Designing Social Security Claiming Incentives: Experimental Evidence

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Abstract

This paper employs laboratory experiments to evaluate policy proposals advocating for lump-sum payments as incentives for delaying Social Security claims. We place subjects in an individual decision-making setting that simulates the retirement phase of life, where they decide when to claim Social Security benefits and make consumption-savings choices. Our experimental data reveal that replacing a greater annuity with a lump-sum payment prompts participants to claim Social Security benefits about one year earlier—a result inconsistent with the rational choice model prediction of no change. Further, subjects systematically underconsume relative to theoretical predictions conditional on both claiming age and current-period starting assets. To explain these deviations, we develop a behavioral model incorporating random attention—where individuals follow a heuristic rule, occasionally allocate attention to solving the intertemporal problem. The model also integrates misperceived continuation probabilities and noisy signals about the benefits of claiming at different ages. We estimate this model by matching observed consumption decisions and validate it through out-of-sample predictions and comparisons with non-targeted data outcomes, such as the distribution of claiming ages and the median expected lifetime utility.

Keywords: Lifecycle model, consumption and savings, Social Security claiming, behavioral and experimental economics.
JEL Codes: C91, D91, E21, H55.

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1 Introduction

Two well-documented anomalies in retirement behavior consistently emerge in empirical data. First, the majority of beneficiaries claim benefits before reaching their full retirement age (FRA)—67 for individuals born in 1960 and later (see Table 6.A4 of Annual Statistical Supplement to the Social Security Bulletin 2023). Common reasons for this behavior include unexpected job termination, liquidity constraints, health shocks, fears of future benefit reductions, and social norms favoring benefit claiming upon retirement (Shoven et al., 2017).[1]

Second, retired households are reluctant to deplete their wealth, a phenomenon known as the "retirement savings puzzle". The literature generally attributes this reluctance to three factors: precautionary savings motives for longevity risk and medical expenditure risks, especially the risk of requiring long-term care; bequest motives, and a reluctance to diminish housing wealth (French et al., 2023). In this paper, we construct an experimental environment where it is always optimal to delay Social Security claims beyond the current FRA and where the only reason to save is for insuring longevity risk. Our objective is to explore whether novel behavioral factors not previously considered in the literature can shed light on these two perplexing retirement puzzles.

Our experimental design aims to replicate the consumption-savings decisions made by those who have entered the retirement phase of life. Subjects begin at age 62, and are endowed with the median household assets observed in the data for the 61-62 age group. Each period in our experiment corresponds to a year. In the first eight periods, when subjects' age ranges between 62 and 70, they must determine whether to claim Social Security benefits. This is a one-time decision and once it is made, they do not revisit it again.

[1]Notably, many of early claimants possess sufficient liquid assets to delay claiming until the FRA or even beyond (Goda et al., 2018), suggesting that financial constraints alone do not fully account for this behavior.

In addition, at each age (period), they decide how much to convert from their cash-on-hand into consumption, with the rest being saved. Consumption is converted into money via a known concave utility function, and maximizing expected experimental payments is equivalent to maximizing expected lifetime utility. The interest rate r on savings is 2.7%, and the discount factor is $1/(1+r)$. The between-period continuation probability is set as the product of the discount factor and an age-dependent survival probability that is calibrated to match the period life table. Subjects are incentivized to optimize their choices as their earnings are tied to their cumulative lifetime utility from consumption prior to a random termination shock.

Our study has three treatments that differ in how delayed claims are rewarded.[2] Treatment 1 (T0) mirrors the current Social Security rule, wherein subjects receive the average primary insurance amount on an annual basis if they claim at the FRA of 67, with annuity benefits adjusted for early and delayed claims. Treatment 2 (T50) allocates incentives for delayed claims equally between the annuity amount and a lump-sum payment. Treatment 3 (T100) fully rewards the delayed claims as a lump-sum payment. For all three treatments, we calibrate delayed rewards to ensure actuarial fairness. We also configure the environmental parameters to ensure that the optimal claiming age predicted by the rational choice model remains unchanged at age 68 across all three treatments. This approach allows us to attribute any observed treatment effect on claiming age solely to behavioral deviations.

Our experimental data identify four behavioral deviations from what rational choice models would predict. First, across all three treatments, the majority of our human subjects claim Social Security before the FRA, even though delaying claims by one year beyond the FRA would have been opti-

[2]The design of the treatment is inspired by several recent policy proposals aimed at offering retirees the option to receive a portion of their delayed-retirement credit as a lump sum. Noteworthy examples of such proposals include the "Providing Choice for Social Security Retirees Act" introduced in the 117th Congress and the "Social Security Reform Act of 2016" from the 114th Congress. These proposals seek to enhance flexibility within the Social Security system and promote delayed benefit claims.

mal. Replacing greater annuities with lump sums exacerbates the tendency for early claiming.[3] Second, we observe that, across all three treatments, our human subjects deplete their assets at a significantly slower rate than predicted by the rational choice theory, conditional on claiming age. Conversely, the majority of subjects tend to underconsume in the early periods and subsequently overconsume in the later periods relative to the optimal level conditional on claiming age. Third, subjects in most periods underconsume relative to the optimal level conditional on both claiming age and current-period starting assets. Notably this underconsumption is more pronounced in our baseline treatment, T0, which has the current Social Security rules. Finally, the expected lifetime utility in all three treatments is significantly lower than what rational choice theory predicts, with the greatest deviation observed in T50.

To explain these deviations, we develop a behavioral model featuring three key elements. First, inspired by the random attention model of Cattaneo et al. (2020), we assume that households employ a heuristic rule of consuming Social Security annuity benefits plus interest income, while occasionally allocating attention to solving the intertemporal problem. Notably, this represents the first application of the stochastic attention model to explain life-cycle decisions. Second, we incorporate the idea that households misperceive the between-period continuation probabilities. Third, we introduce the concept that households do not accurately calculate their expected lifetime utility for different claiming ages; rather, they receive a noisy signal

[3] Maurer et al. (2018) and Maurer and Mitchell (2021) employ strategic survey to investigate the effects of offering lump-sum payments to reward delayed claims. They find that a simple lump-sum provision encourages delayed Social Security claims. The findings of our experiment are *not* in contradiction with theirs, because we configure the environment parameters to ensure that the optimal claiming age remains invariant to the allocations between lump sum and annuity benefit. Under alternative parameters, it is conceivable that replacing a greater annuity with a lump sum could encourage delayed claims according to the rational choice model. Hence, the estimates in Maurer et al. (2018) and Maurer and Mitchell (2021) include both theoretical differences and behavioral deviations, whereas our estimates solely reflect the latter component.

and claim at the age associated with the greatest perceived signal value.

We estimate the model by matching subjects' consumption decisions, and we validate it by assessing both its out-of-sample predictions and its fit with non-targeted data outcomes such as the distribution of claiming ages and the median expected lifetime utility. Our estimation reveals that the probability of paying attention and solving the intertemporal problem follows a U-shaped pattern, peaking at both the beginning and the end of a sequence. Interestingly, overall attention tends to be lower in treatments providing greater annuities, suggesting that subjects allocate more attention to solving the intertemporal problem when their heuristic rule yields very low utility, as in T100. Moreover, our estimates indicate that subjects do not accurately perceive the declining continuation rates; instead, when solving the intertemporal problem, they behave *as if* they were facing a constant continuation rate of 81.8%. This misperception corresponds to an expected lifespan of 5.48 periods, 66% shorter than the objective value of 16.09 periods. Among the three model features, the random attention mechanism generates a slow asset decumulation process, while the combination of probability misperception and noisy signals explains early claims.

This paper contributes to four strands of literature. The first strand of literature uses field surveys or field experiments to study Social Security claiming decisions. Liebman and Luttmer (2012) conducted a survey aimed at comprehending individuals' perceptions of Social Security incentives. This research utilizes a framing approach and reveals that a "break-even" framing leads to earlier claiming compared to alternative presentations, such as gain or loss framing. Brown et al. (2016) further demonstrated that the decision to claim Social Security benefit is sensitive to how the early versus late claiming decision is framed. They found that individuals are more inclined to delay claiming when the later claiming option is presented as a gain, and when the framing provides an anchoring point at older ages rather than younger ages. In our study, we strive to describe the claiming incen-

tive in a neutral manner, informing subjects that the benefit adjustment is actuarially fair, mirroring the approach currently adopted by the Social Security Administration. To mitigate the anchoring effect associated with the label of FRA (Behaghel and Blau, 2012), we present a table illustrating how benefit amounts change with claiming age without referencing the FRA. Liebman and Luttmer (2015) found that providing information about Social Security rules and longevity risk encouraged women to work longer but had no significant effect on when participants started claiming Social Security. Utilizing a stated preference approach, Maurer et al. (2018) and Maurer and Mitchell (2021) concluded that a simple lump-sum provision encourages delayed Social Security claims. As discussed previously in footnote 3, our identified treatment effects on claiming are *not* in contradiction with theirs, because their estimates include both theoretical differences and behavioral deviations, whereas our estimates solely reflect the latter component. Our paper complements these above-mentioned papers in two aspects. First, it provides a new behavioral explanation for early Social Security claiming. Second, it offers insights on how future consumption-savings decisions react to changes in claiming incentives, a question that is challenging to examine using field data.

Our paper also contributes to the understanding of the retirement savings puzzle (see French et al. (2023) for a review). With induced utility, it is straightforward to calculate the trajectory of asset decumulation predicted by rational choice theory and compare that trajectory with observed data realizations. We find that in all three treatments, subjects draw down their assets at a slower rate than predicted by the rational choice model. In addition, the difference between the data and the rational choice model predictions is greatest in our treatment T0 that mirrors the current Social Security system. These observations suggest that behavioral biases could be a contributing factor in explaining the real-world retirement savings puzzle.

The third strand of literature we contribute to involves theoretical and

empirical work utilizing rational inattention models, as reviewed by Gabaix (2019). Within this literature, we follow the studies that allow for stochastic attention (Manzini and Mariotti, 2014; Brady and Rehbeck, 2016; Horan, 2019; Cattaneo et al., 2020), and our innovation lies in applying the stochastic attention framework to explain life-cycle decisions. The last strand of literature we contribute to centers on employing laboratory experiments to study life-cycle decisions (see Arifovic and Duffy (2018) for a review). Within this growing literature, Duffy and Li (2021) were the first to introduce mortality risk into the retirement phase of the life cycle. In this paper, we take this mortality risk one step further and consider a more realistic *age*-adjusted mortality risk. More importantly, we add the pivotal decision of when to claim Social Security benefits.

2 Theoretical Framework

Our experiment focuses on post-retirement decisions. We assume that individuals begin retirement with an initial asset a_1, capturing the accumulated assets before retirement. These individuals confront a known, age-dependent survival risk, denoted by s_j, where subscript j is a period index. Individuals can live for a maximum of J periods. Each model period corresponds to one year. Individuals are tasked with making two decisions: determining the age at which they claim Social Security benefits and allocating their resources each period between consumption and savings across a potential lifespan of J periods.

Subjects can claim Social Security benefits between periods 1 (equivalent to age 62) and 9 (equivalent to age 70). Upon filing a claim they receive benefits $ss(k, j)$, where k denotes the claiming period and j indexes the current period. Delayed claims are rewarded with predetermined lump-sum payments and/or a greater lifetime annuity. Social Security claiming is required if an individual's assets cannot sustain a minimum consumption level $\underline{c}$, or

if they reach period 9, the last period that claiming is allowed. With the goal of maximizing the incentive for consumption smoothing and ensuring that the minimum consumption level is always affordable, we set $\underline{c}$ to be the smallest Social Security annuity benefit that individuals would receive across the three treatments.

Every period, individuals make consumption and savings decisions. Let c_j denote the consumption level and a_j denote the initial assets for period j. We can write the recursive problem for individuals of age j who have claimed Social Security benefits as follows:

$$V_j^b(a_j, k) = \max_{c_j \geq \underline{c}} \left\{ u(c_j) + \beta s_j V_{j+1}^b(a_{j+1}, k) \right\}$$

subject to

$$c_j + a_{j+1} = (1 + r)a_j + ss(k, j) \tag{1}$$

$$a_{j+1} \geq 0 \tag{2}$$

where $V_j^b(a_j, k)$ denotes the value function of individuals at period j with an initial asset amount a_j and who have claimed Social Security at period k. Here, β denotes the discount factor and $u(\cdot)$ represents the utility function. Equation (1) defines the budget constraint, where r denotes the interest rate. Condition (2) is a no-borrowing constraint.

Let $V_j^c(a_j)$ denote the value function for those who claim in the current period. Their recursive problem is given by:

$$V_j^c(a_j) = \max_{c_j \geq \underline{c}} \left\{ u(c_j) + \beta s_j V_{j+1}^b(a_{j+1}, j) \right\}$$

subject to (2) and:

$$c_j + a_{j+1} = (1 + r)a_j + ss(j, j) \tag{3}$$

Finally, let $V_j^n(a_j)$ denote the value function for those who are considering whether to claim benefits or not. Their recursive problem is given by:

$$V_j^n(a_j) = \max \left\{ \max_{c_j \geq \underline{c}} \left\{ u(c_j) + \beta s_j V_{j+1}^n(a_{j+1}) \right\}, V_j^c(a_j) \right\}$$

if choose not to claim, subject to (2) and:

$$c_j + a_{j+1} = (1+r)a_j \tag{4}$$

3 Experimental Design

In this section we first discuss the parameterization of the model that we use in the experiment. Next, we present the rational choice solution for our different treatments, which we use to formulate theoretical predictions for evaluating our experimental data. Finally, we discuss the experimental procedures that we follow in collecting the data.

