scale, and (iii) whether a participant currently suffers (or has suffered) from a prolonged illness. Subjective reports of health have been shown to have important effects on retirement timing (McGarry 2004). We find that the elicited variables are moderately correlated in the expected direction, which suggests that they cover different but related aspects of subjective health.

As an alternative to smoking behavior, we consider the use of bank account overdrafts as a time preference proxy. Unlike in the United States and other countries, where credit cards are used to obtain a flexible short-term credit line, bank overdrafts fulfill this function in Germany.[14] Almost every adult with a bank account has access to a credit line for overdrafts. Features of overdrafts that resemble credit cards are high interest rates relative to other means of consumer credit and the absence of a fixed repayment scheme. Like credit card debt, overdrafts can be carried over for many months or even years.

Regular use of credit card debt or overdrafts might indicate a desire for immediate gratification keeping people from waiting until the next paycheck. Meier and Sprenger (2010) find that present bias correlates with the existence and amount of credit card debt. Shui and Ausubel (2005) show that hyperbolic discounting can explain credit card borrowing behavior in a large field experiment. More recently, Kuchler and Pagel (2021) show that present bias adversely affects the pay-down of credit cards. While overdrafts are less studied, there is evidence that present bias (but not impatience) increases the frequency of overdraft usage (Becker, Jaroszek, and Weber 2017). Frequent users are also more willing to use expensive overdrafts to finance regular consumption.

In the SAVE survey, overdraft usage is measured on a scale from one ("never") to four ("more than six times per year or permanently"). In addition, we use an overdraft indicator that takes a value of one for frequent users (3 or 4 on the scale). Table 8 shows summary statistics for the 2010 wave of the SAVE survey. Overdrafts are more frequently used by nonretirees than by retirees, and 32 percent of the former can be classified as frequent users. The percentage of smokers is 31 percent for nonretirees and 14 percent for retirees. We find that smokers use overdrafts more (2.1) than nonsmokers (1.9, $p < 0.01$), which

14. Most credit cards issued in Germany work similarly to debit cards or charge cards, where the balance is settled in full at the end of each month.

Table 8
Summary Statistics SAVE Survey

	Retirees ($n = 907$)		Nonretirees ($n = 1{,}140$)	
	Mean	SD	Mean	SD
Panel A: Retirement Timing				
Planned retirement age			64.92	2.98
Actual retirement age	58.90	6.82		
Panel B: Time Preferences				
Smoker [0–1]	0.14	0.35	0.31	0.46
Overdraft [1–4]	1.69	1.03	2.15	1.14
Overdraft indicator [0–1]	0.18	0.39	0.32	0.47
Panel C: Demographics				
Age	69.83	8.85	46.21	19.26
Gender [male = 1]	0.52	0.50	0.45	0.50
Income (if >0)	1,517.12	1,108.73	1,519.73	985.16
Number of children	2.04	1.41	1.68	1.37
Education [0–2]	0.45	0.79	0.50	0.78
Married	0.61	0.49	0.63	0.48
Panel D: Additional Controls				
Financial literacy [0–9]	2.94	1.08	2.95	1.04
Subjective life expectancy	80.33	7.06	78.60	8.40
Private pension insurance (PPI)	0.08	0.28	0.44	0.50
Panel E: Health Controls				
Health status [1–5]	3.16	0.83	3.58	0.80
Satisfaction health [0–10]	5.54	2.45	6.44	2.31
Prolonged illness	0.69	0.46	0.43	0.50

Notes: The table presents summary statistics for the SAVE 2010 survey for subsamples of retirees and non-retirees. Variables are as defined in the Appendix.

suggests that the two time-inconsistency proxies are related. The correlations between the two proxies are 0.08 ($p < 0.01$) for the 2010 wave and 0.23 ($p < 0.01$) for the panel. Additional control variables in the SAVE survey include demographics, financial literacy, subjective life expectancy, and whether or not participants own private pension insurance (see Appendix below).

