Retirement and commitments with present-biased preferences

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Abstract

Present-biased preferences induce dynamically inconsistent decisions, implying a motive for people to constrain their future choices. We present a simple model of savings and retirement to show that sophisticated people, who are aware of their bias, use illiquid assets to constrain future consumption and to prevent retiring earlier than planned. Empirical evidence using survey data from Germany confirms the model predictions. We find that naïve present-biased people retire on average 1.6 years earlier than time-consistent, while sophisticated people are more likely to hold illiquid assets and retire 1.9 years later than naïve.

1 Introduction

Income adequacy in old age is crucial to ensure retirees' well-being, and it largely depends on past saving and retirement decisions. These two decisions are interconnected and share an inter-temporal dimension, meaning that time preferences play an important role. Present-biased preferences, which give stronger relative weight to the near future as it gets closer (O'Donoghue and Rabin, 1999), lead to dynamically inconsistent saving and retirement decisions, creating an incentive for individuals to limit their future options.

In this paper, we study consumption and retirement decisions of present-biased people when savings can be invested in an illiquid asset. We distinguish between naïve people, who are not aware of their present-bias, and sophisticated ones, who are. While naïve people deviate from the planned consumption path and may retire earlier than planned, we show that sophisticated people use the illiquid asset to constrain future consumption and labour supply. It is intuitive

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that low liquidity incentivizes work and constraints consumption, but there may not exist a liquidity level that leads to both first-best consumption and retirement age. Instead, we show that the optimal liquidity level for the case of exogenous retirement also leads to the first-best retirement age when retirement is endogenous.

We further test the model predictions using population-representative survey data from Germany. We exploit the German Socio-Economic Panel's Innovation Sample and categorize people as time-consistent, naïve, partially or fully sophisticated present-biased following the method of Cobb-Clark et al. (2024). In practice, we compare information on their ideal, predicted, and realized body weight to infer their type. First, in line with the model predictions, we find that fully sophisticated people are 13 percentage points (around 60%) more likely to hold illiquid assets compared to both naïve and time-consistent people. Second, naïve people retire on average 1.6 years earlier than time-consistent, while fully sophisticated people retire 1.9 years later than naïve. Third, we find that part of the positive correlation between full sophistication and retirement age is due to the illiquid assets. Moreover, illiquid assets are positively correlated with later retirement even after conditioning on time preferences and sophistication. However, partially sophisticated people behave similarly to naïve individuals, suggesting that for them the perceived benefit of committing is lower than its cost.

Our work contributes to the literature on savings and retirement with present-biased preferences (Phelps and Pollak, 1968; Laibson, 1997; Diamond and Kőszegi, 2003; Schreiber and Weber, 2016; Merkle et al., 2022; Groneck et al., 2024). In particular, Laibson (1997) studies saving decisions of present-biased agents and their demand for illiquid assets while abstracting from labour supply choices. On the other hand, Diamond and Kőszegi (2003) study retirement decisions of present-biased agents when commitments are not available. We combine the insights from these two models in a unified theoretical framework to show that illiquid assets can be used to constraint multiple interconnected decisions, such as consumption and retirement. On the empirical side, we present the first evidence of differences in retirement behaviour between naïve and sophisticated people. Merkle et al. (2022) show that present-biased people retire earlier than time-consistent ones. We go beyond their results by distinguishing between naïve, partially, and fully sophisticated present-biased people, and we show that only naïve and partially sophisticated retire earlier than time-consistent people, while only fully sophisticated are more likely to use commitments compared to time-consistent.

Importantly, our model allows us to study the theoretical *effects* (under some assumptions) of time preferences and sophistication on outcomes, while our empirical analysis presents *correlational* evidence that is consistent with the model predictions. Because it's difficult to exploit exogenous variation in preferences, the literature on time-inconsistency and commitments has focused on correlational evidence, and it has found mixed evidence.[1] For example, Augenblick et al. (2015) and Kaur et al. (2015) find a positive correlation between the demand for commitments and time-inconsistency, while John (2020) and Sadoff et al. (2020) find a negative correlation. Instead, we find a positive correlation between the use of commitments and full sophistication about one's own time-inconsistency. Furthermore, we provide the first evidence that fully sophisticated people are able to overcome their time-inconsistency in the retirement context, and that this result stems – at least partially – from the use of commitments.

The remainder of the paper is organized as follows. In section 2, we first solve the model for the cases of exogenous retirement, and then endogenize the retirement decision. In section 3, we introduce an illiquid asset. Section 4 presents the empirical evidence. Section 5 concludes.

2 Model

Our model setup follows Diamond and Kőszegi (2003), but we later add illiquid assets in section 3. Time preferences are modelled with a quasi-hyperbolic discounting function, such that the agent maximizes $u_1 + \sum_{t=2}^{T} \beta\delta^t u_t$. We assume $\beta \in (0, 1)$ and $\delta = 1$.[2] We further assume a logarithmic utility over consumption and $T = 3$. In period 1, the agent works and earns $w_1 > 0$, and decides consumption c_1 and savings $s_1 = w_1 - c_1$.[3] In period 2, he decides to work or to retire, and how much to consume (c_2) and save. If he works, he earns $w_2 > 0$ and suffers an additive disutility $e = 1$.[4] In period 3, he cannot work and consumes what's left (c_3). There is no uncertainty and no return on savings.

In section 2.1, we study the consumption decision. In section 2.2, we endogenize the retirement decision. We first review the findings of Diamond and Kőszegi (2003), who showed that for certain levels of savings (s_1) retirement can be time-inconsistent. Differently from their work, we further show that such levels of savings can endogenously originate within the model.[5]

[1] Instead, Carrera et al. (2022) and Westphal (2024) exploit experimental variation in sophistication about time-inconsistent preferences.

[2] As in Laibson (2015) and Fahn and Seibel (2022) to simplify the exposition.

[3] w_1 can be interpreted as the sum of initial wealth and period 1 wage.