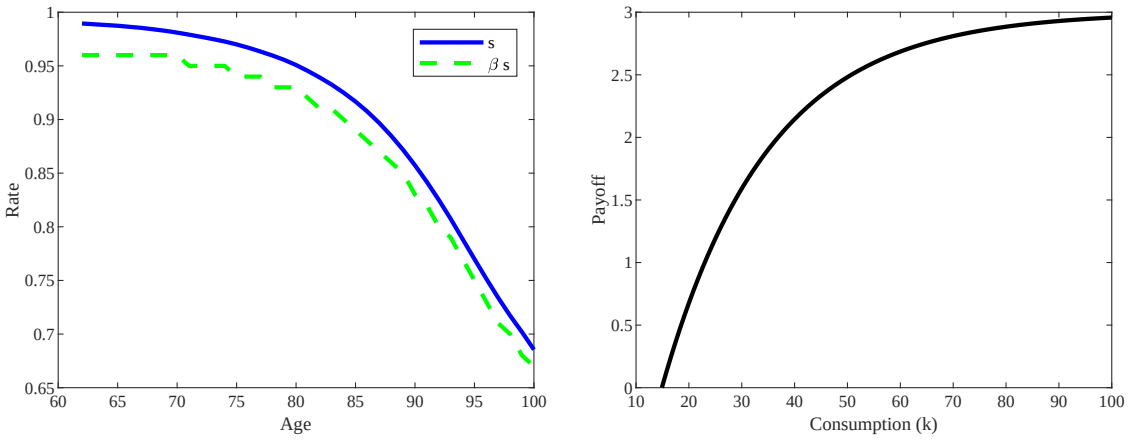
3.1 Parameterization

The experiment is calibrated to match the details of the 2016 US economy. We set the maximum period J to 40, aligning the duration of the experiment with a retirement span from age 62 to 101. The interest rate r is 2.7%, matching the intermediate real interest rate assumed in the 2016 Social Security Trustee's report. The discount factor β is set to $1/(1+r)$. The initial asset, $(1+r)a_1$, is set to \$145,350, matching the medium household assets for the age group 61-62 in the 2016 Survey of Consumer Finances. (For married households, assets are equally split between the husband and the wife.)

Figure 1(a) displays the period-specific survival rates s_j, which represent the average survival rates for men and women reported in the 2016 Period Life Table for the Social Security Area population. The between-period continuation probability is set to be the product of β and s_j, reflecting the

survival-adjusted discount rate. Subjects are presented with a table containing a set of numbers $(\beta s_j) \times 100, j = 1 \ldots J$ that are rounded to the nearest integer. We implemented the continuation risk using the block-random termination design of Fréchette and Yuksel (2017), and the random numbers that determine the continuation of the experiment were only revealed at the end of each 40-period sequence. Subjects knew that the current sequence of payments would cease accumulation if they drew a random number, selected uniformly from 1 to 100, that exceeded a period-dependent threshold $(\beta s_j) \times 100$ in the table of age-adjusted continuation probabilities. However, they did not learn whether and when the sequence would end until they had made decisions for all 40 periods. This design allows us to record decisions over the entire 40 periods for every subject. In contrast, real-world consumption decisions are only observed for survivors, making them subject to selection bias.

As shown in Figure 1(b), the per-period utility function is set to $u(c) = 3 \times (1 - e^{-(c-14887)/20000})$. This function serves to convert subjects' consumption choices into dollar earnings; it is our way of inducing a concave utility function to ensure a unique optimal solution. We set the minimum consumption level to be \$14,887 in every period, matching the Social Security benefits received by individuals who claim benefits in period 1 (corresponding to age 62) in all three treatments (see Table 1). The addition of a minimum consumption requirement is intended to provide stronger incentives for finding the optimal claiming period and consumption path, since subjects will receive zero earnings if they adopt the simple strategy of claiming at the earliest possible age and consuming their Social Security annuity benefits in every period thereafter. Notably, subjects are endowed with sufficient initial assets, enabling consumption well above the minimum level prior to claiming at any age. Specifically, even if they opt to delay claiming until the latest age of 70, they can still afford a constant consumption level of \$19,907 for eight periods before claiming.



(a) Survival and continuation rate

(b) Utility function

Figure 1: Environmental Variables

3.2 Treatments and Predictions

We consider three different treatments that vary by how delayed claims are rewarded. Each treatment provides an actuarially fair benefit adjustment based on claiming age. Treatment 1 (T0, or the benchmark) is designed to replicate the current Social Security rules, which do not provide lump-sum rewards for delayed claiming. The benefit amount for those who claim at the FRA of 67 is set to $20,858, matching the average Primary Insurance Amount of beneficiaries aged 65-69 in 2016 on an annual basis. The benefit levels for other claiming ages are computed to maintain the present value of Social Security benefits unchanged regardless of claiming age. Specific benefit levels are detailed in Column (1) of Table 1. Appendix Table C1 compares the adjustment factors relative to the FRA in our T0 versus the actual adjustment factors applicable to the 1960 and later birth cohorts, demonstrating a close resemblance.

In Treatment 3 (T100 or 100% lump sum), we replace the permanent increase in benefit levels associated with delaying claims with a one-time

lump-sum payment issued at the time of claiming. Similar to T0, this lump-sum amount is calculated to maintain the present value of Social Security benefits unchanged across different claiming ages. As detailed in Columns (4) and (5) of Table 1, under this treatment, individuals consistently receive a fixed annuity amount of $14,887 upon claiming, while the lump-sum benefits increase with claiming age. Treatment 2 (T50, or 50% lump sum) serves as an intermediate case between T0 and T100. In the T50 treatment, individuals who delay Social Security claims receive 50% of the permanent benefit increase seen in T0, coupled with a lump-sum payment that is 50% of that in T100.

Table 1: Changes of Social Security Benefits across Treatments

	T0	T50		T100	
Age	Per period benefits (1)	Per period benefits (2)	Lump Sum when claim (3)	Per period benefits (4)	Lump Sum when claim (5)
62	14887	14887	0	14887	0
63	15865	15376	7725	14887	15447
64	16938	15913	15744	14887	31506
65	18117	16502	24112	14887	48219
66	19418	17153	32812	14887	65637
67	20858	17873	41912	14887	83838
68	22457	18672	51449	14887	102893
69	24241	19564	61457	14887	122915
70	26238	20563	71999	14887	144014

Figure 2 illustrates the relationship between claiming age and expected lifetime utility (expected experimental payoff), revealing an inverted U-shaped pattern. Because the implicit return for delaying a claim surpasses the return on assets (i.e.,$(1+r)/s_j > 1+r$), delaying Social Security claims is the preferred method of saving for the future, leading to gradual increase in expected lifetime utility from claiming at 62 to claiming at 68. The utility gain from delaying claiming follows the order of $T0 > T50 > T100$, reflect-

ing the insurance value of greater annuities in T0 and T50. Delays beyond age 68 remain a feasible option but at the cost of unfavorable reductions in early-period consumption and hence lower expected lifetime utility. Across all three treatments, it is optimal to claim Social Security at the same age of 68 (period 7). However, it is important to note that with different parameterizations, the optimal claiming age may vary across treatments. Conditional on claiming optimally at age 68, expected lifetime utility follows the order of $T0 = 16.98 > T50 = 16.44 > T100 = 15.57$.

Figure 3 displays the optimal consumption profile and asset profile for an individual who claims optimally at age 68. As shown in Figures 3(a) a larger annuity provided in T0 increases consumption in later periods but comes at the cost of reduced consumption in early periods. Before claiming, individuals in T50 and T100 consume at the same rate and fully deplete their assets by the end of age 67, in anticipation of receiving large lump-sum payments in the next period ($51,449 in T50 and $102,893 in T100). The binding no-borrowing constraint at age 67 accounts for the subsequent rise in consumption in these two treatments. Conversely, in T0, without lump-sum payments, individuals must spend less in order to keep about $5k assets until age 68. After claiming, due to early access to a greater portion of Social Security wealth, consumption levels are higher in T100 until they fall below the annuity level provided by the other two treatments. With longevity risk alone, the rational choice model does not predict a slow decumulation of assets. As shown in Figure 3(b), the optimal asset holdings are projected to reach zero after age 73 in T0, after age 81 in T50, and after age 84 in T100.

Note that the optimal decisions shown in Figure 3 are conditional on claiming benefits optimally at age 68. As demonstrated in Appendix Figures C1-C3, individuals who claim at different ages will have distinct optimal consumption and asset paths. Across all three treatments, two common features emerge. First, delaying claims results in greater consumption in later periods at the expense of lower consumption in early periods. Second, due

to the declining continuation probability and the availability of Social Security annuity benefits, individuals should fully deplete their assets long before reaching the maximum lifespan of age 101. Given claiming age, asset levels permanently reach zero more quickly in treatments with greater annuities and smaller lump sums. For all combinations of claiming age and treatment, it is optimal to hold no assets after age 86.[4]

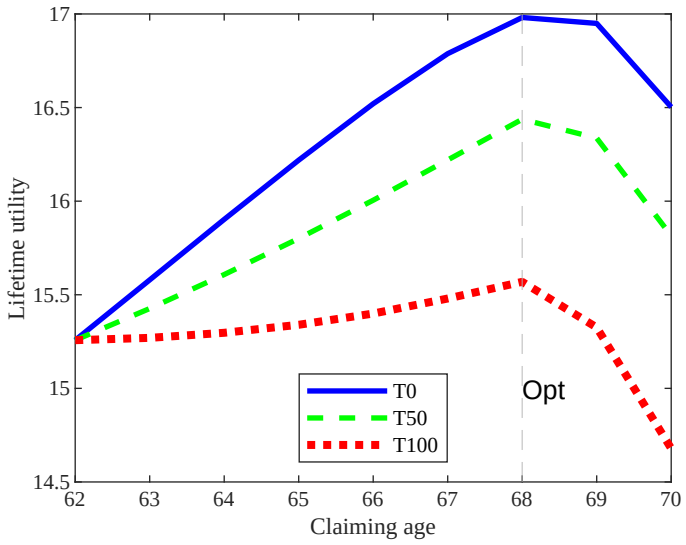
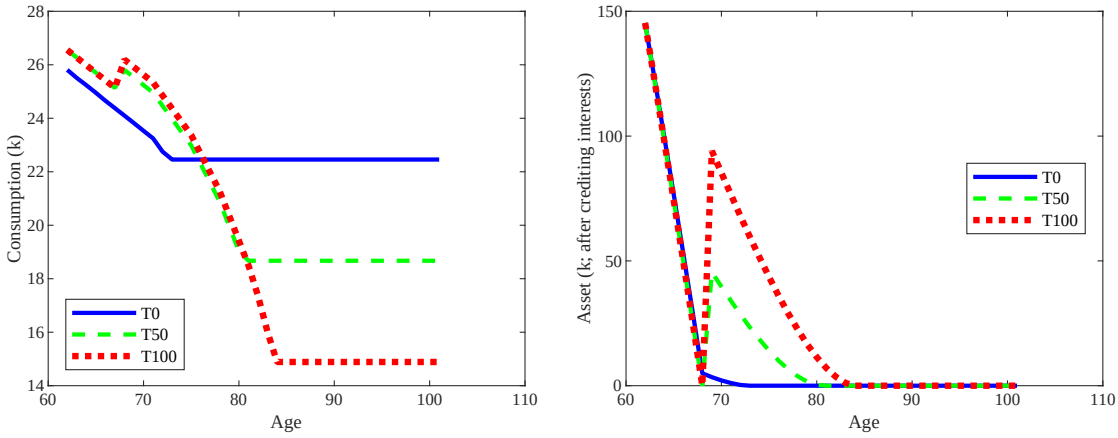


Figure 2: Expected lifetime utility by claiming age

3.3 Experimental Procedures

Subjects were recruited from the UC Irvine Experimental Social Science subject pool using the SONA Systems recruitment software. Our subjects were undergraduate students at UC Irvine from various majors, all without prior experience in our experiment. Each subject was restricted to participating

[4]In the experiment, we restrict consumption to integer values, and asset levels less than $1 are effectively treated as having zero assets.



(a) Consumption

(b) Asset

Figure 3: Optimal consumption and asset profile

in only one treatment (experimental session). Random assignment was employed to allocate subjects to the different treatment conditions.

The experiment was computerized and programmed in oTree (Chen et al., 2016). The experimental program consisted of an instruction phase, including tests to assess subjects' comprehension of the instructions, followed by two life-cycle "sequences", each having an unknown length. Subjects were informed that one of the two sequences would be randomly selected for payment. Since they did not know in advance which of the two sequences would be chosen, they were incentivized to do their best in both sequences. Appendix A provides the experimental instructions and computer screenshots for treatment T50. Instructions and decision screens for the other two treatments are variants of these instructions with only the benefit amounts replaced by the treatment-specific values.