B. Comparison of Data Sets

The planned retirement age of SAVE participants is comparable to the FAZ sample, while the actual retirement age is lower. The data sets further strongly differ in average income, education, and the fraction of female participants (Tables 1 and 8). This reflects the educated, more affluent, and predominantly male readership of the FAZ business section. Further differences arise from the fact that SAVE oversamples older participants and has a much higher fraction of retirees. For illustration, we provide an explicit comparison for income and education in Online Appendix E. We compare the values in the two surveys with official data from the German federal statistical office. As expected for a representative survey, income and education of SAVE participants are very close to the German average. The FAZ sample differs remarkably, as net income is almost double the German average and university education more than three times more common.

While there is little reason to believe that inconsistencies observed for educated and affluent people will be absent in a more representative sample, the SAVE results provide evidence against selection effects. In addition, we replicate the prior analyses for the FAZ sample for less-educated or lower-income participants. The results displayed in Online Appendix E show that effect sizes are often larger in these subsamples (even though sometimes insignificant due to a much smaller sample size). This is consistent with the common view that more sophisticated people are less susceptible to bias. For example, Stango and Zinman (2023) show for a number of behavioral biases, including time inconsistency, that biasedness decreases with education and income, even though there is large heterogeneity.

C. SAVE: Results for Actual Retirement Age

We first repeat the analysis of actual retirement age with data from the SAVE 2010 survey. We use the cross-section in this analysis and will later zoom in on those who retire during the panel. In the 2010 wave, 907 participants indicate that they are already retired. We proxy for time preferences by smoking habits and overdraft usage. As smoking has negative effects on health, we include variables on participants' health status in the analysis. A second concern is the selective mortality of smokers. Studies that analyze the effect of regular cigarette smoking find that, on average, it reduces life expectancy by ten years (Doll et al. 2004; Sakata et al. 2012; Jha et al. 2013). Consequently, the health status of the surviving smokers in the data set is biased upward. However, observing more healthy smokers is an advantage, as we are interested in the component of the smoking variable that is correlated with time preferences, not health. Within the panel, we observe only slightly higher panel attrition for smokers among retirees (Online Appendix F).

Table 9 presents the results of linear regressions with the actual retirement age as the dependent variable. In Column 1, only smoking as a time inconsistency proxy is included in the regression. In Column 2, control variables on participants' health status are added. Column 3 includes health controls, demographics, and other control variables. In all three specifications, smoking predicts earlier retirement. The average difference in actual retirement age between smokers and nonsmokers is about 3.6 years (Column 1). Adding health variables (Column 2) does not change the magnitude and significance of the effect. In the full model with all controls (Column 3), the coefficient for the smoking indicator is somewhat reduced but still negative and strongly significant. As we control for health, life expectancy, and further personal characteristics, we attribute the remaining difference between smokers and nonsmokers mostly to time preferences. In a robustness test, we find similar coefficients for former smokers who are identified by using prior waves of the SAVE panel (Online Appendix F).

Table 9
Actual Retirement Age SAVE Survey

	Actual Retirement Age					
	(1)	(2)	(3)	(4)	(5)	(6)
Smoker [0/1]	–3.605 (0.79)***	–3.548 (0.79)***	–2.661 (0.78)***			
Overdraft [1–4]				–1.679 (0.27)***	–1.589 (0.27)***	–1.394 (0.25)***
Health status		1.577 (0.48)***	1.327 (0.47)***		1.428 (0.49)***	1.369 (0.47)***
Satisfaction health		0.017 (0.15)	0.014 (0.14)		0.073 (0.15)	–0.017 (0.15)
Prolonged illness		0.397 (0.57)	0.658 (0.55)		0.423 (0.58)	0.422 (0.54)
Gender			1.388 (0.48)***			1.053 (0.47)**
Married			–0.689 (0.5)			–1.345 (0.5)***
Number of children			0.103 (0.16)			0.197 (0.16)
Education			0.874 (0.24)***			0.725 (0.26)***
Income [log]			–0.269 (0.06)***			–0.216 (0.06)***
Financial literacy			–0.104 (0.2)			–0.112 (0.2)
Life expectancy			0.153 (0.03)***			0.142 (0.04)***
Private pension insurance (PPI)			–4.506 (1.07)***			–4.14 (1.01)***
Constant	59.395 (0.23)***	54.042 (1.53)***	42.748 (3.01)***	61.843 (0.44)***	56.48 (1.59)***	46.675 (3.38)***
R^2	0.033	0.062	0.150	0.067	0.097	0.208
Observations	907	907	905	753	753	752

Notes: The table shows the results of six cross-sectional OLS regressions for the 2010 wave of the SAVE survey. The dependent variable is actual retirement age using the subsample of retired participants. Regressions include either smoking or overdraft usage as a proxy for time inconsistency. Variables are as defined in the Appendix. All five imputations of the SAVE data are used. Coefficients and standard errors are calculated according to Rubin (1987). Significance: *$p<0.1$, **$p<0.05$, ***$p<0.01$.