[4] Results do not qualitatively differ for $e > 0$, but, for example, for large enough values of e retirement is never time-inconsistent. We therefore focus on a simple case where retirement can be time-inconsistent.

[5] Our analysis also relates to Holmes (2010), who studies the specific case when $w_1 = w_2$ and shows that retirement cannot be time-inconsistent.

2.1 Consumption decision

The agent's choices can be modelled as an equilibrium in a sequential game played by different selves (self 1 in period 1, self 2 in period 2, etc.). To fix ideas, we first ignore the retirement decision: The agent only works in period 1, earns w_1, and the only choice he makes concerns consumption/savings. For the rest of the paper, we adopt the following notation: We use subscripts to indicate periods, e.g. c_2 is consumption in period 2, and we use asterisks to indicate the self who is deciding, e.g. c_2^{**} is the optimal consumption according to self 2's preferences, while c_2^* is the optimal consumption from the perspective of self 1.

2.1.1 Naïve Agent

A naïve self 1 solves the following problem, where period 2 is weighted equally to period 3:

$$\max_{c_1,c_2,c_3} u(c_1) + \beta u(c_2) + \beta u(c_3) \text{ s.t. } c_1 + c_2 + c_3 = w_1$$

which yields $c_1^* = \frac{1}{1+2\beta}w_1$, $c_2^* = \frac{1}{2}s_1^* = \lambda_1 s_1^*$, and $c_3^* = \frac{1}{2}s_1^* = (1-\lambda_1)s_1^*$, with $s_1^* = \frac{2\beta}{1+2\beta}w_1$ and $\lambda_1 = \frac{1}{2}$ is the share of savings that self 1 would like self 2 to consume. However, self 2 solves the following problem, where the relative weight of period 2 to period 3 ($1/\beta$) is higher compared to the problem above:

$$\max_{c_2,c_3} u(c_2) + \beta u(c_3) \text{ s.t. } c_2 + c_3 = s_1^*$$

which yields $c_2^{**} = \frac{1}{1+\beta}s_1^* = \lambda_2 s_1^*$ and $c_3^{**} = \frac{\beta}{1+\beta}s_1^* = (1-\lambda_2)s_1^*$, where $\lambda_2 = \frac{1}{1+\beta}$ is the optimal share that self 2 consumes. Since $\beta \in (0,1)$, $c_2^* < c_2^{**}$ and $c_3^* > c_3^{**}$, and self 2 consumes more than originally planned by self 1.

2.1.2 Sophisticated Agent

A sophisticated self 1 knows that self 2 consumes c_2^{**} as defined above, regardless of his initial planning. His choice is then the solution of the problem in (1). As shown by Phelps and Pollak (1968), it yields the same optimal saving of naïve self 1, meaning that the realized consumption path of naïve and sophisticated agents is the same.

$$\max_{s_1} u(w_1 - s_1) + \beta u\left(\frac{1}{1+\beta}s_1\right) + \beta u\left(\frac{\beta}{1+\beta}s_1\right) \tag{1}$$

This property of the logarithmic utility simplifies the analysis when retirement is endogenous, and it highlights that the optimal consumption/saving levels of self 1 for period 1 do not depend on the consumption allocation between periods 2 and 3. Consider any two different allocations characterized by λ_i and λ_j. From the perspective of self 1, moving from allocation j to i shifts lifetime utility upwards or downwards (ΔU does not depend on s_1):

$$\begin{aligned}\Delta U &\equiv \beta \ln(\lambda_i s_1) - \beta \ln(\lambda_j s_1) + \beta \ln((1-\lambda_i)s_1) - \beta \ln((1-\lambda_j)s_1) \\ &= \beta \ln\left[\frac{\lambda_i(1-\lambda_i)}{\lambda_j(1-\lambda_j)}\right] \end{aligned} \tag{2}$$

With $\lambda_i = \lambda_1$ and $\lambda_j = \lambda_2$, $\Delta U > 0$ by construction.

2.2 Retirement decision

We now study the retirement decision given the conditional consumption policies outlined above. In particular, self 2 can now work and earn $w_2 > 0$ while suffering a disutility cost $e = 1$.

2.2.1 Naïve Agent

Self 2 decides the consumption allocation and consumes a fraction of wealth equal to $\lambda_2 = \frac{1}{1+\beta}$ in period 2. He works if[6]

$$u(\lambda_2(s_1+w_2)) - u(\lambda_2 s_1) + \beta[u((1-\lambda_2)(s_1+w_2)) - u((1-\lambda_2)s_1)] \geq e \tag{3}$$

Since utility is concave, condition (3) holds for $s_1 \leq \bar{k}_2$, that is the value for which self 2 is indifferent between working or not:

$$\bar{k}_2 \equiv \frac{w_2}{\exp(\frac{1}{1+\beta}) - 1} \tag{4}$$

Consider now self 1's point of view. Since self 1 is naïve, he thinks that self 2 will stick to the allocation that is optimal for self 1 (λ_1) and that self 2 will decide based on the following comparison:

$$\beta[u(\lambda_1(s_1+w_2)) - u(\lambda_1 s_1)] + \beta[u((1-\lambda_1)(s_1+w_2)) - u((1-\lambda_1)s_1)] \geq \beta e$$

[6] We assume that the agent works when indifferent.

or

$$u(\lambda_1(s_1+w_2)) - u(\lambda_1 s_1) + [u((1-\lambda_1)(s_1+w_2)) - u((1-\lambda_1)s_1)] \geq e \tag{5}$$