Subjects who have not yet claimed Social Security are presented with two decision screens in each period. On the first screen, they are informed about their current age, current-period starting assets (after crediting interest

payments), and how Social Security annuity benefits and lump-sum payments vary based on their claiming age. On the same screen, they are asked to decide whether to claim benefits in that period. Subjects are required to claim if they do not have enough assets to cover the minimum consumption requirement or if they have reached age 70.

On the second screen, the information on age and starting assets are reiterated. Additionally, subjects are provided with their Social Security payments (if claimed) and their cash-on-hand. On this screen, subjects have the option to make their consumption decisions using a slider or by directly inputting numbers into a box if they prefer. Before clicking the submit button to finalize their decisions, subjects can consider various consumption values and see their impact on current-period earnings, current-period ending assets, and next-period starting assets. All these values are automatically calculated and listed on the decision screen. The positioning of the sliders is dynamic. In each new period, the slider is positioned at the previous period's choice if that amount is affordable; otherwise, it is positioned at the value of cash-on-hand. For the first period, the slider position is set at the minimum consumption amount of $14,887.

At the end of the session, we collected additional demographic data, including information on age, gender, education, and income. We also asked several questions, covering risk altitudes, time preferences, anticipated lifespans, anticipated retirement age, anticipated claiming age, and confidence in the Social Security system. Finally, subjects were asked to complete a risk preference elicitation task designed to reveal their degree of risk aversion as well as to answer four cognitive reflection test questions (Frederick (2005), Toplak et al. (2014)) and three financial literacy questions (Lusardi and Mitchell (2011)). Only the risk elicitation task was incentivized with a small additional monetary payment, depending on the choices that subjects made. Appendix B provides details about this end-of-experiment questionnaire.

4 Findings

We report data for 96 subjects: 35 for T0, 30 for T50, and 31 for T100. Table 2 reports mean characteristics of subjects across the three treatments.[5] Subjects assigned to T50 and T100 received experimental payoffs significantly lower than those assigned to T0. These significant reductions in payoffs are attributed to both the treatment effects and the difference in the number of paid periods. Across both sequences, the average termination period is, 17.3, 16.8, 16.7 for T0, T50, T100, respectively—values that are quite similar across the three treatments. However, for the paid sequence, the experiment lasts an average of 21.3 periods for T0, but only lasts 19.0 periods for T50 and 16.9 periods T100. To avoid bias associated with the difference in termination periods, in the analysis below we focus on expected lifetime utility, which is calculated based on ex-ante continuation probabilities (βs_j). Expected lifetime utility equals the expected payoffs subjects would receive from our experiment and should be the target function for subjects to maximize.

Moreover, as all of our treatments involve individual choices, we treat each subject as a single observation and conduct our data analysis using all observed decisions from both sequences. Thus, we have 192 ($= 96 \times 2$) subject-sequence pairs. To separate the two margins of adjustment—claiming versus consumption-savings decisions—we first discuss treatment effects on claiming decisions. After that, we study consumption and savings decisions. We conclude this section by analyzing the overall effect on expected lifetime utility and the cumulative utility for subjects who (by chance) ended a sequence early versus those who ended a sequence later.

[5] Out of the 36 pairwise comparisons of observed subject characteristics, 4 differences are significant at the 5% level: the difference in financial literacy and time preference between T0 and T50, and the difference in risk preference and anticipated lifespan between T50 and T100. None of these four differences is statically significant at the 1% level.

Table 2: Summary Statistics

	All (1)	T0 (2)	T50 (3)	T100 (4)
Age	20.46	20.66	20.37	20.32
Male	0.31	0.37	0.27	0.29
White	0.19	0.17	0.20	0.19
Cognitive response test	2.33	2.09	2.47	2.48
Financial literacy	2.22	1.97	2.40	2.32
Risk preference	5.69	5.63	6.67	4.81
Risk altitudes	5.46	5.46	5.43	5.48
Time preference	6.45	6.97	5.93	6.35
Anticipated lifespan	85.46	85.63	82.63	88.00
Anticipated retirement age	62.91	64.43	62.43	61.65
Anticipated claiming age	66.55	66.49	66.43	66.74
Confidence in SS system	2.88	2.91	2.97	2.74
Payoff	15.28	18.12	14.64	12.70
Obs	96	35	30	31

Note: Please refer to Appendix B for the end of experiment questionnaire.

4.1 Claiming age

Recall that for all three treatments, the optimal claiming age is 68. Figure 4 shows the cumulative distribution function (CDF) of claiming age by treatment and by sequence. In the first sequence (S1) of all three treatments, the median claiming age is lower than the current FRA of 67. The experience gained from completing one retirement life cycle enables subjects to delay their claiming ages in the second sequence (S2). Despite this, the median values for all three treatments remain lower than the optimal claiming age of 68. Additionally, a comparison between treatments reveals that subjects assigned to T0 are more likely to delay their claims compared to those assigned to the other two treatments.

To quantify the difference between the observed data and the rational choice prediction, we estimate the following regression equation:

$$\Delta y_{is} = \text{Const.} + \sum_{k=2}^{3} \delta_k Tk_i + \sigma S2_s + X_i\zeta + \epsilon_{is} \tag{5}$$

where Δy_{is} represents the deviation of the observed data outcome of y_{is} (e.g., claiming age, log consumption, assets, expected utility or cumulative utility under various termination periods) for subject i in sequence s from the rational choice model prediction y^r_{is}, i.e., $\Delta y_{is} = y_{is} - y^r_{is}$. Depending on the outcome of interest, y^r_{is} could be the unconditional optimum (for the analysis of claiming age and utility) or the conditional optimum (for the analysis of log consumption and assets). Tk_i is a 0-1 indicator variable equal to 1 if subject i is assigned to treatment Tk. $S2_s$ is an indicator variable that equals 1 for sequence 2.[6]. The X_i represents 12 individual characteristic

[6]We experimented with regression models including interaction terms between $S2_s$ and treatment dummies, but did not find these interaction terms to be significant. To reduce complexity, we do not include these interaction terms in the reported results. Concerned about the potential impact of treatment assignments on selected control variables, such as anticipated claiming age, we further re-estimate the model using a subset of variables likely unaffected by treatment assignments, i.e., male, white, cognitive response test score,

variables that are reported in Table 2 and are included to improve precision. To interpret the constant term as the average of Δy_{is} in T0, we reconstruct the 12 control variables by demeaning them. The coefficient δ_k captures the treatment effect on the deviations. Our H_0 is always Const. $= \delta_2 = \delta_3 = 0$, i.e., the observed data conform to the rational choice model. Standard errors are clustered at the subject level.

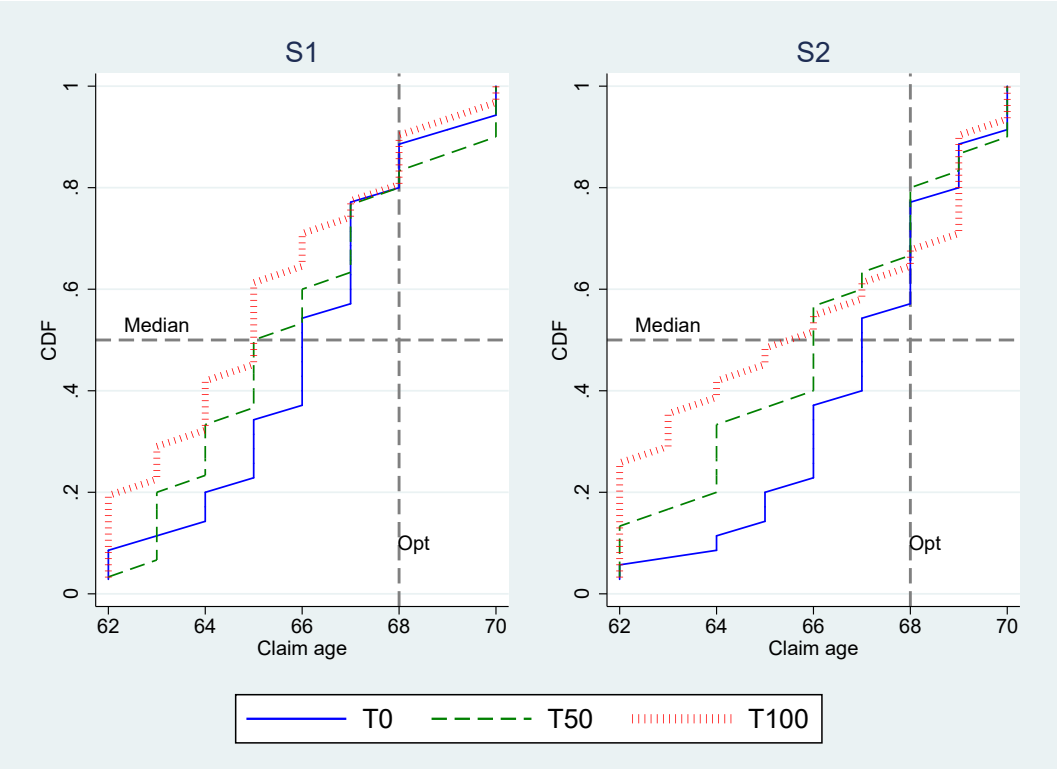


Figure 4: CDF of claiming age

Column (1) of Table 3 reports estimates for deviations in claiming age.[7] On average, subjects assigned to T0 claim Social Security 1.5 years earlier

financial literature score, and risk preference. We find similar estimates for Const., δ_2, and δ_3. All these results are available upon request.

[7]The presented tables only report the coefficients for selected variables; the full list of regression coefficients are available upon request.

than the optimal age of 68. The replacement of annuities with lump sums in T50 and T100 encourages subjects to claim Social Security even earlier by an additional 1.0 year (marginally significant at the 10% level) and 1.5 years, respectively. Experience gained from completing sequence 1 helps subjects delay the average claiming age by 0.58 years.

Table 3: Deviation of Claiming Age and Assets

	Claiming	Assets (k)- optimum|claiming				
	Age	62-69	70-79	80-89	90-101	62-101
	(1)	(2)	(3)	(4)	(5)	(6)
Cons	-1.47***	8.10*	36.39***	42.27***	33.21***	31.25***
	(0.34)	(4.24)	(6.33)	(7.28)	(8.24)	(6.05)
T50	-1.00*	-17.24***	-30.12***	-13.86	-12.43	-18.17**
	(0.51)	(6.40)	(8.81)	(9.73)	(11.07)	(8.27)
T100	-1.47**	-28.04***	-43.63***	-27.00***	-25.83***	-31.02***
	(0.58)	(6.22)	(9.38)	(9.67)	(9.16)	(7.67)
S2	0.58**	0.71	-2.40	-8.21**	-5.70	-4.22
	(0.25)	(4.35)	(4.48)	(3.58)	(3.52)	(3.14)
R^2	0.13	0.17	0.23	0.16	0.11	0.20

Note: This table presents estimates from Equation (5). The dependent variables include the deviation of claiming age from the unconditional optimum (column 1) and starting assets (k) from the optimum conditional on claiming age for various age brackets (columns 2-6). The number of observations is 192. Standard errors are clustered at the subject level. *** p<0.01, ** p<0.05, and * p<0.10.

4.2 Consumption and asset allocations

Figure 5 compares the average log consumption and assets of each treatment to those predicted by the rational choice model, conditional on claiming age. Due to the change in the distribution of claiming age (see Figure 4), the model predictions slightly differ across the two sequences. Note that this prediction corresponds to the *unconditional* optimum calculated for previous life-cycle experiments without a claiming decision. In T0, the consumption profile is almost flat across the entire life cycle; on average, in the early periods,

subjects underconsume relative to the model prediction, and they overconsume in later periods. In T100, subjects, on average, initially overconsume relative to the model prediction. However similar to T0, their consumption quickly falls below the model prediction, and then in the later periods of life, they rebound to levels above the model prediction. The average for T50 generally falls between that of T0 and T100: in the early periods, most subjects underconsume relative to the model prediction, and in later periods, they over-consume. There is no significant difference between sequences and similar patterns are found for the median values, as displayed in Appendix Figure C4.

The right panels of Figure 5 compare the data asset path with the optimal path conditional on claiming age. According to rational choice theory, regardless of treatment and claiming age, no one should have positive assets after age 86. However, in our experiments, subjects assigned to T0 and T50, on average, hold significantly positive assets into their late 90s, and experience learned from S1 do not help to eliminate this irrational holding of retirement wealth into a very old age.[8]

Columns (2)-(6) of Table 3 report the estimates of the deviation of assets from the optimal level given each subject's claiming age. Notice that these optimal levels are calculated while accounting for longevity risk, and any significant deviation is attributed to behavioral biases. This table reveals that from their 70s onward, subjects assigned to T0 hold, on average, about 33-42k more in assets than predicted by the rational choice model. As T0 is calibrated to match the U.S. economy, our findings suggest that behavioral biases could be a potential explanation for the "retirement savings puzzle".

The degree of excess asset holdings is much lower in T50 but is still significant after age 80. For T100, the average asset level is significantly less than the theoretical prediction in their 60s, because subjects in this treat-

[8]Even in the very last period of life at age 101, in both T0 and T50, about 1/3 of subjects in their first sequence left more than 1k unspent, which is money left on the table. And in the second sequence this share decreases to 29% in T0 and 13% in T50.