In Columns 4–6, we repeat the analysis for overdraft usage as a time preference proxy. We find that frequent overdraft usage is negatively related to retirement age in all specifications. Economically, a shift of two notches on the four-point scale has an effect about equal in magnitude to smoking. For overdraft usage, it is most important to control for variables such as income and financial literacy. As the results in Column 6 show, the coefficient for overdrafts remains relatively stable when including controls. We conclude that inconsistent time preferences proxied by smoking habits or overdraft usage contribute to earlier retirement (in line with Hypothesis 1).

Besides the time-inconsistency proxies, poor health is predictive of early retirement. Self-assessed health status is associated with a 1.3–1.5 year reduction in retirement age for a one-point decrease on the five-point scale. This variable seems to subsume the other health variables, which remain insignificant. In the full model (Columns 3 and 6), gender, income, and education show the same effects as for the FAZ sample (Table 4). In addition, life expectancy and owning private pension insurance obtain statistical significance. Quite intuitively, participants with shorter life expectancy retire earlier, and those who own private pension insurance retire earlier. For smoking behavior, $\delta = 2.8$ for the regression with full controls, and for overdraft usage $\delta = 4.2$.

To exploit the panel structure of the data, we next concentrate on participants who retire during the panel ($n = 123$). We compare their age in the year they retire with the planned retirement age they expressed in the last survey wave prior to retirement. This allows us to identify individuals who retired earlier than planned. It turns out that such time inconsistencies are quite frequent—40 percent of participants retire earlier than they indicated just a year prior. Figure 5 shows a strong correlation between retiring earlier than planned and both smoking behavior and overdraft usage. While nonsmokers retire earlier in only 30 percent of cases, the fraction for smokers is twice as high. For frequent overdraft users, the incidence is also much higher than for nonfrequent users. We confirm this relationship in regressions with all controls (Online Appendix F).

The within-person results confirm the existence of time inconsistencies in retirement timing decisions. Hyperbolic discounters not only retire earlier (in both FAZ data and SAVE data), they are also more likely to disregard their own plan. The short time period of just a year between stated preference and decision suggests that, in line with theory, preference shifts happen in the final years prior to retirement. We will revisit this issue in the analysis of revisions in the planned retirement age below.

D. SAVE: Results for Planned Retirement Age

In a second test, we track the planned retirement age of individuals in the SAVE panel. The analysis is restricted to 1,653 nonretirees who participate at least twice in the SAVE survey in 2008–2011. We hereby compare similar samples across time and obtain within-person changes in planned retirement age. We run panel regressions with participant fixed effects and planned retirement age as the dependent variable. A survey wave variable is included to show the effect of progressing time on planned retirement age. It takes a value of zero for the year 2008 and values of one to three for subsequent years. The fixed effects absorb all static controls, which leaves us with subjective health measures that change over time and may have a profound effect on planned retirement