The difference between (3) and (5) is just the factor $\beta \in (0,1)$, which generates time-inconsistent preferences, while the different λs are innocuous. The left-hand side of (5) is greater than that of (3), and naïve self 1 thinks that the threshold that self 2 will use to decide is

$$\bar{k}_1 \equiv \frac{w_2}{\exp(\frac{1}{2})-1}, \tag{6}$$

with $\bar{k}_1 > \bar{k}_2$. For $\bar{k}_2 < s_1 \leq \bar{k}_1$, self 2 retires, but naïve self 1 thinks that self 2 will work. Expanding on Diamond and Kőszegi (2003), we note that the saving level is not exogenous, but it comes from the choice of self 1. Naïve self 1 solves the following problem:

$$\begin{aligned} s_1^* &= \arg\max_{s_1} U(s_1) \\ &= \arg\max_{s_1} u(w_1 - s_1) \\ &\quad + \beta[u(\lambda_1 s_1) + u((1-\lambda_1)s_1)] \times \mathbb{1}\{s_1 > \bar{k}_1\} \\ &\quad + \beta[u(\lambda_1(s_1+w_2)) + u((1-\lambda_1)(s_1+w_2)) - e] \times \mathbb{1}\{s_1 \leq \bar{k}_1\} \\ &= \max_{s_1}\ U^w(s_1) \times \mathbb{1}\{s_1 > \bar{k}_1\} + U^r(s_1) \times \mathbb{1}\{s_1 \leq \bar{k}_1\} \end{aligned} \tag{7}$$

where $U(s_1)$ is the lifetime utility of naïve self 1, $U^w(s_1)$ is the lifetime utility conditional on working in period 2, and $U^r(s_1)$ conditional on retiring in period 2. The savings level that maximizes the conditional utilities $U^w(s_1)$ and $U^r(s_1)$ are given by s_1^w and s_1^r (and do not depend on λ_1, see (2)):

$$s_1^w = \frac{2\beta w_1 - w_2}{1+2\beta}, \tag{8}$$

$$s_1^r = \frac{2\beta w_1}{1+2\beta}. \tag{9}$$

In order to have time-inconsistency we need that (i) self 1 wants to work and (ii) self 2 prefers to retire given self 1 optimal savings decision s_1^w. That is equivalent to (i) $U^w(s_1^w) \geq U^r(s_1^r)$ (which implies $s_1^* = s_1^w$ and $s_1^w \leq \bar{k}_1$) and (ii) $\bar{k}_2 < s_1^w$. These two conditions boil down to a condition on the realized state $\{w_1, w_2\}$. In particular, the ratio w_1/w_2 needs to be low enough

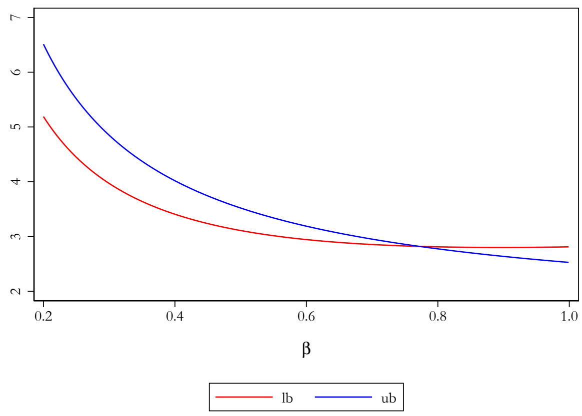

Figure 1: Bounds on w_1/w_2 for time-inconsistent retirement as a function of β, see (10).

such that self 1 wants to work but high enough such that self 2 retires, and the bounds on this ratio, lb and ub, depend on time preference β (see (10)). Figure 1 plots these bounds as function of β, showing the possibility of time-inconsistent retirement: For certain values of β it holds that $ub > lb > 0$, such that (10) is satisfied for some positive w_1, w_2.

$$lb \equiv \frac{1}{2\beta}\left[\frac{1+2\beta}{\exp(\frac{1}{1+\beta})-1}+1\right] < \frac{w_1}{w_2} \leq \frac{1}{\exp(\frac{\beta}{1+2\beta})-1} \equiv ub \tag{10}$$

We can therefore distinguish three cases. Case 1: when $w_1/w_2 < ub$ and $w_1/w_2 < lb$, self 1 and self 2 agree to work in period 2. Case 2: when $w_1/w_2 > ub$, self 1 and self 2 agree to retire in period 2. Case 3: when $lb < w_1/w_2 \leq ub$, self 1 would like to work in period 2, but self 2 retires given self 1's first-best savings.

2.2.2 Sophisticated Agent

A sophisticated self 1 knows that self 2 chooses the consumption allocation for periods 2 and 3 and that self 2 works if $s_1 \leq \bar{k}_2$. This means that self 1 can influence the time of retirement by choosing the level of savings that self 2 will inherit. We formalize sophisticated self 1's problem below:

$$\begin{aligned}
\max_{s_1} U(s_1) = \max_{s_1} \; & u(w_1 - s_1) \\
& + \beta[u(\lambda_2 s_1) + u((1-\lambda_2)s_1)] \times \mathbb{1}\{s_1 > \bar{k}_2\} \\
& + \beta[u(\lambda_2(s_1+w_2)) + u((1-\lambda_2)(s_1+w_2)) - e] \times \mathbb{1}\{s_1 \leq \bar{k}_2\} \\
= \max_{s_1} \; & U^w(s_1) \times \mathbb{1}\{s_1 > \bar{k}_2\} + U^r(s_1) \times \mathbb{1}\{s_1 \leq \bar{k}_2\}
\end{aligned} \tag{11}$$

(with λ_2 and $\bar{k}_2$ instead of λ_1 and $\bar{k}_1$ compared to (7)). In particular, because of (2), the savings that maximise $U^w(s_1)$ and $U^r(s_1)$ are the same for naïve and sophisticated (see (8) and (9)).

Because of the concavity of utility, the solution of (11) is one of the following: s_1^r, s_1^w or $\bar{k}_2$. Assume now that $U^w(s_1^w) > U^r(s_1^r)$, meaning that self 1 first-best is to save s_1^w and work in $t = 2$. If $\bar{k}_2 < s_1^w$, self 1 instead saves $\bar{k}_2$ or s_1^r. As shown in Diamond and Kőszegi (2003), if $U^w(\bar{k}_2) \geq U^r(s_1^r)$, self 1 under-saves in order to induce self 2 to work since he cannot reach $U^w(s_1^w)$. On the other hand, if $U^w(\bar{k}_2) < U^r(s_1^r)$, self 1 over-saves to compensate for the early retirement decision of self 2. However, differently from Diamond and Kőszegi (2003), we show next that a sophisticated self 1 can use an illiquid asset to reach his first-best retirement age and consumption allocation, with no need to over or under-save.