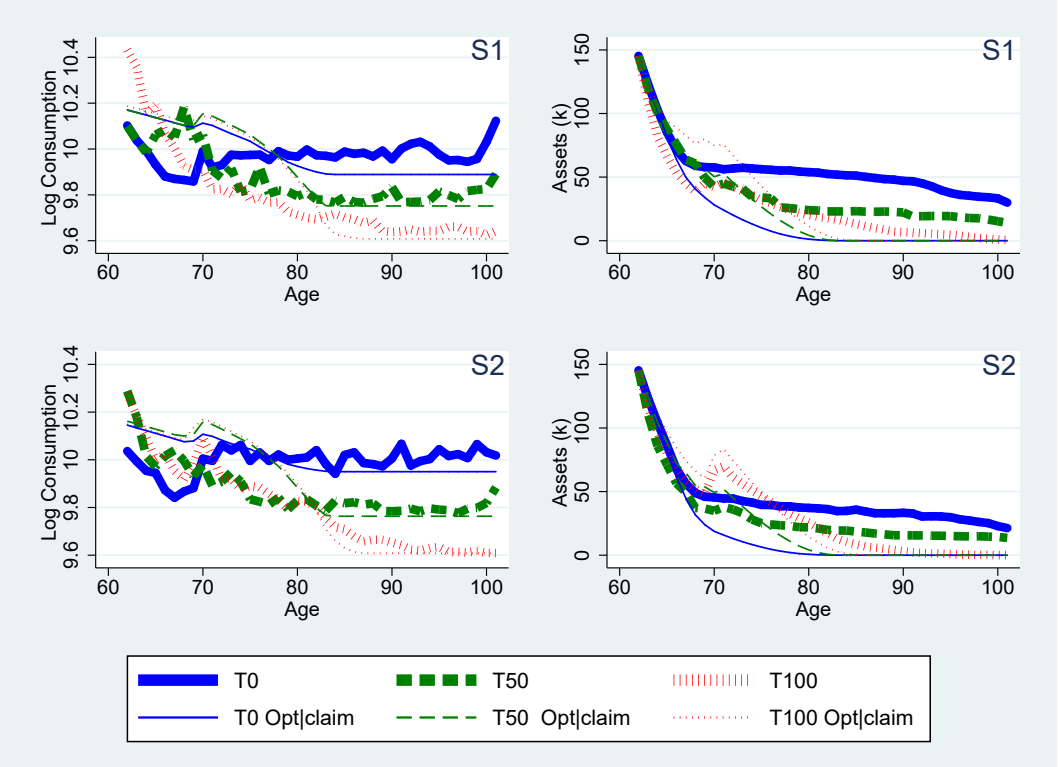


Figure 5: Mean log consumption and assets by treatment

ment overconsume at the very beginning of each sequence. However, from the late 60s to the early 80s, these subjects, on average, underconsume relative to theory predictions, leading to an average asset level in their 80s that significantly surpasses the model's prediction. In summary, across all three treatments and in both sequences, the experimental data consistently show that subjects deplete their assets at a much slower rate than the rational choice model suggests, and this difference is greater in treatments that provide a larger annuity, i.e., T0.

Table 4 provides the estimates of Equation (5) on the deviation of log consumption from the optimal level conditional on claiming age.[9] For T0,

[9]Appendix Table C3 reports the mean squared error (MSE) of log consumption from the optimal level conditional on claiming age. The MSE is greater in the early periods,

average consumption is about 17% and 6% below the conditional optimum when subjects are aged in their 60s and 70s, respectively. However, average consumption exceeds the conditional optimum in the remaining 21 years (ages 80-101). The pattern of underconsumption in early periods followed by overconsumption in later periods is persistently observed in treatments T50 and T100, although generally to a lesser extent compared with T0. This finding contrasts with what is observed in most life-cycle laboratory experiments that do not begin with retirement or involve a claiming decision; in those studies, relative to the unconditional optimum, subjects overconsume in the early (working) periods and underconsume in later (retirement) periods (for example see Duffy and Li (2019)). We believe this difference is generated by three features of our experimental design that are not present in any prior life-cycle consumption/savings experiments: 1)framing the life-cycle planning problem as applying only to the retirement phase of life, 2) the requirement to make a benefit-claiming decision, and 3) the use of age-dependent mortality risk.

Next, we assess how the consumption data compare to the optimum conditional on *both* claiming age and current-period starting assets. This alternative model prediction is generally referred to as the *conditional* optimum in previous life-cycle experiments without a claiming decision. As shown in Figures 6 and C5, in most periods across all three treatments, subjects underconsume relative to this alternative optimum conditional on both claiming age and starting assets. Table 5 provides further insights, revealing that for T0, on average over 40 years, consumption is 28% less than the optimum conditional on both claiming age and starting assets. This deviation is -20% for the age group 60-69, and gradually increases to -33% for the age group 90+. The extent of underconsumption decreases in the two treatments providing lump sums, although the deviations for both T50 and T100 still remain sig-

reflecting that subjects have more assets and can make larger mistakes. Additionally, the MSE in both T50 and T100 is about 50% greater than that in T0, as receiving a lump sum payment induces subjects to make more consumption mistakes.

Table 4: Deviation of log consumption from optimum|claiming

Age	62-69	70-79	80-89	90-101	62-101
	(1)	(2)	(3)	(4)	(5)
Cons	-0.17***	-0.06***	0.06***	0.09***	-0.01
	(0.02)	(0.02)	(0.02)	(0.02)	(0.01)
T50	0.09***	-0.16***	-0.03	-0.03	-0.04***
	(0.03)	(0.03)	(0.03)	(0.02)	(0.01)
T100	0.14***	-0.16***	-0.03	-0.06**	-0.04***
	(0.03)	(0.03)	(0.03)	(0.02)	(0.01)
S2	-0.01	0.04*	-0.00	-0.03**	-0.00
	(0.02)	(0.02)	(0.01)	(0.01)	(0.01)
R^2	0.20	0.29	0.05	0.12	0.14

Note: This table presents estimates from Equation (5). The dependent variable is the average deviation of log consumption from optimum, conditional on claiming age, as predicted by rational choice theory, for various age brackets. The number of observations is 192. Standard errors are clustered at the subject level. *** p<0.01, ** p<0.05, and * p<0.10.

nificantly negative at the 5% level for age groups 70-79, 80-89, and 90-101.

4.3 Expected lifetime utility and cumulative utility

Figure 7 displays the CDF of expected lifetime utility, which is the sum of per-period utility multiplied by the cumulative continuation probability, separately for S1 and S2. This figure reveals that the vast majority of subjects have expected lifetime utility far below the expected levels predicted by the rational choice model, and there is little improvement with experience. The theory further predicts a smaller difference in expected lifetime utility between T0 and T50 than that between T50 and T100. However, the data show a relatively large difference between T0 and T50, and almost no difference between T50 and T100.

Column (1) of Table 6 presents estimates of the deviation of expected

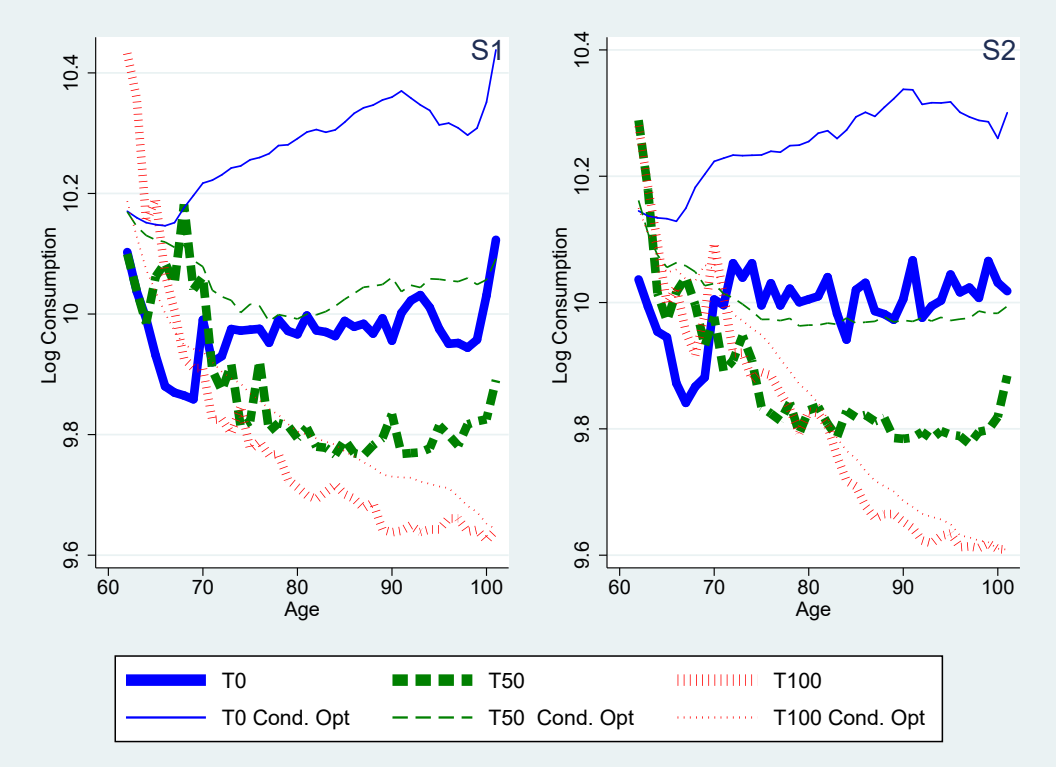


Figure 6: Mean log consumption and mean optimum conditional on both claiming age and starting assets

lifetime utility from the unconditional optimum predicted by the rational choice model. On average, the data in our experiment are about 22%-33% lower than the theoretical prediction.[10] Unlike other outcome variables, the estimated effect for T50 no longer falls between that for T0 and T100; the gap in expected lifetime utility between the data average and the model's prediction is greatest in T50. This primarily reflects that replacing greater annuities with lump-sum payments leads subjects to claim earlier in time (see Table 3), and this early claiming behavior is associated with a much

[10]The exact percentage deviations are -22% ($= \frac{-3.80}{16.98}$) for T0, -33% ($= \frac{-3.80-1.59}{16.44}$) for T50, and -27% ($= \frac{-3.80-0.41}{15.57}$) for T100. The denominators are the expected lifetime utility values predicted by the rational choice model as reported in Section 2

Table 5: Deviation of log consumption from optimum|claiming and starting assets

Age	62-69	70-79	80-89	90-101	62-101
	(1)	(2)	(3)	(4)	(5)
Cons	-0.20***	-0.26***	-0.33***	-0.33***	-0.28***
	(0.04)	(0.03)	(0.04)	(0.06)	(0.04)
T50	0.16***	0.09**	0.10*	0.09	0.10**
	(0.05)	(0.04)	(0.05)	(0.08)	(0.05)
T100	0.26***	0.18***	0.23***	0.24***	0.23***
	(0.05)	(0.04)	(0.04)	(0.07)	(0.04)
S2	-0.03	0.04**	0.06***	0.06***	0.04**
	(0.03)	(0.02)	(0.02)	(0.02)	(0.02)
R^2	0.23	0.18	0.25	0.18	0.23

Note: This table presents estimates from Equation (5). The dependent variable is the average deviation of log consumption from optimum conditional on both claiming age and current period starting assets. The number of observations is 192. Standard errors are clustered at the subject level. *** p<0.01, ** p<0.05, and * p<0.10.

greater utility loss in T50 than in T100 (see Figure 2).

The mean effects on expected lifetime utility conceal distributional differences between subjects who ended a sequence early versus those who ended a sequence later. Columns (2)-(5) of Table 6 report estimates of the deviations of cumulative utility for various termination ages—70, 78.09 (expected termination age), 90 and 101 (maximum lifespan)—from the corresponding values predicted by rational choice theory. The effect on cumulative utility mostly aligns with the effect on expected utility, with the magnitude of the negative deviation increasing as the sequence continues for a longer duration. The only exception is that subjects assigned to T100 have a smaller deviation than those in T0 if the experiment terminates at age 70, reflecting the overconsumption in T100 in the first few periods (see Figure 5).

In summary, our preceding analysis reveals four key findings that challenge rational choice theory:

Finding 1: Across all three treatments, subjects, on average, choose to

Table 6: Deviation of expected and cumulative utility from unconditional optimum

	Expected	Cumulative utility			
	lifetime	62-70	62-78.09	62-90	62-101
	(1)	(2)	(3)	(4)	(5)
Cons	-3.80***	-3.37***	-4.31***	-5.53***	-5.82***
	(0.40)	(0.46)	(0.46)	(0.79)	(1.31)
T50	-1.59**	0.61	-2.43***	-3.09**	-3.86*
	(0.70)	(0.62)	(0.78)	(1.34)	(1.98)
T100	-0.41	1.51**	-1.64*	-0.86	0.02
	(0.68)	(0.72)	(0.89)	(1.21)	(1.77)
S2	0.42	-0.54	0.47	1.27**	1.34
	(0.33)	(0.43)	(0.43)	(0.63)	(0.81)
R^2	0.08	0.13	0.09	0.14	0.13

Note: This table presents estimates from Equation (5). The dependent variable includes the deviation of expected lifetime utility from that predicted by rational choice theory (column 1) and the deviations of cumulative utility for various termination ages from that predicted by rational choice theory (columns 2-5). The number of observations is 192. Standard errors are clustered at the subject level. *** p<0.01, ** p<0.05, and * p<0.10.