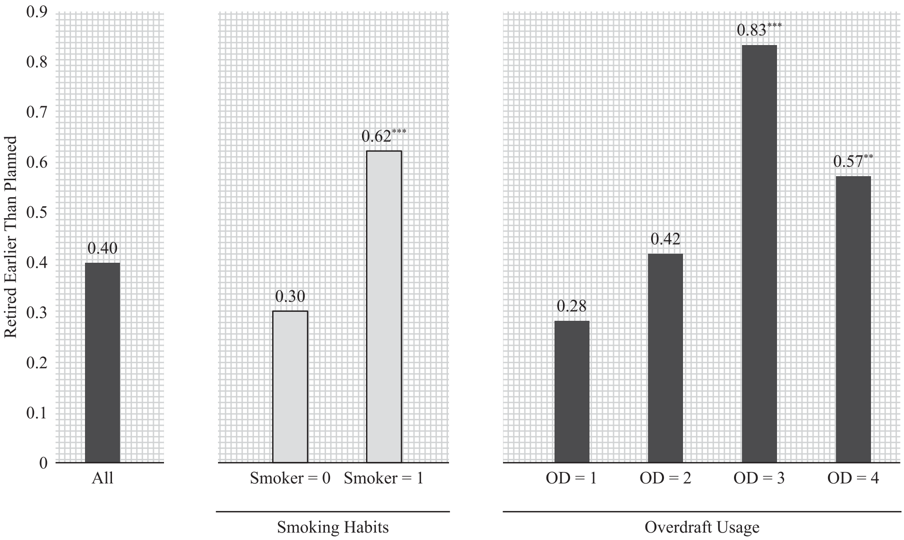

Figure 5

Retirement Timing by Overdraft Usage and Smoking Habits

Notes: The figure shows the fraction of participants who retire earlier than planned in the 2008–2011 SAVE waves. Earlier than planned retirement is assumed if the planned retirement age in wave $t-1$ (PRA_{t-1}) is larger than the actual retirement age indicated in wave t (ARA_t). Significance: $*p<0.1$, $**p<0.05$, $***p<0.01$, relative to the group of nonsmokers or to the group not using overdrafts (overdraft = 1).

timing. The SAVE data are multiply imputed, and all five imputations are used. Coefficients and standard errors for imputed data are calculated according to Rubin (1987).

Table 10 presents results for smoking behavior (Panel A) and overdraft usage (Panel B). Column 1 shows the full sample in both panels. It reveals that survey participants reduce their planned retirement age each year by about 0.1 years. After ten years, this would result in one year earlier planned retirement. Unlike for the FAZ sample, this is a within-subject effect, as we track participants over time. To classify participants, we identify smokers and overdraft users as those who smoke or use overdrafts frequently in at least one survey wave.[15] As before, we expect time-inconsistent participants to revise their planned retirement age downward, while time-consistent participants do not. We thus split the sample by the two time inconsistency proxies.

Columns 2–4 of Panel A show results for smokers, who reduce their planned retirement age more strongly, by about 0.2 years each year. Hyperbolic discounting predicts this effect to be concentrated among people approaching retirement. We thus further restrict the sample to participants over age 40 and over age 50. The effect becomes

15. As behavior is very stable, fractions are only slightly higher than the cross-sectional summary statistics displayed in Table 8. The aim is to group people consistently as either time inconsistent or consistent. We obtain similar results when using wave-by-wave behavior. However, as the proxies are not available for 2011, the panel would be shorter.

Table 10
Planned Retirement Age SAVE Survey

Panel A	Full Panel	Smoker			Nonsmoker		
		All	Age > 40	Age > 50	All	Age > 40	Age > 50
	(1)	(2)	(3)	(4)	(5)	(6)	(7)
Wave	–0.093	–0.197	–0.256	–0.321	–0.036	–0.055	–0.085
	(0.05)*	(0.09)**	(0.12)**	(0.15)**	(0.05)	(0.06)	(0.09)
Health status	0.010	–0.011	0.006	0.046	–0.012	–0.014	0.125
	(0.03)	(0.06)	(0.06)	(0.08)	(0.04)	(0.05)	(0.05)**
Satisf. health	–0.100	0.028	–0.003	–0.074	–0.165	–0.131	–0.094
	(0.14)	(0.27)	(0.28)	(0.34)	(0.15)	(0.14)	(0.18)
Prolonged illness	0.083	–0.067	–0.198	–0.403	0.19	0.122	–0.073
	(0.13)	(0.25)	(0.32)	(0.53)	(0.14)	(0.15)	(0.2)
Constant	65.572	66.696	67.091	67.681	64.883	64.961	64.702
	(0.56)***	(1.15)***	(1.46)***	(2.29)***	(0.55)***	(0.58)***	(0.78)***
R^2	0.003	0.007	0.011	0.033	0.003	0.003	0.014
Obs	4,043	1,449	990	436	2,594	1,802	952

(*continued*)

Table 10 (*continued*)