3 Commitment device

3.1 Consumption decision

In this section, we only consider a sophisticated agent, because a naïve agent would not use commitments. Again, we start with the case of exogenous retirement. Assume now that an illiquid asset is available. In period 1, self 1 decides to invest a share α of his savings in the liquid asset and $(1-\alpha)$ in the illiquid one. Both assets do not yield any return.[7] In period 2, self 2 has at his disposal only the liquid savings αs_1.[8] In period 3, self 3 consumes what is left, that is $\alpha s_1 - c_2 + (1-\alpha)s_1$.

The problem of self 2 is now different because he cannot consume his preferred quantity if this is larger than its liquidity. This is formalized by a liquidity constraint (LC) on top of the budget constraint (BC):

$$\max_{c_2,c_3} u(c_2) + \beta u(c_3)$$

$$\text{s.t. } c_2 \leq \alpha s_1 \qquad \text{(LC)}$$

$$c_3 = \alpha s_1 - c_2 + (1-\alpha)s_1 \qquad \text{(BC)}$$

[7] The qualitative results do not depend on the identical returns assumption.

[8] We assume, as in Laibson (1997), that if the agent sells the illiquid asset in period 2 he would get paid in period 3. If he applies for a loan at time 2, the associated cash will not be available for consumption until time period 3.

which yields

$$c_2^{**} = \begin{cases} \lambda_2 s_1 & \text{if } \lambda_2 s_1 \le \alpha s_1 \\ \alpha s_1 & \text{otherwise} \end{cases}, \tag{12}$$

$$c_3^{**} = \begin{cases} (1-\lambda_2) s_1 & \text{if } \lambda_2 s_1 \le \alpha s_1 \\ (1-\alpha) s_1 & \text{otherwise} \end{cases}.$$

This shows how self 1 can constrain the choice of self 2, $\{c_2^{**}, c_3^{**}\}$, through α. We have shown above that self 1 would like self 2 to consume $c_2^* = \lambda_1 s_1 = \frac{1}{2}s_1$, and his optimal savings s_1^r are given by (9). With log utility, the choice of c_1/s_1 is not affected by the allocation between periods 2 and 3. Therefore, the illiquid asset shifts upward the lifetime utility of the agent, because the consumption allocation between periods 2 and 3 is improved and the optimal c_1/s_1 does not change. Self 1 sets $\alpha^* = \lambda_1 = \frac{1}{2} < \frac{1}{1+\beta} = \lambda_2$ and $s_1^* = s_1^r$. In this way, self 2 is forced to consume all the liquid savings in period 2 and all the illiquid ones in period 3, where these consumption levels correspond to the first-best of self 1.

3.2 Retirement decision

We now introduce the retirement decision in period 2. Self 2's consumption plan if he retires is given by (12). We refer to this plan as (c_2^{r**}, c_3^{r**}). Self 2's problem conditional on working, instead, is given by:

$$\max_{c_2, c_3} u(c_2) - e + \beta u(c_3)$$

$$\text{s.t. } c_2 \le \alpha s_1 + w_2 \tag{LC}$$

$$c_3 = \alpha s_1 + w_2 - c_2 + (1-\alpha) s_1 \tag{BC}$$

which yields

$$c_2^{w**} = \begin{cases} \lambda_2 (s_1 + w_2) & \text{if } \lambda_2 (s_1 + w_2) \le \alpha s_1 + w_2 \\ \alpha s_1 + w_2 & \text{otherwise} \end{cases}, \tag{13}$$

$$c_3^{w**} = \begin{cases} (1-\lambda_2)(s_1 + w_2) & \text{if } \lambda_2 (s_1 + w_2) \le \alpha s_1 + w_2 \\ (1-\alpha) s_1 & \text{otherwise} \end{cases}.$$

For given values of s_1 and α set by self 1, self 2 computes $\{c_2^{r**}(s_1,\alpha), c_3^{r**}(s_1,\alpha)\}$ and $\{c_2^{w**}(s_1,\alpha), c_3^{w**}(s_1,\alpha)\}$. Self 2 decides to work or not by comparing the difference in utilities from the two consumption plans and the disutility e. The choice of self 1 regarding s_1 and α influences both future consumption and retirement. We now analyse the three cases in which self 1 and self 2 agree or disagree on the retirement decision.

Case 1: $w_1/w_2 < ub$ and $w_1/w_2 < lb$ (Self 1 and self 2 agree to work in period 2 given self 1's first-best saving s_1^w and no commitment.)

Self 1 sticks to s_1^w and sets $\alpha = \alpha^w$ to reallocate consumption from period 2 to 3:

$$\lambda_1(s_1^w + w_2) = \frac{1}{2}(s_1^w + w_2) = \alpha^w s_1^w + w_2 \implies \alpha^w = \frac{\frac{1}{2}(s_1^w + w_2) - w_2}{s_1^w} \tag{14}$$

Appendix 6.1 shows that self 2 would still prefer to work given α^w and s_1^w. This result implies that self 1 can reach his first-best consumption allocation and retirement age.

Case 2: $w_1/w_2 > ub$ (Self 1 and self 2 agree to retire in period 2 given self 1's first-best saving s_1^r and no commitment.)

Self 1 sticks to s_1^r and sets $\alpha = \alpha^r$ to reallocate consumption from period 2 to 3:

$$\lambda_1 s_1^r = \frac{1}{2}s_1^r = \alpha^r s_1^r \implies \alpha^r = \frac{1}{2} \tag{15}$$

Appendix 6.2 shows that self 2 would still prefer to retire given α^r and s_1^r. Also for this case, the result implies that self 1 can reach his first-best consumption allocation and retirement age.

Case 3: $w_1/w_2 \in (lb, ub]$ (Self 1 and self 2 disagree on the retirement decision given self 1's first-best saving s_1^w and no commitment.)