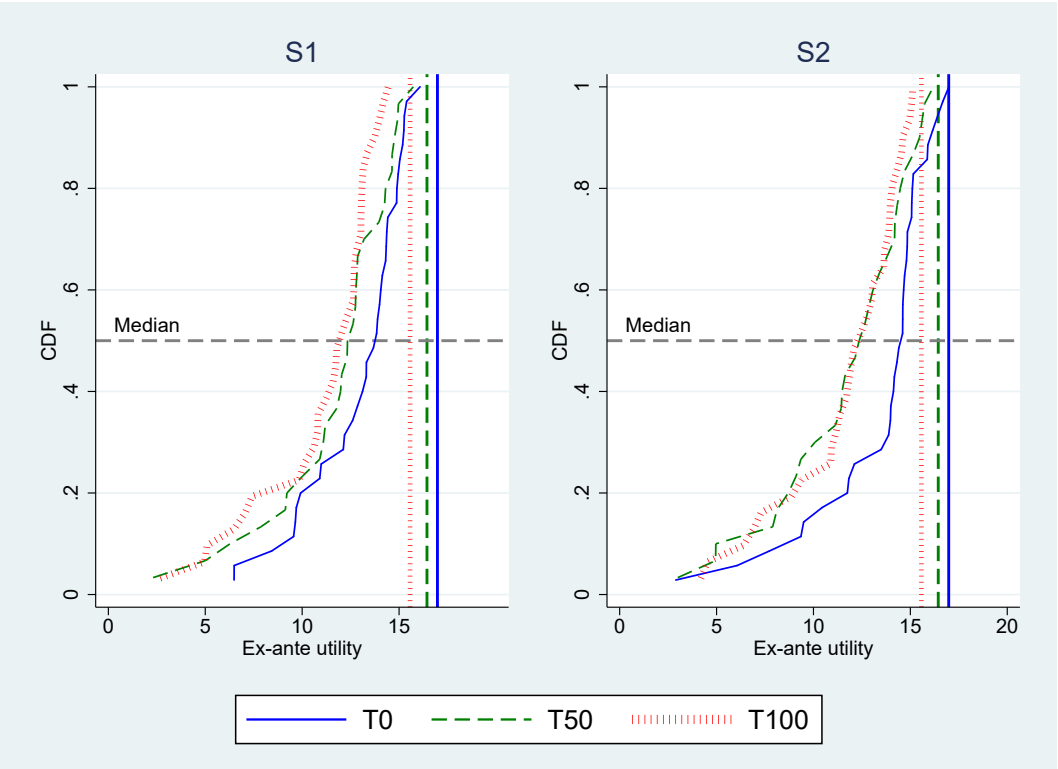


Figure 7: CDF of expected lifetime utility

claim Social Security earlier than the optimal age of 68, with a greater deviation in treatments that provide lump sums.

Finding 2: Across all three treatments, our subjects decumulate their assets at a significantly slower rate than predicted by rational choice theory, conditional on claim age. Conversely, subjects generally underconsume in the early periods, and overconsume in later periods, compared to the optimal level, conditional on claiming age.

Finding 3: Compared to the optimal level conditional on *both* claiming age and current-period starting assets, subjects underconsume in most periods, with more pronounced underconsumption in treatments providing smaller lump sums.

Finding 4: The expected lifetime utility in the experiment falls significantly below theoretical predictions, with the largest deviation occurring in T50.

5 Behavioral Model

To explain these findings, we develop a behavioral model based on the random attention model of Cattaneo et al. (2020). In this model, individuals adopt a heuristic rule, occasionally allocating random attention to solving the intertemporal problem. The model also integrates misperceived continuation probabilities and noisy signals about expected lifetime utility for different claiming ages. We estimate this model by matching subjects' consumption decisions and validate it through out-of-sample predictions and comparisons with non-targeted data outcomes, such as the distribution of claimings age and median expected lifetime utility. We estimate the model using only S1 consumption data and the sequence indicator is suppressed for brevity.

5.1 Theory

The model assumes that subjects do not perfectly observe the expected lifetime utility associated with different claiming ages. Rather each subject i receives noisy signals about expected lifetime utility and selects the age k_i corresponding to the greatest signal value. Subsequently, given k_i and starting assets a_{ij} in the current period j, subjects pick consumption c_{ij}. Every period, her choice problem consists of two elements: a heuristic consumption level c_{ij}^h, and an optimal consumption level c_{ij}^* that is solved for k_i and a_{ij} under the misperceived continuation probability. Specifically, c_{ij}^* is solved for the intertemporal problem introduced in Section 2 by replacing the objective between-period continuation probability βs_j with the misperceived probability $p(\beta s_j)$. To capture that most subjects have a tendency to maintain a

relatively constant asset level, we consider the following heuristic rule:

$$c_{ij}^{h}(a_{ij}, k_i) = \begin{cases} \min\{ss(k_i, k_{i+1}), \hat{c}(k_i)\} & \text{if } j < k_i \\ ss(k_i, k_{i+1}) + ra_{ij} & \text{otherwise} \end{cases} \tag{6}$$

where $ss(k_i, k_i + 1)$ is the annuity amount of Social Security benefits for each treatment. The $\hat{c}(k_i) = \frac{a_1 R(1-1/R)}{1-(1/R)^{k^i-1}}$ represents the maximum constant consumption level that is affordable for those who postpone claiming until age k_i. This functional form assumes that before claiming, subjects consume a constant amount equal to Social Security annuity benefits if that is affordable, or otherwise the maximum affordable level.[11] After claiming, subjects adopt an interest-only retirement strategy, consuming their social security annuity benefits plus interest income.

Subjects consistently observe the heuristic consumption level, and attention is directed to solving the intertemporal problem with a period-dependent probability μ_j^t that varies by treatment t. Hence, with a probability $1 - \mu_j^t$, the consideration set contains only one element $\{c_{ij}^h\}$, the heuristic rule. In this scenario, we formulate the following data-generating process for subject i in period j who opts to claim at k_i and possesses a starting asset of a_{ij}

$$\log c_{ij} = \log c_{ij}^h + \epsilon_{ij}, \text{ where } \epsilon_{ij} \sim i.i.d.N(0, \sigma^2)$$

where ϵ_{ij} represents the decision error that follows a normal distribution with mean zero and standard deviation σ. This error encompasses the possibility that subjects may not perfectly solve the intertemporal problem or precisely adjust the slider to the desired level.

With a probability μ_j^t, the consideration set contains two elements $\{c_{ij}^*, c_{ij}^h\}$, where c_{ij}^* represents the solution to the intertemporal problem described in Section 2 but with βs_j substituted by $p(\beta s_j)$. Subjects believe that c_{ij}^* leads

[11] Only individuals who claim at age 69 and later in T0, and those who claim at age 70 in T50, have a maximum affordable level that is less than their annuity benefits. This affects 8 out of 96 subjects from the student sample.

to a higher payoff than c_{ij}^h. In this scenario, our experimental consumption data are generated by the following process:

$$\log c_{ij} = \log c_{ij}^* + \epsilon_{ij}, \text{ where } \epsilon_{ij} \sim i.i.d.N(0, \sigma^2)$$

5.2 Estimation

Following Zhang and Maloney (2012), we parameterize the perceived continuation probabilities using two parameters:

$$\log \frac{p(\beta s_j)}{1 - p(\beta s_j)} = \eta \log \frac{\beta s_j}{1 - \beta s_j} + (1 - \eta) \log \frac{p_0}{1 - p_0}$$

where η is the slope of the log odds transformation, and p_0 is the fixed point where perceived probability coincides with objective probability. The above functional form implies that

$$p(\beta s_j) = \frac{1}{1 + (\frac{1-\beta s_j}{\beta s_j})^{\eta} (\frac{1-p_0}{p_0})^{1-\eta}}$$

We parameterize the attention rule $\mu_j(k_i, c_{ij}^h)$ using the following functional form:

$$\mu_j^t = \frac{1}{1 + \exp^{-(\alpha_1 + \alpha_2 j + \alpha_3 j^2 + \alpha_{T0} \mathcal{I}_{t=T0} + \alpha_{T50} \mathcal{I}_{t=T50})}} \tag{7}$$

where $\mathcal{I}_{t=T0}$ and $\mathcal{I}_{t=T50}$ are indicator functions for treatments T0 and T50, respectively. We employ a second-order polynomial function $(\alpha_1 + \alpha_2 j + \alpha_3 j^2)$ to model the life-cycle variations in attention. Additionally, α_{T0} and α_{T50} capture the treatment difference in attention. The sum of life-cycle variations and treatment differences is transformed into a probability ranging from 0 to 1 using the standard logistic function.

Our behavioral model is characterized by a vector of eight parameters $\theta = [\eta, p_0, \alpha_1, \alpha_2, \alpha_3, \alpha_{T0}, \alpha_{T50}, \sigma]$. For a given θ, claiming age k_i, and starting

Table 7: Estimates of behavioral model

		Bootstrapped 95% CI	
Para	Point	Lower	Upper
Errors			
σ	0.1723	0.1635	0.1812
Attention rule			
α_1	1.3660	1.1030	1.8501
α_2	-0.2726	-0.3387	-0.2326
α_3	0.0064	0.0053	0.0082
α_{T0}	-1.9869	-2.5079	-1.6869
α_{T50}	-1.1869	-1.7239	-0.8774
Probability misperception			
η	0.0000	0.0000	0.1033
p_0	0.8175	0.7174	0.8532

asset levels a_{ij}, the likelihood of observing subject i in period j choosing consumption c_{ij} is:

$$\mathcal{L}(c_{ij}) = \frac{\mu_j^t}{\sigma}\varphi(\frac{\log c_{ij} - \log c_{ij}^*}{\sigma}) + \frac{1-\mu_j^t}{\sigma}\varphi(\frac{\log c_{ij} - \log c_{ij}^h}{\sigma})$$

where φ denotes the standard normal probability density function. The log likelihood of the entire sample is the sum of the logarithms of the likelihood computed across periods and subjects.

$$\hat{\theta} = \arg\max_{\theta} \sum_i \sum_{j=1}^{J} \log \mathcal{L}(c_{ij})$$

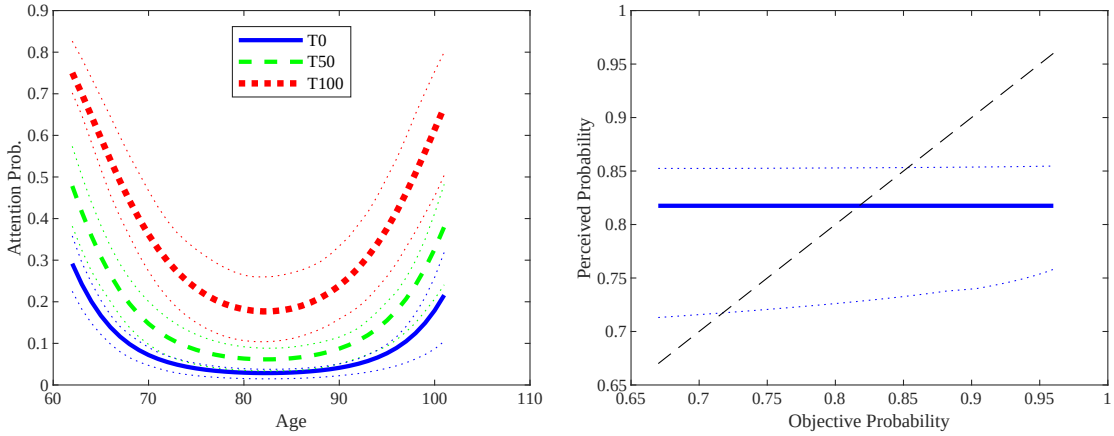
We employ a Nelder-Mead simplex algorithm to find the maximum likelihood estimate $\hat{\theta}$ that solves the aforementioned problem for all S1 consumption data. The S2 consumption data are reserved for checking out-of-sample predictions. We utilize the bootstrap method to construct the 95% confidence interval (see Appendix D for the numerical method).

Table 7 reports the point estimates and 95% confidence intervals. The

standard deviation of the consumption error is 0.17, with a tightly estimated 95% confidence interval ranging from 0.16 to 0.18. To facilitate understanding of other model parameters, Figure 8 plots the attention rule and the relationship between perceived and objective probability. As displayed in Figure 8(a), the probability of paying attention to solving the intertemporal problem follows a U-shaped pattern; with subjects paying more attention at the beginning and the end of a sequence. Across treatments, for each period, the attention probability follows the order of $T100 > T50 > T0$. This implies that attention is endogenous to the level of Social Security annuity benefits: subjects are more likely to pay attention and solve the intertemporal problem if the heuristic rule delivers a low utility level, such as in T100.