Panel B	Full Panel	Overdraft = 1			Overdraft = 0		
		All	Age > 40	Age > 50	All	Age > 40	Age > 50
	(1)	(2)	(3)	(4)	(5)	(6)	(7)
Wave	–0.093	–0.111	–0.183	–0.236	–0.086	–0.098	–0.125
	(0.05)*	(0.09)	(0.11)*	(0.15)	(0.06)	(0.07)	(0.09)
Health status	0.010	0.049	–0.021	0.093	–0.038	0.005	0.112
	(0.03)	(0.06)	(0.06)	(0.09)	(0.04)	(0.05)	(0.05)**
Satisf. health	–0.100	–0.249	–0.238	–0.199	–0.008	–0.014	–0.026
	(0.14)	(0.25)	(0.21)	(0.28)	(0.16)	(0.18)	(0.2)
Prolonged illness	0.083	0.031	–0.051	–0.047	0.101	0.015	–0.281
	(0.13)	(0.18)	(0.18)	(0.29)	(0.18)	(0.22)	(0.32)
Constant	65.572	65.616	66.579	65.726	65.591	65.360	65.721
	(0.56)***	(0.93)***	(1.08)***	(1.43)***	(0.69)***	(0.85)***	(1.28)***
R^2	0.003	0.006	0.008	0.022	0.002	0.002	0.014
Obs.	4,043	1,356	924	411	2,687	1,868	977

Notes: The table shows the results of seven fixed-effects panel regressions with planned retirement age in years as the dependent variable. Data used for the analysis come from SAVE 2008, 2009, 2010, and 2011, encoded in the variable wave. All variables are as defined in the Appendix. All five imputations of the SAVE data are used. Coefficients and standard errors are calculated according to Rubin (1987). Significance: *$p < 0.1$, **$p < 0.05$, ***$p < 0.01$.

stronger the closer participants are to retirement and amounts to 0.26 years each year for those over 40 and even 0.32 years for those over 50. In contrast, it remains insignificant for participants under 40 (not tabulated). Even the relatively short panel thus illustrates how a difference in actual retirement age of more than three years (documented in Table 9) can arise, as there is no similar reduction for nonsmokers (Columns 5–7). The declining health of smokers does not explain the effect. Overdraft usage in Panel B exhibits qualitatively similar but less pronounced results. Frequent overdraft users reduce their planned retirement age more strongly than nonusers, but not significantly so.

We reexamine the take-up of private pension insurance to study whether hyperbolic discounters anticipate their earlier than planned retirement. If they were sophisticated, they might seek to make up for expected losses in retirement benefits. Online Appendix Table F.4 shows results of a regression of private pension ownership on time preference proxies. We find no or even a negative effect of time inconsistency. We interpret this as a sign of naivete. Participants do not anticipate earlier than planned retirement, or they are unable to commit to private pension insurance.

VI. Discussion

Policy interventions in retirement timing mostly target later retirement. This can be justified by keeping social security systems solvent, as they are burdened by increasing life expectancy and low birth rates in many developed countries. The primary lever is adjustments to the social security rules, such as shifts in early or full retirement age or adjustments to the social security formula. French (2005) and French and Jones (2012) analyze the effects of such policy changes using a structural approach under the assumption of time-consistent individuals. In their models, general reductions in retirement benefits or shifts in retirement age are less effective than the removal of disincentives to work, such as earnings tests or actuarially unfair adjustments for early or late claiming.

The effects of changes to the social security rules hereby depend much on the forward-looking behavior of individuals (French 2005). As structural retirement models almost exclusively rely on exponential time preferences, consistent behavior over time is the norm. However, we find evidence that time-inconsistent individuals are naive about their time preferences, which means that they have limited capacity to offset changes to the rules by adjusting their consumption behavior. Even sophisticated hyperbolic discounters need commitment devices to implement a forward-looking plan that considers their future behavior. When Gustman and Steinmeier (2012) introduce hyperbolic discounting to structural retirement models, they model sophisticated individuals with access to commitment devices. Individuals are able to implement a consistent intertemporal consumption plan, which is why they find little differences in response to policy interventions. In addition, they model leisure preferences independently of time preferences, which are thus not subject to present bias.[16]

16. This is in contrast to the theoretical literature, which mostly models work as an effort cost that reduces current consumption utility (Diamond and Köszegi 2003).