In order to force self 2 to work, self 1 has to set a low α. Similarly, in order to improve the consumption allocation, he has to set a low α. Self 1 sets $s_1 = s_1^w$, which induces retirement if no commitment is provided, and the same α^w as in case 1. Appendix 6.3 shows that self 2 prefers to work given savings s_1^w and a share of liquid savings α^w if $w_1/w_2 \in (lb, ub]$. Also for this case, the result implies that self 1 can reach his first-best consumption allocation and retirement age.

3.3 Partially Sophisticated Agent

So far, we assumed that people are either fully sophisticated or naïve about their present-bias. Partially sophisticated people fall between these two extreme cases. Following O'Donoghue and Rabin (2001), partially sophisticated individuals are aware of their present-bias, but they underestimate it. In practice, a partially sophisticated self 1 thinks that self 2 discounts future utility by a factor $\tilde{\beta}$, with $\beta < \tilde{\beta} < 1$. Therefore, partially sophisticated self 1 thinks that self 2 consumes more than self 1's optimal share, but not as much as self 2 actually consumes. Partially sophisticated self 1 also thinks that self 2 decides to retire based on $\tilde{\beta}$, meaning that he might end up retiring earlier than planned.

A partially sophisticated agent values commitments, but less than a fully sophisticated one. If the commitment is free, partially and fully sophisticated people behave in the same way in our model. If the commitment comes at a positive price, there is a range of values of the price for which fully sophisticated people commit but partially sophisticated don't.

4 Empirical Evidence

4.1 Hypotheses

In the first part of the paper, we have presented a stylized model with some simplifying assumptions. In our model, fully and partially sophisticated agents use illiquid assets to commit their future selves, while naïve agents (and time-consistent) don't. In the data, we do not expect sophisticated people to *always* hold illiquid assets, because they might use alternative commitments, or because uncertainty and associated costs make their use less appealing. Similarly, we do not expect naïve and time-consistent people to *never* hold illiquid assets, because they might be useful for reasons other than commitment.[9] We also expect partially sophisticated people to commit less often than fully sophisticated individuals, because commitments come at a positive cost (at least in terms of transaction or opportunity costs).

Nevertheless, we expect the model predictions regarding differences between types to hold on average, which leads to a testable ordering of the probability of holding illiquid assets. Consider the regression equation in (16), where $Illiquid_i$ is a dummy for holding illiquid assets, TI is a dummy for being time-inconsistent, PS (FS) is a dummy for being partially (fully) sophis-

[9] Also the assumptions of a logarithmic utility over consumption and an additive disutility of work quantitatively affect the conclusions from our model, but the same differences across types hold under different parametrizations.

ticated, and X_i is a vector of controls. The coefficient θ_1 measures differences between naïve and time-consistent people, θ_2 (θ_3) measures differences between partially (fully) sophisticated and naïve people.

$$Illiquid_i = \theta_0 + \theta_1 TI_i + \theta_2 PS_i + \theta_3 FS_i + \theta_4 X_i + \varepsilon_i \tag{16}$$

We state our first hypothesis in terms of coefficients from (16):

Hypothesis 1. $\theta_1 = 0$ *and* $\theta_3 > \theta_2 > 0$ *in (16).*

The first hypothesis is also consistent with a model with exogenous retirement. However, our model also predicts a testable – and different – ordering of types with respect to their retirement age. Consider the regression equation in (17), where we regress retirement age on the same covariates as above.

$$RetAge_i = \theta_0 + \theta_1 TI_i + \theta_2 PS_i + \theta_3 FS_i + \theta_4 X_i + \varepsilon_i \tag{17}$$

The retirement age of time-consistent people could be both higher (direct effect of present-bias on retirement) or lower (indirect effect of present-bias on retirement through savings) compared to naïve individuals. Merkle et al. (2022) showed that the direct effect is stronger, and we base our hypothesis on their results: Naïve present-biased people retire earlier than time-consistent ($\theta_1 < 0$ in (17)). Our model predicts that sophisticated people use the illiquid asset to avoid retiring earlier than planned, meaning that we expect sophisticated people to retire later than naïve ones, and more so if they are fully rather than partially sophisticated ($\theta_3 > \theta_2 > 0$ in (17)). Putting things together, we state the second hypothesis as follows:

Hypothesis 2. $\theta_1 < 0$ *and* $\theta_3 > \theta_2 > 0$ *in (17).*

The first two hypotheses are also consistent with a model in which people use illiquid assets to constrain consumption and a second commitment device to constrain retirement. However, a distinctive aspect of our model is that it predicts a positive effect of illiquid assets on the retirement age. Or, in other words, once we condition on holding illiquid assets, retirement behaviour should differ less between naïve and sophisticated people. Considering the following regression (where $Illiquid_i$ should be measured before retirement)

$$RetAge_i = \theta_0 + \theta_1 TI_i + \theta_2 PS_i + \theta_3 FS_i + \theta_4 X_i + \theta_5 Illiquid_i + \varepsilon_i \tag{18}$$

we state a third hypothesis as follows:

Hypothesis 3. *$\theta_5 > 0$ in (18). θ_3 and θ_2 are lower in (18) compared to those in (17).*

4.2 Data

We test our hypotheses using data from the German Socio-Economic Panel's Innovation Sample (Richter and Schupp, 2015). We use the data and categorization method from Cobb-Clark et al. (2024) (CC from now on).[10] We classify individuals using information on their ideal (in 2017), predicted (in 2017 for 2018), and realized (in 2018) weight according to the following criteria:[11]

- Time-consistent: Predicted = Ideal, Actual = Predicted;
- Naïve: Predicted = Ideal, Actual > Predicted;
- Fully sophisticated: Predicted > Ideal, Actual = Predicted;
- Partially sophisticated: Predicted > Ideal, Actual > Predicted.