Figure 8(b) clearly indicates that subjects exhibit a misperception regarding continuation probabilities. Our point estimate suggests that subjects do not respond to period-varying continuation probabilities and behave as if facing a constant probability of 81.8% that the experiment will continue for another period. Under this misperception, future consumption is more heavily discounted before age 91 when the perceived probability is lower than the objective value, and less heavily discounted after that when the reverse is true. This point estimate also indicates a perceived expected duration of 5.48 years, which is 66% shorter than the objective average duration of 16.09 years. As shown in Figure 8(a), in T100 subjects are more likely to pay attention to solving the intertemporal problem than the other two treatments. This heightened attention, coupled with the underestimation of continuation probabilities, lead the average log consumption level in T100 to surpass the rational choice model predictions in the first few periods (see Figure 6). The overestimation of continuation probabilities in later periods also contributes to the slow decumulation of assets. It is important to note that our estimates are derived from a simplified economy that abstracts from health shocks. In reality, following a negative health shock, the vast majority of individuals would appropriately update their survival probability and pay more atten-

tion to the intertemporal problem.



(a) Attention rule μ_j^t

(b) Probability misperception

Figure 8: Point estimates and 95% confidence intervals

5.3 Validation

To assess the fit of our behavioral model, we first compare the deviation of log consumption from that predicted by our behavioral model against the rational choice model.[12] As shown in Figure 9, our behavioral model aligns well with the data, with the corresponding deviations centering around zero for almost all periods and in all three treatments. However, deviations from rational choice model predictions are predominantly negative and significant. Appendix E reports a decomposition exercise to elucidate the importance of two mechanisms—random attention versus probability misperception—in shaping life-cycle consumption patterns. As detailed in this appendix,

[12] We calculate the deviation from the behavioral model as $\log c_{ij} - [\mu_j^t \log c_{ij}^* + (1 - \mu_j^t) \log c_{ij}^h]$. All consumption values are conditional on both claiming age and starting assets.

random attention to the intertemporal problem is the primary mechanism that helps narrow the gap between model predictions and data averages.

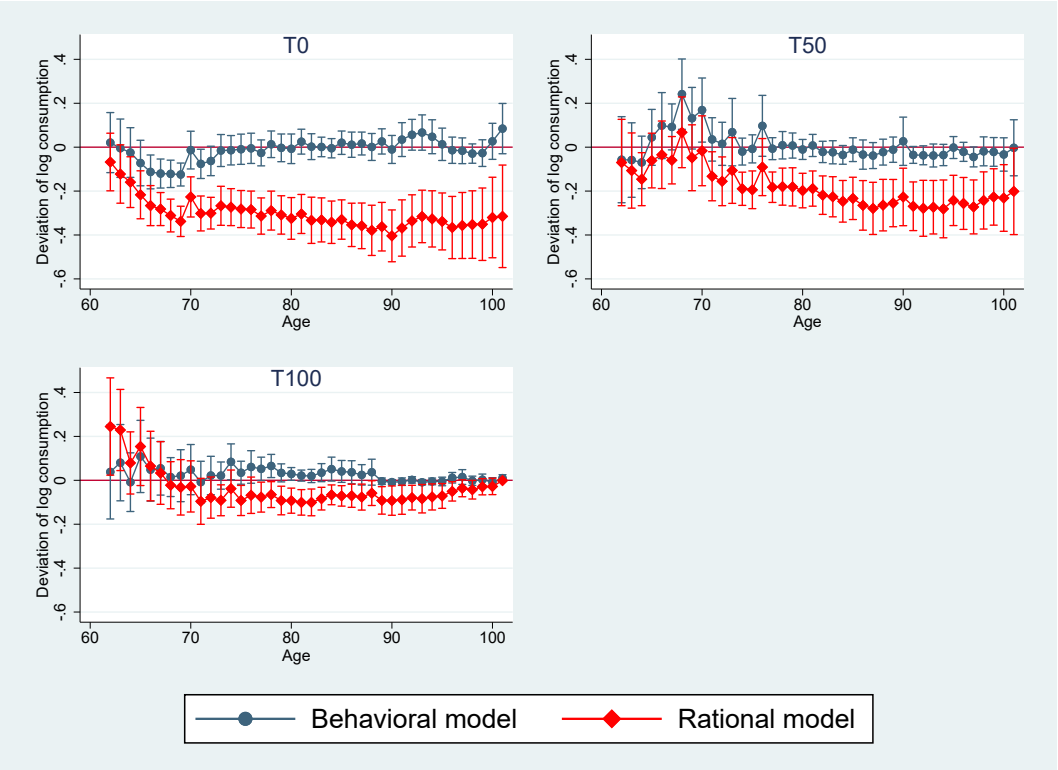


Figure 9: Deviation of log consumption in S1 from model predictions conditional on claiming age and current assets

We assess the out-of-sample predictions of our behavioral model using two approaches. First, as the model is estimated using S1 data only, we can compare the model predictions with data averages for S2. Second, we re-estimate our behavioral model based on the decisions of two-thirds of subjects in S1 and compare data averages with model predictions for the remaining one-third of subjects.[13] As shown in Figure 10, the behavioral model fits both samples quite well, and the rational choice model continues to significantly overpredict the level of consumption.

[13]Point estimates for this subsample are reported in Column (4) of Appendix Table C5.

We next compare the predictions of our behavioral model with aspects of the data that are not targeted in our estimation. As explained earlier, we assume subjects decide when to claim Social Security benefits based on noisy signals about expected lifetime utility and pick the age with the greatest signal value. Since it is not clear whether subjects are sophisticated enough to incorporate both random attention and probability misperception when calculating the expected lifetime utility, we consider four alternatives:[14]

1. The expected lifetime utility generated by the rational choice model, discounted using objective continuation probabilities (referred to as "R" in Figure 11 and the discussion follows)

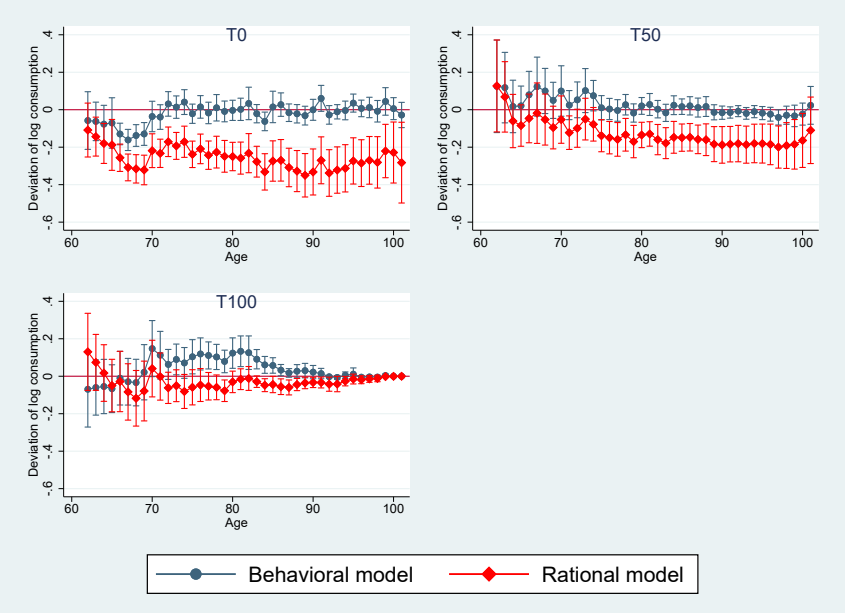
2. The expected lifetime utility calculated using decisions predicted by the behavioral choice model, discounted using objective continuation probabilities (referred to as "B")

3. The expected lifetime utility calculated using decisions predicted by the rational choice model but discounted using the misperceived continuation probabilities (referred to as "R mp")

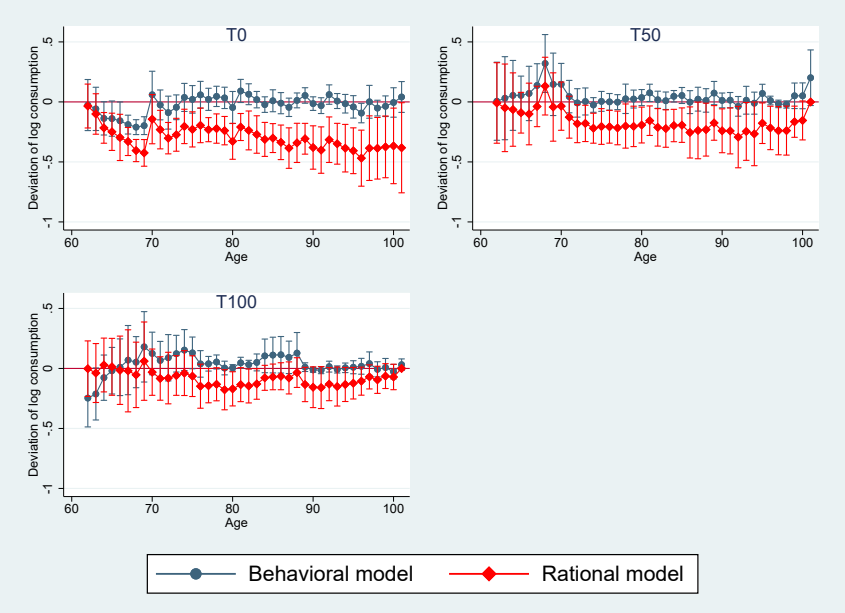
4. The expected lifetime utility calculated using decisions predicted by the behavioral model but discounted using misperceived continuation probabilities (referred to as "B mp").

Following the standard discrete choice model, we assume the noise is randomly drawn from the Type 1 Extreme Value distribution. Thus, the probability of claiming at age k is $\frac{exp(V_k)}{\sum_{j=1}^{9} exp(V_j)}$, where V_k denotes the expected lifetime utility of claiming at age k that is constructed using the four alternative approaches described above.

[14]Appendix D explains the numerical method for finding the predictions of the behavioral model and constructing the confidence intervals. We also consider an alternative assumption that subjects receive noisy signals about cumulative utility up to their expected termination period and use these signals to decide their claiming age. This assumption produces a poorer fit than the results presented here.

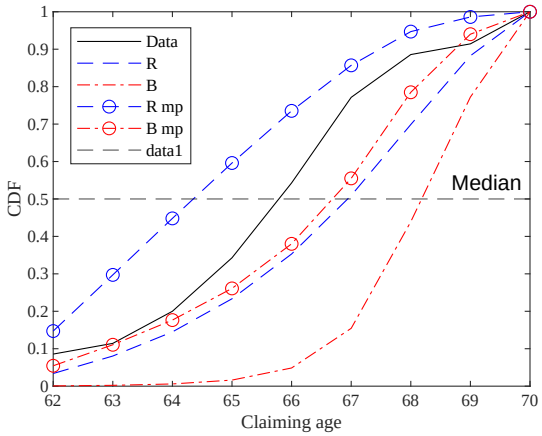


(a) S2

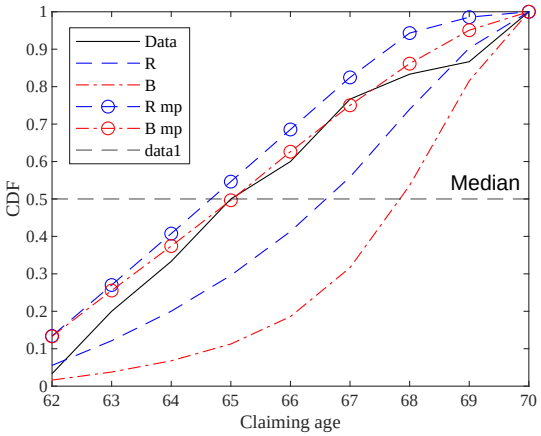


(b) 1/3 of S1

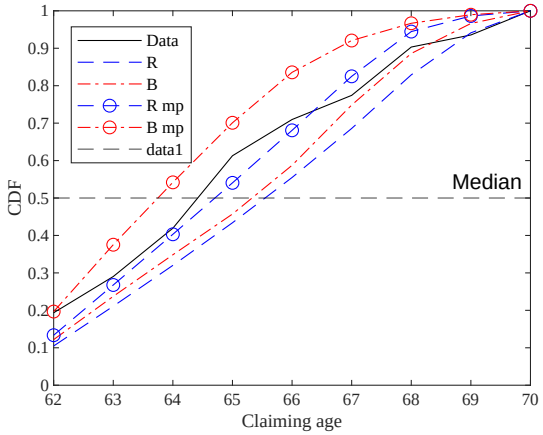
Figure 10: Out-of-sample predictions: the deviation of log consumption conditional on claiming age and current assets



(a) T0



(b) T50



(c) T100

Figure 11: CDF of claiming age in S1

Note: This figure displays the CDF of data claiming age (solid line) and that predicted by four alternative approaches.