Under more realistic assumptions of partly naive hyperbolic discounters and limited commitment devices, we expect rule changes to have the strongest effect when they impact incentives around the point of retirement rather than in later years. For example, the German social security system has a benefit reduction of only 3.6 percent per year for claiming early, which is less than what would be actuarially fair (Blundell, French, and Tetlow 2016). A stronger penalty would disproportionally affect time-inconsistent individuals, as they tend to retire earlier and weigh an immediate consumption loss more heavily. Indeed, Gustman and Steinmeier (2012) find a stronger response of hyperbolic discounters to steeper retirement credits. As they model the retirement credit for retiring after the full retirement age, it seems likely that differences would be even more pronounced for early retirement penalties.

An interesting case is earnings tests, which are a strong disincentive to work after claiming retirement benefits (French 2005).[17] Forward-looking individuals respond to the removal of the earnings test by working longer, whereby exponential discounters react more strongly (Gustman and Steinmeier 2012). However, time-inconsistent retirees face another consequence of earnings tests, which is that they make it more costly to reverse a premature entry into retirement. We find that time-inconsistent retirees often experience retirement regret that could be reduced by removing barriers for reentry. More generally, the possibility to reverse claiming decisions would be an interesting but rarely discussed policy intervention.

Although we have just described a case in which hyperbolic discounters would benefit from greater flexibility to reverse previous decisions that they no longer consider optimal, flexibility can also be harmful. Börsch-Supan et al. (2018) illustrate this for the case of gradual work hour reduction, which is equally likely to delay full retirement as it is to induce earlier part-time retirement. Sophisticated hyperbolic discounters have a natural demand for commitment devices that tie their hands, for example, by setting an early retirement age before which it is not possible to draw retirement benefits. In structural models, the effect of shifting the early retirement age is modest (French 2005; Gustman and Steinmeier 2005), but in reality such shifts have relatively large effects (Manoli and Weber 2016). What the models do not capture are social norms on appropriate retirement ages, a reluctance to spend from savings to finance early retirement, and loss aversion relative to reference ages (Behaghel and Blau 2012; Merkle, Schreiber, and Weber 2017). Thaler and Shefrin (1981) discuss that norms are useful to enhance self-control. Therefore, setting a later early retirement age works as a commitment device even if liquidity allows for retirement before the early retirement age.

Dealing with time-inconsistent individuals might call for more innovative policy interventions, such as refined commitment devices. An example is allowing contributors to lock in a specific retirement age ex ante. Changes would then only be possible in case of unexpected shocks (for example, severe health decline or job loss). Bond and Sigurdsson (2017) suggest contracts that combine commitment with the flexibility to react to shocks by exploiting preference reversals in hyperbolic preferences. Yu (2021) proposes a solution that involves menus of different retirement consumption

17. An earnings test entails the reduction or taxation of retirement benefits when receiving labor income.

paths depending on claiming age. Some off-paths exist only to motivate effort in the employment phase but are theoretically never chosen when retiring. It is difficult to imagine such policies in reality, as they increase complexity, and almost surely some retirees will be locked in inferior options due to decision mistakes. As a simpler alternative, a waiting period of several months between claiming and receiving benefits would protect both naive and sophisticated hyperbolic discounters from the most immediate impact of present bias.[18]

VII. Conclusion

In an experiment on choices within the social security system, we relate the decision of when to retire to participants' time preferences. In cooperation with the *Frankfurter Allgemeine Zeitung*, a large and well-circulated German newspaper, we recruited more than 2,000 participants. They answered a set of questions on the preferred time to receive a tax refund, which allows us to measure their time preferences. We use this measure to analyze the effect of inconsistent (hyperbolic) time preferences on participants' actual and planned retirement age. We find that participants with hyperbolic time preferences are more likely to show inconsistent retirement planning. Time-inconsistent participants advance their planned retirement as they age. The temptation of early retirement seems to increase further when retirement approaches. From age 50, they reduce their planned retirement age relative to the group of time-consistent participants.