To test the first hypothesis, we define a dummy which equals one if the individual reports having an automated saving plan in 2016. These include personal pension schemes with state grant (Riester- or Rüruprente), other personal pension schemes, building savings contracts, cash-value life insurances, and capital formation savings payment, which are inherently illiquid. To test the second hypothesis, we construct the retirement age variable from cross-sectional data, using the question about the last year in which people have been working. Because this question was last asked in 2020, we focus on people born before 1950, who are least 71 by then (above statutory retirement). Indeed, the last reported working year for this group is 2017, suggesting that they have all retired by 2020. With these variables, we estimate equation (16) and (17) and control for gender, year of birth, state of residence fixed-affects, month of interview fixed-effects, weight in 2017, height, health status in 2017, patience, and crystallized intelligence.

In order to test the third hypothesis, we would like to include a dummy for holding illiquid assets at young age in the regression for the retirement age. However, 99% of the people for which we observe the retirement age were already retired in 2016, when we measure illiquid assets. We

[10] The data we use differs slightly from that in CC, who had early access to a preliminary version while we use the publicly released one.

[11] Our classification might suffer from errors. Provided it is moderately positively correlated with the true types, miss-classification leads to attenuation bias, making it more difficult to find evidence consistent with the hypotheses (see Mirenda et al., 2022 for a similar argument).

	Time-consistent	Naïve	Part. Soph.	Fully Soph.	Total
Female (0/1)	0.53	0.51	0.58	0.49	0.53
	(0.50)	(0.50)	(0.49)	(0.50)	(0.50)
Year of birth	1957.71	1964.11	1967.72	1961.99	1963.11
	(16.47)	(17.79)	(16.99)	(17.55)	(17.58)
Saving plan in 2016 (0/1)	0.24	0.21	0.27	0.36	0.26
	(0.43)	(0.41)	(0.45)	(0.48)	(0.44)
Illiquid products in 2012 (0/1)	0.38	0.29	0.23	0.47	0.33
	(0.49)	(0.46)	(0.42)	(0.50)	(0.47)
Retirement age	61.11	59.57	59.34	61.24	60.38
	(4.16)	(4.63)	(4.80)	(3.89)	(4.42)
Labour force in 2020 (0/1)	0.56	0.63	0.70	0.68	0.64
	(0.50)	(0.48)	(0.46)	(0.47)	(0.48)
Weight in 2017 (kg)	71.89	80.01	86.48	80.74	79.77
	(13.05)	(16.20)	(17.94)	(15.00)	(16.60)
Height (cm)	170.69	171.25	171.48	171.59	171.22
	(8.85)	(8.90)	(9.49)	(8.99)	(9.05)
Health status in 2017 (1-5)	2.44	2.55	2.73	2.54	2.57
	(0.87)	(0.95)	(0.95)	(0.89)	(0.93)
Patience	0.12	0.03	-0.05	-0.16	-0.00
	(0.93)	(1.04)	(1.01)	(0.99)	(1.00)
Crystalized intelligence	0.19	-0.17	-0.11	0.23	-0.00
	(0.97)	(1.06)	(1.01)	(0.80)	(1.00)
Individuals	288	387	298	182	1,155
Share	24.9%	33.5%	25.8%	15.8%	100%

Standard deviations in parentheses.

Table 1: Summary statistics.

Note: Patience and crystallized intelligence are standardized measures.

therefore use a different outcome and the whole sample. We define a binary outcome for being in the labour force in 2020 and estimate regression (18) both controlling and not controlling for having a saving plan in 2016.[12] We use an indicator for being in the labour force rather than being employed to account for possible differences in unemployment risk across types. Exits from the labour force are also more likely to be permanent and to reflect retirement.

We further define a dummy variable for holding at least one illiquid financial product using survey questions asked in 2012. We consider the following as illiquid products: Fixed deposit accounts, bonds, shares, equity or property funds, annuity or money market fund, mixed, umbrella, or hedge funds. Because this variable is only defined for a small fraction of our sample, we consider this as a robustness exercise.

Table 1 presents summary statistics. The table already suggests that fully sophisticated individuals are most likely to have illiquid assets and they retire approximately at the same age of time-consistent people, while naïve and partially sophisticated people retire earlier.

[12]We use labour force participation because specific questions about retirement status are not available for these years.

4.3 Results

Table 2 presents the results. Estimates in column 1 are consistent with Hypothesis 1: Naïve people are as likely as time-consistent individuals to hold illiquid assets, while fully sophisticated people are more likely (+13 percentage points (p.p.)). The coefficient for partial sophistication is also positive and in line with our hypothesis, but not statistically significant.

Estimates in column 2 are also consistent with Hypothesis 2: Naïve people retire on average 1.6 years earlier than time-consistent individuals, while fully sophisticated people retire on average 1.9 years later than naïve. Again, the coefficient for partial sophistication is positive, but small and not significant.

Column 3 also tests Hypothesis 2 and it shows that naïve people are 6 p.p. less likely to be in the labour force in 2020 compared to time-consistent individuals, while fully sophisticated are 8 p.p. more likely compared to naïve. Column 4 further shows that – once we control for the take-up of saving plans – the correlation between full sophistication and labour force participation decreases by 1 p.p..[13] This suggests that part of the correlation between full sophistication and labour force participation in 2020 is due to holding a saving plan in 2016. Furthermore, holding a saving plan correlates positively with future labour force participation. The estimates are thus consistent with Hypothesis 3.

Finally, in columns 5 to 7, we exploit a smaller sample for whom we can define a dummy variable for holding illiquid products in 2012. The estimates show that our main results are robust to alternative variable definitions.[14]

Taken together, our results suggest that partially sophisticated people under-estimate their present-bias to the extent that the cost of committing outweighs its perceived benefits. We measure their sophistication level as the share of the self-control problem they are aware of ($\frac{predicted\ weight - ideal\ weight}{actual\ weight - ideal\ weight}$, see Augenblick and Rabin 2019). Their average sophistication level is 0.5, which suggests that being aware of half the size of the bias is not enough to induce different behaviour compared to being completely unaware of it.

[13] Jointly estimating columns 3 and 4 we obtain a p-value of 0.02 for the test of equality of the coefficients for full sophistication.