Figure 11 compares the data CDF of claiming ages with that predicted using four alternative approaches. To assess the overall performance, we calculate the MSE by taking the average of the squared deviation of data CDF from model predictions over ages 62-69 for all three treatments. The CDF for age 70 is excluded, as there is always a perfect match. We find the MSE follows the order of B = 0.074 > R = 0.017 > R mp = 0.012 > B mp = 0.008. From both the figure and these MSE values, it is evident that the two approaches incorporating misperceived continuation probabilities—"B mp" and "R mp"— provide a better fit for the data than the two alternatives assuming objective continuation probabilities. The MSE for "B mp" approach is 35% smaller than the second best "R mp" approach, although the "R mp" approach fits T100 slightly better. Moreover, as reported in Appendix Table C2, the "B mp" approach produces an average (median) claiming age of 66.7 (67) for T0, 65.6 (66) for T50, and 64.5 (64) for T100, while the 'R mp' approach generates almost no change in mean or median claiming age across treatments. Therefore, the behavioral model with misperceived continuation probability—"B mp" approach—successfully matches the distribution of claiming age across treatments. This success in replicating Finding 1 is attributed to the change in expected lifetime utility with respect to claiming age. As shown in Appendix Figure C6, under the "B mp" approach, the expected lifetime utility exhibits an inverted U-shape pattern in T0, incentivizing delayed claims. In both T50 and T100, the expected lifetime utility is slightly higher at age 62 than at other ages, encouraging early claims. It is important to note that without noisy signals regarding expected utility for different claiming ages, all approaches predict that subjects should claim at a single age that maximizes their expected lifetime utility. Thus, both probability misperception and noisy signals are crucial for matching the data claim distribution.

Next, we aim to examine **Finding 2** by comparing the average assets observed in the data with those predicted by two competing models—the

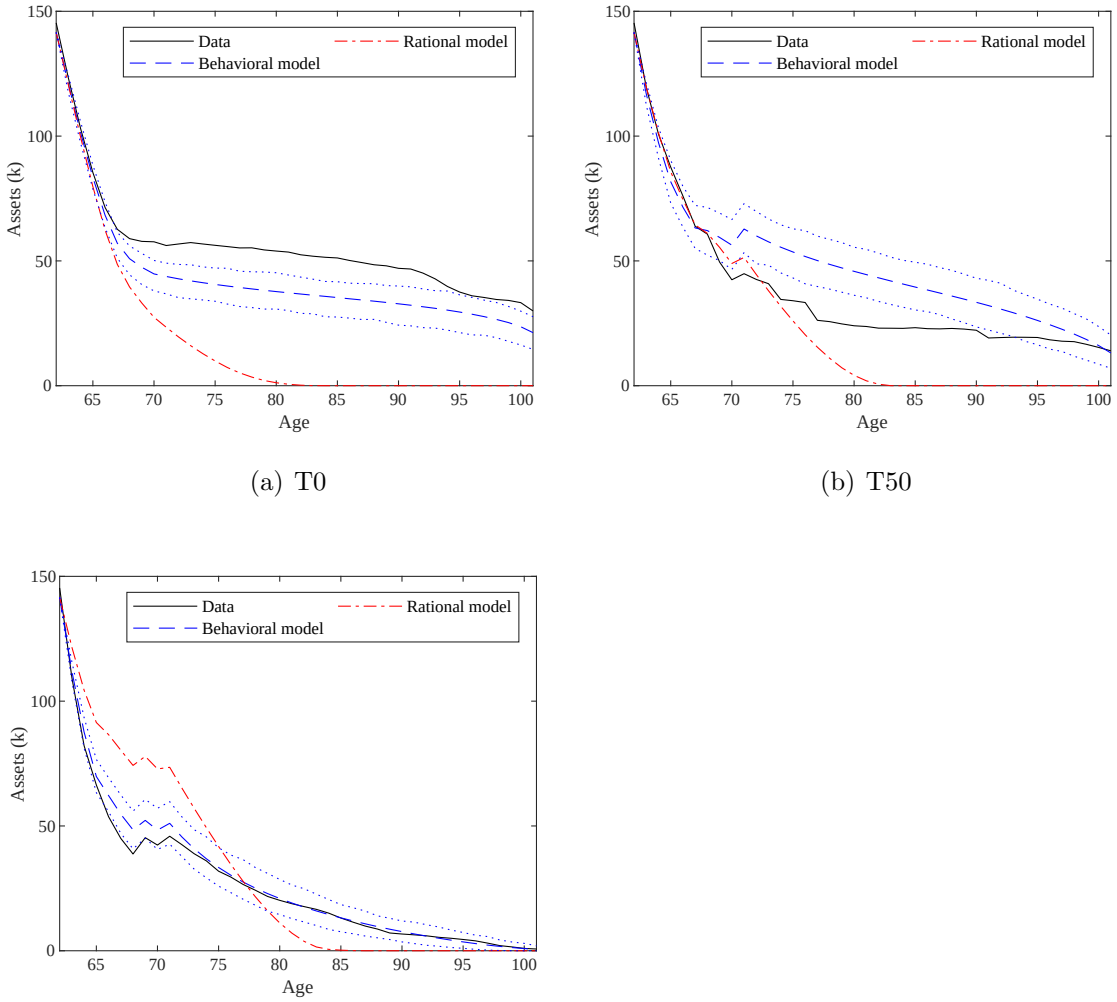
Table 8: Median expected lifetime utility in S1

	Median|Claiming			Opt|68			
	Data	Behavioral	Rational	Rational	(1)-(4)	(2)-(4)	(3)-(4)
	(1)	(2)	(3)	(4)	(5)	(6)	(7)
T0	13.84	13.96	16.52	16.98	-3.14	-3.02	-0.46
		[13.41,14.54]					
T50	12.48	12.25	15.80	16.44	-3.95	-4.19	-0.64
		[11.74,12.66]					
T100	12.04	12.09	15.33	15.57	-3.52	-3.48	-0.24
		[11.77,12.41]					

Notes: Bootstrapped 95% confidence intervals in square brackets. Column (4) reports the unconditional optimum predicted by the rational choice model

behavioral model and the rational choice model—conditional on claiming age. As detailed in Appendix D, we conduct model simulations by randomly assigning claiming age based on the data distribution for each treatment, making the analysis conditional on the claiming patterns of our small sample. Figure 12 illustrates that, across all three treatments, the behavioral model generates an average asset profile that is closer to the data than the rational choice model. Notably, among three key model features, random attention is the sole mechanism contributing to slower decumulation of assets. For treatments T0 and T50, the experimental means fall outside the 95% confidence intervals produced by the behavioral model for an extended period. This divergence primarily stems from a small difference in consumption levels during early periods, which subsequently impacts asset holdings for all remaining periods. As shown in Appendix Figure C7, with a few exceptions, experimental means of log consumption conditional on claiming age mostly fall within the 95% confidence intervals produced by the behavioral model.

Finally, to shed light on **Finding 4**, we compare the expected lifetime utility observed in the data with that predicted by two competing models. We focus on analyzing median values, since there are always a few subjects



(a) T0

(b) T50

(c) T100

Note: This figure displays the data average assets (solid line) and that predicted by two alternative models. The dotted lines represent the 95% confidence interval, constructed using the bootstrap method explained in Appendix D.

Figure 12: S1 Data Assets and Model Predictions | Claiming Age

performing very poorly in every treatment (see Figure 7), and median values are less impacted by these extremes. As reported in Columns 1-3 of Table 8,

the data medians closely match the median expected lifetime utility predicted by our behavioral model, with both consistently lower than the medians generated by the rational choice model.

5.4 Robustness Check

We perform two sets of robustness checks with alternative heuristic rules and restricted subsamples. The heuristic rule in the baseline behavioral model avoids spending the lump-sum payment and pre-specifies the fraction of assets consumed before and after claiming. In the first set of robustness checks, we relax these assumptions and instead use and estimate the following heuristic rule:

$$c_{ij}^{h}(a_{ij}, k_i) = \begin{cases} \min\{ss(k_i, k_{i+1}), \hat{c}(k_i)\} + \zeta_2 a_{ij} & \text{if } j < k_i \\ ss(k_i, k_{i+1}) + \zeta_1[ss(k_i, j) - ss(k_i, k_{i+1})] + \zeta_3 a_{ij} & \text{otherwise} \end{cases}$$

where $[ss(k_i, j) - ss(k_i, k_{i+1})]$ represents the one-time lump-sum payment received when claiming benefits in T50 and T100, and ζ_1 captures the average fraction of lump-sum payments consumed in the period of claiming. Additionally, ζ_2 and ζ_3 represent the fractions of assets consumed before and after claiming, respectively. The baseline heuristic rule assumes $\zeta_1 = \zeta_2 = 0$ and $\zeta_3 = r = 0.027$ (see Equation (6)). We sequentially introduce these three additional parameters, initially incorporating only ζ_1 and subsequently adding all three. As reported in Appendix Table C4, the estimated ζs closely align with the baseline restricted values. However, these alternative heuristic rules yield higher Bayesian information criterion (BIC) numbers, indicating a potential risk of over-fitting.

In our experiments, subjects sometimes select their default consumption level, mirroring habitual consumption observed in the real world. Moreover, for subjects with no assets, their heuristic rule is the same as the solution to the rational choice model and the revised intertemporal problem with mis-

perceived probabilities. To assess the impact of these complicating factors on estimated parameters, in the second set of robustness checks, we re-estimate our baseline model on three subsamples by separately excluding: 1) those with current-period consumption equal to the default but not their heuristic rule; 2) those with current-period starting assets less than 1k; and 3) those with current-period starting assets less than 10k. As shown in columns (5)-(7) of Appendix Table C5, these sample restrictions result in minimal changes to the point estimates. With the exception of, σ, the standard deviation of the consumption errors. all other estimates fall within the 95% confidence interval from the full sample. The estimate for σ is smaller for those opting out of the default (column 5), and greater for those with more assets (columns 6-7).

6 Conclusions

In our life-cycle experiment investigating Social Security claiming and retirement consumption-savings decisions, we implement three treatments that vary by the allocation of lump-sum payments versus greater annuities as rewards for delayed claims. Despite all adjustments being calibrated as actuarially fair, we find that expected lifetime utility is significantly higher in the treatment that rewards delayed claim with a greater annuity than in the two treatments that reward delayed claim with partial or fully lump-sum payments. Overall, we identify four key findings that are inconsistent with the rational choice model. To reconcile these inconsistencies, we develop a behavioral model that incorporates random attention, probability misperception, and noisy signals.

The primary contribution of this paper lies in offering novel behavioral explanations that illuminate two long-standing retirement puzzles: the tendency for early claiming of Social Security benefits and the retirement savings puzzle. Among the three key features of our behavioral model, random atten-

tion to the intertemporal problem emerges as the primary mechanism responsible for the slow decumulation of assets in retirement; while the combination of probability misperception and noisy signals accounts for the observed early claiming behavior.

That said, our simplified model may *not* provide a conclusive message on the best incentive scheme for rewarding delayed claims, because our experimental environment abstracts from several real-life considerations, such as retirement decisions, joint household couples, state-dependent utility, and the need for debt repayment. Instead, we view our study as a first small step in exploring behavioral biases in the retirement phase. Our paper is not the final word on the subject matter rather provides insights and avenues for future research. Extensions of our experimental framework can include incorporating retirement decisions, introducing health risks, and modifying the induced utility function to account for health-dependent utility or bequest motive. We leave these extensions for future studies.

References

Arifovic, Jasmina and John Duffy, "Heterogeneous agent modeling: experimental evidence," in C. Hommes and B LeBaron, eds., *Handbook of Computational Economics*, Vol. 4, Elsevier, 2018, pp. 491–540.

Behaghel, Luc and David M Blau, "Framing social security reform: Behavioral responses to changes in the full retirement age," *American Economic Journal: Economic Policy*, 2012, *4* (4), 41–67.

Brady, Richard L and John Rehbeck, "Menu-dependent stochastic feasibility," *Econometrica*, 2016, *84* (3), 1203–1223.

Brown, Jeffrey R, Arie Kapteyn, and Olivia S Mitchell, "Framing and Claiming: How Information-F Raming Affects Expected Social Security Claiming Behavior," *Journal of Risk and Insurance*, 2016, *83* (1), 139–162.

Cattaneo, Matias D, Xinwei Ma, Yusufcan Masatlioglu, and Elchin Suleymanov, "A random attention model," *Journal of Political Economy*, 2020, *128* (7), 2796–2836.

Chen, Daniel L, Martin Schonger, and Chris Wickens, "oTree—An open-source platform for laboratory, online, and field experiments," *Journal of Behavioral and Experimental Finance*, 2016, *9*, 88–97.

Duffy, John and Yue Li, "Lifecycle consumption under different income profiles: Evidence and theory," *Journal of Economic Dynamics and Control*, 2019, *104*, 74–94.

__ **and** __ , "Do Tax Deferred Accounts Improve Lifecycle Savings? Experimental Evidence," Working paper 2021.

Fréchette, Guillaume R and Sevgi Yuksel, "Infinitely repeated games in the laboratory: Four perspectives on discounting and random termination," *Experimental Economics*, 2017, *20* (2), 279–308.

Frederick, Shane, "Cognitive reflection and decision making," *Journal of Economic Perspectives*, 2005, *19* (4), 25–42.

French, Eric, John Bailey Jones, and Rory McGee, "Why Do Retired Households Draw Down Their Wealth So Slowly?," *Journal of Economic Perspectives*, 2023, *37* (4), 91–113.

Gabaix, Xavier, "Behavioral inattention," in "Handbook of behavioral economics: Applications and foundations 1," Vol. 2, Elsevier, 2019, pp. 261–343.