While plans might not reflect future behavior, the influence of time preferences can be confirmed for the actual retirement age of participants who are already retired. On average, time-inconsistent participants retire 1.75 years earlier than time-consistent participants. Earlier retirement has severe financial consequences for the remaining lifetime because it results in a permanent decrease in monthly retirement benefits (of about 10 percent in the German social security system). In addition, time-inconsistent participants are more likely to regret their retirement decision. A third of retired participants who are classified as time inconsistent indicate that they would retire later if they could make the retirement entry decision again. This suggests that they retire rather spontaneously and not in line with their prior and later preferences.

18. Time-consistent contributors would be (largely) unaffected by these changes, as their retirement plans are stable over time. A similar solution has been advocated in a blog by Beeminder (https://blog.beeminder.com/flexbind, accessed November 17, 2023), a self-tracking app to reach personal goals.

Appendix: Variable Definitions

Variable	Description
FAZ Survey	
Planned retirement age	Age in years when nonretired participants plan to retire ("*At what age do you plan to retire?*"). Nonretirees only.
Actual retirement age	Age in years when retired participants did retire ("*At what age did you retire?*"). Retirees only.
Full retirement age	Full retirement age according to the German social security system based on the birth year of participants.
Retirement regret	Indicator that equals one if participants felt they retired too early ("*If you were to retire again, would you retire earlier, later, or at the same age?*"). Retirees only.
Inconsistency indicator	Refers to the time preference question as displayed in Figure 1. Indicator equals one if a participant makes at least one time-inconsistent choice in the direction of hyperbolic discounting.
Number inconsistent answers	Refers to the time preference question as displayed in Figure 1. Count of the number of inconsistent choices in the direction of hyperbolic discounting (0–3).
Impatience	Agreement on a seven-point Likert scale (1–7) with the statement "*I am an impatient person*."
Age	Current age of participants in years.
Gender	Indicator that equals one if a participant is male.
Income	Self-reported monthly net income. Nonretirees only.
Retirement benefits	Retirement income from social and private insurance. Retirees only.
Satisfaction with benefits	Agreement on a seven-point Likert scale (1–7) with the statement "*I am satisfied with my monthly retirement benefits*."
Number of children	Number of participant's children.
Education	Variable that takes a value of two for a university degree or higher, a value of one for a high school degree (German Abitur), and a value of zero for a lower or no degree.
Married	Indicator that equals one if a participant is married.
Risk aversion	Agreement on a seven-point Likert scale (1–7) with the statement "*I am a risk-averse person*."
Loss aversion	Agreement on a seven-point Likert scale (1–7) with the statement "*I am very afraid of losses*."
Financial literacy	Number of correct responses to six financial literacy questions (see Online Appendix A).
Subjective life expectancy	Self-reported life expectancy in years of age.
Private pension insurance	Indicator if participant owns private pension insurance.

(*continued*)

Variable	Description
SAVE Survey	
Planned retirement age	Age in years when nonretired participants plan to retire ("*At what age do you plan to retire?*"). Nonretirees only.
Actual retirement age	Age in years when retired participants did retire ("*At what year did you enter retirement?*"). Retirees only.
Smoker	Indicator that equals one if a participant responds yes to the question "*Do you smoke regularly?*" at least once in the used rounds of the panel.
Overdraft	Overdraft measures the self-reported usage of the overdraft option provided by the participant's bank. It ranges from one (never use overdraft) to four (more than 6 times per year).
Overdraft indicator	Indicator that equals one if participants use the overdraft option frequently (overdraft ≥ 3) at least once in the used rounds of the panel.
Age	Current age of participants in years.
Gender	Indicator that equals one if a participant is male.
Income	Self-reported monthly net income.
Number of children	Number of participant's children.
Education	Variable that takes a value of two for a university degree or higher, a value of one for a high school degree (German Abitur), and a value of zero for a lower or no degree.
Married	Indicator that equals one if a participant is married.
Financial literacy	Number of correct responses to nine financial literacy questions (see Online Appendix B).
Subjective life expectancy	Self-reported life expectancy in years of age.
Private pension insurance	Indicator that equals one if a participant owns private pension insurance.
Health status	Self-assessed health status on a five-point scale (from very good (=5) to very bad (=1)).
Satisfaction with health	Self-reported satisfaction with own health on a ten-point scale (from completely satisfied (=10) to not at all satisfied (=0)).
Prolonged illness	Indicator that takes the value of one if a participant reports to have prolonged health problems, illnesses, or disabilities.

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