[14] We also reject the null that the coefficient for full sophistication in column 6 is smaller than that in column 7 (p-value = 0.075).

	(1) Saving plan in 2016	(2) Retirement age	(3) Labour force in 2020	(4) Labour force in 2020	(5) Illiquid products in 2012	(6) Retirement age	(7) Retirement age
TI	-0.02	-1.62**	-0.06**	-0.06**	-0.03	-4.18***	-3.91**
	(0.04)	(0.75)	(0.03)	(0.03)	(0.07)	(1.56)	(1.49)
PS	0.05	0.10	0.01	0.00	0.01	1.55	1.23
	(0.04)	(1.02)	(0.03)	(0.03)	(0.07)	(2.78)	(2.69)
FS	0.13***	1.88**	0.08**	0.07**	0.18**	4.14**	3.37*
	(0.04)	(0.83)	(0.03)	(0.03)	(0.08)	(1.70)	(1.69)
Saving plan in 2016				0.09***			
				(0.03)			
Illiquid products in 2012							2.31*
							(1.27)
Observations	1,155	232	1,155	1,155	351	75	75
R-squared	0.09	0.17	0.45	0.46	0.20	0.40	0.44
Controls	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Sample	Everyone	Born before 1950	Everyone	Everyone	Interviewed in 2012	Born before 1950 and interviewed in 2012	Born before 1950 and interviewed in 2012

Standard errors clustered at the household level in parentheses.
*** p<0.01, ** p<0.05, * p<0.1

Table 2: Regression estimates.

Note: TI indicates being time-inconsistent, PS (FS) being partially (fully) sophisticated. Controls include gender, year of birth, state FE, month of interview FE, weight, height, health status, patience, and crystallized intelligence.

5 Conclusion

This paper extends the analysis of retirement decisions with present-biased preferences by studying the role of illiquid assets as commitment devices, building on insights from Laibson (1997) and Diamond and Kőszegi (2003). A simple model shows that sophisticated individuals use illiquid assets not only to influence future consumption but also to prevent retiring earlier than planned. This ability to commit leads sophisticated agents to reach both their first-best consumption levels and retirement age.

Empirical evidence using population-representative German data supports the main model prediction: Naïve present-biased individuals retire on average 1.6 years earlier than time-consistent, while fully sophisticated individuals retire 1.9 years later than naïve. We also find that (i) fully sophisticated people are more likely to hold illiquid assets, and (ii) part of the correlation between full sophistication and retirement age is due to the illiquid assets. These results highlight the role of illiquid assets as commitment devices to influence retirement decisions.

Our results have important implications for policy. Retirement planning tools and policies that encourage the use of illiquid assets, such as pension plans with restricted early access or automated saving schemes, may help sophisticated individuals achieve their long-term goals both in the savings and labour supply domain. Moreover, insights into the determinants of sophistication may inspire new policies to extend working lives, complementing traditional ones.

6 Appendix

6.1 Case 1

Self 1 and self 2 agree to work given saving s_1^w and no commitment, that is $U^w(s_1^w) = U(s_1^w) \geq U(s_1^r)$, meaning that the following holds (for any λ, see Section 2.2):

$$\ln(\lambda(s_1^w + w_2)) - \ln(\lambda s_1^w) + \beta[\ln((1-\lambda)(s_1^w + w_2)) - \ln((1-\lambda)s_1^w)] \geq e \tag{19}$$

Self 1 sets α such that

$$\lambda_1(s_1^w + w_2) = \frac{1}{2}(s_1^w + w_2) = \alpha^w s_1^w + w_2$$
$$\alpha^w = \frac{\frac{1}{2}(s_1^w + w_2) - w_2}{s_1^w} < \lambda_1 = \frac{1}{2}$$

and the liquidity constraint (LC) in (13) binds by construction. Conditional on working, self 2 is liquidity constrained and consumes $\alpha^w s_1^w + w_2 = \lambda_1(s_1^w + w_2)$ in period 2 and $(1-\lambda_1)(s_1^w + w_2)$ in period 3. Because the LC conditional on working (13) binds, the LC conditional on retiring (12) also binds:

$$\frac{1}{1+\beta}(s_1^w + w_2) > \alpha^w s_1^w + w_2$$
$$\frac{1}{1+\beta}(s_1^w + w_2) - w_2 > \alpha^w s_1^w + w_2 - w_2$$
$$\frac{1}{1+\beta}s_1^w - \frac{\beta}{1+\beta}w_2 > \alpha^w s_1^w$$
$$\frac{1}{1+\beta}s_1^w > \alpha^w s_1^w$$

Thus, conditional on retiring, self 2 is liquidity constrained and consumes $\alpha^w s_1^w$ in period 2 and $(1-\alpha^w)s_1^w$ in period 3. Self 2 works if

$$\ln(\lambda_1(s_1^w + w_2)) - \ln(\alpha^w s_1^w) + \beta[\ln((1-\lambda_1)(s_1^w + w_2)) - \ln((1-\alpha^w)s_1^w)] \geq e \tag{20}$$

Because (i) (19) holds, (ii) $\alpha^w < \lambda_1 < \lambda_2$, and (iii) self 2 utility is concave in λ with λ_2 being optimum, then (20) is satisfied and self 2 works given s_1^w and α^w.

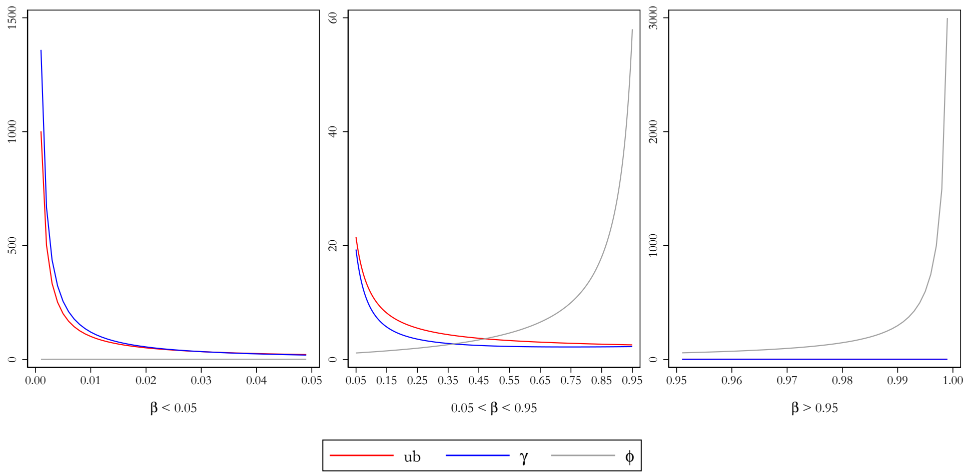

Figure 2: Bounds on w_1/w_2 for case 2 as a function of β, see Section 6.2.

6.2 Case 2

Self 1 and self 2 agree to retire given self 1's first-best saving level s_1^r and no commitment, which occurs when $w_1/w_2 > ub$. We show here that, conditional on self 1 saving s_1^r and investing a share $\alpha^r = 1/2$ in the liquid asset, self 2 still prefers to retire when $w_1/w_2 > ub$.

Conditional on retiring, the LC of self 2 binds by construction. However, if self 2 work, the LC does not necessarily bind (this happens when $w_1/w_2 \leq (1 + 2\beta)/(1 - \beta) \equiv \phi$, which can occur when $w_1/w_2 > ub$ as shown in Figure 2). We thus focus on the case in which the LC of self 2 does not bind if he works. In fact, if self 2 prefers to retire when working allows to break the LC, it follows that he also prefer to retire if working does not allow to break the LC.

If the LC does not bind, self 2 works if

$$\ln(\lambda_2(s_1^r + w_2)) + \beta \ln((1 - \lambda_2)(s_1^r + w_2)) - \ln(a^r s_1^r) - \beta \ln((1 - \alpha^r)s_1^r) \geq e$$

which, after substituting, boils down to

$$\frac{w_1}{w_2} \leq \frac{1}{\left(\exp\left(\frac{1-\beta\ln(\beta)}{1+\beta}\right) - \frac{2}{1+\beta}\right)^{\frac{(1+\beta)\beta}{2\beta+1}}} \equiv \gamma. \tag{21}$$

But $\frac{w_1}{w_2} \leq \gamma$ contradicts the two conditions on the ratio w_1/w_2, namely $w_1/w_2 > ub$ and $w_1/w_2 \leq \phi$ (see Figure 2), meaning that self 2 would not change his decision and work if self 1 uses the commitment device.

6.3 Case 3

Self 1 and self 2 disagree on the retirement decision given self 1's first-best saving level s_1^w and no commitment, which happens when $lb < w_1/w_2 \leq ub$. Suppose that self 1 saves s_1^w and invest a share α^w in the liquid asset. Section 6.1 shows that the LC of self 2 binds both if he works and if he retires in period 2. Thus self 2 works if

$$\ln(\lambda_1(s_1^w + w_2)) - \ln(\alpha^w s_1^w) + \beta[\ln((1-\lambda_1)(s_1^w + w_2)) - \ln((1-\alpha^w)s_1^w)] \geq e \tag{22}$$

First, note that $\alpha^w s_1^w$ needs not to be positive. If $\alpha^w s_1^w \leq 0$, self 2 works. If $\alpha^w s_1^w > 0$, after substituting, (22) boils down to

$$\frac{w_1 + w_2}{\beta w_1 - w_2 - \beta w_2} \geq \exp(e - \ln(\beta)).$$

Define the ratio $r \equiv w_1/w_2$ and substitute $w_1 = rw_2$

$$\frac{r+1}{\beta r - 1 - \beta} \geq \exp(e - \ln(\beta)). \tag{23}$$

Because $1 - \beta \exp(e - \ln(\beta)) = 1 - \exp(e) < 0$, (23) gives

$$r \equiv \frac{w_1}{w_2} \leq \frac{-(1+\beta)\exp(e-\ln(\beta)) - 1}{1 - \beta\exp(e - \ln(\beta))} \equiv \delta. \tag{24}$$

Figure 3 shows that $ub < \delta$, meaning that condition (24) is satisfied whenever $lb < w_1/w_2 \leq ub$. Therefore, self 1 choses s_1^w and α^w, and self 2 works.

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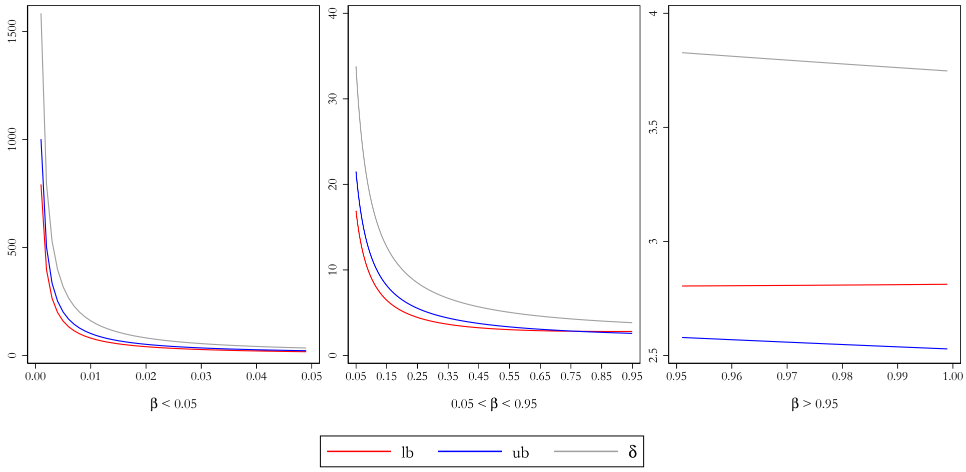

Figure 3: Bounds on w_1/w_2 for case 3 as a function of β, see Section 6.3.

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