Goda, Gopi Shah, Shanthi Ramnath, John B Shoven, and Sita Nataraj Slavov, "The financial feasibility of delaying Social Security: evidence from administrative tax data," *Journal of Pension Economics & Finance*, 2018, *17* (4), 419–436.

Horan, Sean, "Random consideration and choice: A case study of "default" options," *Mathematical Social Sciences*, 2019, *102*, 73–84.

Liebman, Jeffrey B and Erzo FP Luttmer, "The perception of Social Security incentives for labor supply and retirement: The median voter knows more than you'd think," *Tax Policy and the Economy*, 2012, *26* (1), 1–42.

__ **and** __ , "Would people behave differently if they better understood social security? Evidence from a field experiment," *American Economic Journal: Economic Policy*, 2015, *7* (1), 275–99.

Lusardi, Annamaria and Olivia S Mitchell, "Financial literacy around the world: an overview," *Journal of Pension Economics & Finance*, 2011, *10* (4), 497–508.

Manzini, Paola and Marco Mariotti, "Stochastic choice and consideration sets," *Econometrica*, 2014, *82* (3), 1153–1176.

Maurer, Raimond and Olivia S Mitchell, "Older peoples' willingness to delay social security claiming," *Journal of Pension Economics & Finance*, 2021, *20* (3), 410–425.

_ , _ , Ralph Rogalla, and Tatjana Schimetschek, "Will they take the money and work? People's willingness to delay claiming social security benefits for A lump sum," *Journal of Risk and Insurance*, 2018, *85* (4), 877–909.

Shoven, John B, Sita Slavov, and David A Wise, "Social Security Claiming Decisions: Survey Evidence," NBER Working Paper w23729 2017.

Toplak, Maggie E, Richard F West, and Keith E Stanovich, "Assessing miserly information processing: An expansion of the Cognitive Reflection Test," *Thinking & Reasoning*, 2014, *20* (2), 147–168.

Zhang, Hang and Laurence T Maloney, "Ubiquitous log odds: a common representation of probability and frequency distortion in perception, action, and cognition," *Frontiers in neuroscience*, 2012, *6*, 1.

Online Appendix

A Experimental Instructions and Screenshots

A.1 Instructions for T50

Welcome to this study in the economics of individual decision-making. You are guaranteed $10.00 for completing this study.

These instructions explain how you can earn additional amounts of money from the decisions that you make.

The study consists of two main tasks. After completing the second task you will be asked to complete a questionnaire. After you complete the questionnaire, one of the two tasks will be randomly chosen with equal probability and your earnings from the chosen task will be added to your $10.00 participation payment and paid out to you. Since you do not know in advance which of the two tasks will be chosen for payment, you will want to do your best in both tasks.

Please note that the experiment can take up to 2 hours to complete, though you may be able to complete it more quickly.

In the first decision task you make a sequence of consumption and savings decisions over the "retirement phase" of a lifecycle. This sequence consists of 40 "periods", corresponding to each year of a retirement lifetime from age 62 to age 101. Whether you continue to "survive" and make decisions from one period to the next depends on a predrawn random whole number between 1 and 100 (both inclusive), where each of the 100 numbers had an equal chance of being drawn. If the random number is strictly greater than the period specific survival cutoff, then you "die" and your earnings for the sequence are determined by your current, cumulative earnings over the lifecycle up to the period in the retirement phase when you die. Any remaining savings balances that you have as of that period will become worthless.

The survival cutoffs are displayed in the Table below. For instance, the cutoff for period 1 (age 62) is 96. This means that, if the random number drawn for period 1 is 97, 98, 99, or 100, then the sequence is over and your earnings for the sequence are determined by the amount of consumption you chose for the period 1 only. All future decisions do not affect your payment for the current sequence. If the random number drawn for period 1 (age 62) is between 1 and 96 (both inclusive), then you "survive" to the second period and your savings from period 1 carry over to that next period. Similarly, a cutoff of 92 for period 20 means that, conditional on living to period 20, if the random number for period 20 is either 93, 94, 95, 96, 97, 98, 99, or 100, then period 20 is the last period that you would accumulate payments for consumption choices in the sequence and all future decisions do not affect your payment for the sequence. The results of all draws will be revealed to you only at the end of the sequence. This means that you will not know whether the sequence has ended until after you have completed all 40 periods of the sequence.

Period	Corresponding age	Cutoff	Expected periods remaining	Period	Corresponding age	Cutoff	Expected periods remaining
1	62	96	16.09	21	82	91	7.37
2	63	96	15.72	22	83	91	7
3	64	96	15.33	23	84	90	6.59
4	65	96	14.93	24	85	89	6.22
5	66	96	14.51	25	86	88	5.86
6	67	96	14.07	26	87	87	5.52
7	68	96	13.62	27	88	86	5.2
8	69	96	13.14	28	89	85	4.88
9	70	96	12.65	29	90	83	4.57
10	71	95	12.13	30	91	82	4.3
11	72	95	11.72	31	92	80	4.02
12	73	95	11.28	32	93	79	3.78
13	74	95	10.83	33	94	77	3.52
14	75	94	10.34	34	95	75	3.27
15	76	94	9.94	35	96	73	3.02
16	77	94	9.51	36	97	71	2.77
17	78	93	9.05	37	98	70	2.49
18	79	93	8.66	38	99	68	2.14
19	80	93	8.24	39	100	67	1.67
20	81	92	7.78	40	101	0	1

Note: that the "Expected periods remaining" is based on the cutoff numbers and includes the current period, which has a survival probability of 1. The displayed cutoff numbers reflect both real life mortality risk and intertemporal discounting of amounts received in the future.

You enter the first period of retirement with an initial, lump-sum, one-time savings endowment of 145,350 "points". You can think of this as the amount that you saved during your working years for your retirement. You are also entitled to Social Security benefits paid per period, also in points. Social security benefits are composed of two amounts: 1) an annuity amount that increases with your claiming age, and 2) a one-time lump-sum amount that also increases with claiming age and that is paid out only in the year/period of claiming benefits. As shown in the table below, the amount of Social Security benefits and lump-sum benefits you receive each period depends on when you start claiming those Social Security benefits, between ages 62-70 or periods 1-9. You receive zero Social Security benefits before claiming, and after claiming benefits you receive the one-time lump-sum payment and the same per period (annual) benefit for all remaining periods of the sequence (conditional on "survival"). The benefit formula is designed so that on average, the Social Security system will neither lose nor make money regardless of when you start to claim benefits. In addition to deciding when to claim Social Security benefits, your other main task in each period is to choose how much of your available points to convert into current period consumption or "money"; the remaining point balance is automatically saved for

consumption use in future periods.

Claiming age	Claiming period	Annual Benefit after claiming	Lump Sum in claiming period	Total in claiming period
62	1	14887	0	14887
63	2	15376	7725	23101
64	3	15913	15744	31657
65	4	16502	24112	40614
66	5	17153	32812	49965
67	6	17873	41912	59785
68	7	18672	51449	70121
69	8	19564	61457	81021
70	9	20563	71999	92562

The following table presents the above information in an alternative manner. Your per-period Social security benefit depends on when you claim it. After you claim it, you will get the same SSB amount in every subsequent period. Your SSB benefit in all periods until you claim it is 0 as depicted by the blanks in the table.

Claiming period		1	2	3	4	5	6	7	8	9
SSB at age	SSB in period	Per period social security benefit								
62	1	14887								
63	2	14887	23101							
64	3	14887	15376	31657						
65	4	14887	15376	15913	40614					
66	5	14887	15376	15913	16502	49965				
67	6	14887	15376	15913	16502	17153	59785			
68	7	14887	15376	15913	16502	17153	17873	70121		
69	8	14887	15376	15913	16502	17153	17873	18672	81021	
70	9	14887	15376	15913	16502	17153	17873	18672	19564	92562
71+	10+	14887	15376	15913	16502	17153	17873	18672	19564	20563

Your earnings for each period depend on your consumption choice, which is the number of points you choose to convert into money for that period. What you don't consume is saved, and your savings can matter for the number of points that you can convert into money (or consume) in future periods. As shown in the table below, your savings earn 2.7% interest each period, paid out in additional points.

Ending period savings for current period	Interest Earned between periods	Beginning period savings for next period
0	0	0
5,000	135	5,135
10,000	270	10,270
15,000	405	15,405
20,000	540	20,540
25,000	675	25,675
30,000	810	30,810
35,000	945	35,945
40,000	1080	41,080
45,000	1215	46,215
50,000	1350	51,350
55,000	1485	56,485
60,000	1620	61,620
65,000	1755	66,755
70,000	1890	71,890
75,000	2025	77,025
80,000	2160	82,160
85,000	2295	87,295
90,000	2430	92,430
95,000	2565	97,565
100,000	2700	102,700
200,000	5400	205,400
400,000	10800	410,800
800,000	21600	821,600
1,600,000	43200	1,643,200

Beginning balance = Ending balance of last period $\times$ 1.027

You will be given tables and figures showing the relationship between consumption choices in each period and money earned, and the slider used to make choices on your decision screen also calculates your period earnings from your consumption choice. The

precise formula is as follows:

$$\text{Earnings} = [1 - e^{-(\frac{\text{consumption}-14887}{20000})}] \times 3$$

Note the following:

1. The greater the consumption you choose, the greater are your earnings for that period, but the less income/points you will have for future periods.
2. The money you earn from consumption is proportionally diminishing; the difference in your earnings from consuming 25,000 rather than 20,000 points is larger than the difference from consuming 30,000 rather than 25,000 points, and so on.
3. To avoid negative payoffs, you will never be able to consume less than 14887 points in any period. You can think of this as the minimum consumption expenditure you need in order to live. Your choices will be restricted so that you can never consume less than 14887 points.

For periods 1 to 8, you will be asked whether you want to claim Social Security Benefits if you have not yet done so. You will be forced to claim benefits in the current period, if your available points are not sufficient to cover the minimum of consumption of 14887 or if you enter into period 9 (age 70), the period when annual benefits will stop growing with further claiming delays. In addition, each period you are asked to submit how much you want to consume. The remaining amount will be saved. Once you move the slider to a particular consumption choice, the computer will calculate for you your current period earnings from consumption and your end of period savings using the following formula:

If you have claimed Social Security benefits:
Savings at the end of current period = Savings at the beginning of the current period + Total Social Security payments - consumption

If you have not yet claimed Social Security benefits:
Savings at the end of current period = Savings at the beginning of the current period - consumption

Given the method for determining savings at the end of the current period, your savings for the beginning of the next period is determined by the formula:
Savings at the beginning of the next period = Savings at the end of the current period $\times$ (1.027)

Following the first period of a sequence, and in every period thereafter, you will be reminded of your social security benefit amount (the amount is 0 if you have not yet claimed benefits), your beginning period savings, your consumption amount, your end of period savings, the money (consumption) earned for the period, and your cumulative money earned for the sequence.

Recall that whether you continue to "survive" from one period to the next depends on a pre-drawn random whole number between 1 and 100 (both inclusive), where each of the 100 numbers had an equal chance of being drawn. You will be informed about the termination period in the 40-period sequence only after all 40 periods have been played. The listed cumulative money earned on the information screen, is assuming that the random draw is always at or below the period threshold. If the random draw is above

the period threshold, then all periods after that draw will be excluded from your final payment for the sequence.

After this first task is completed, you will receive instructions for the second task. Your earnings from the first or second task determine how much additional money you earn in the experiment (above your $7.00 participation payment). You can never earn less than $0 from the first or the second task of the experiment.

There is a quiz on the next page based on the given instructions. There will be no 'Back button', so please make sure that you understand the instructions so far.

Quiz

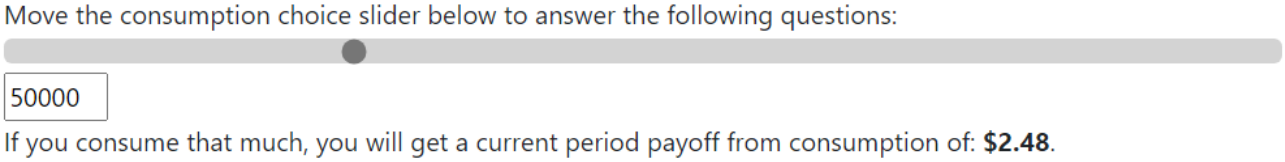
Before continuing on to the first part of the study, we ask that you successfully complete the following quiz (on this and next page). If you get an answer wrong, you will be told so, and you will have the opportunity to correct your answer. Your performance on this quiz does not affect your payoff in any way, but you will not be able to proceed to the first task until you have correctly answered all of the quiz questions.

In answering these quiz questions, you may consult the table provided below.

Claiming age	Claiming period	Annual Benefit after claiming	Lump Sum in claiming period	Total in claiming period
62	1	14887	0	14887
63	2	15376	7725	23101
64	3	15913	15744	31657
65	4	16502	24112	40614
66	5	17153	32812	49965
67	6	17873	41912	59785
68	7	18672	51449	70121
69	8	19564	61457	81021
70	9	20563	71999	92562

In the first task I will make decisions in a sequence of [Answer: 40] periods.

Suppose you claim Social Security benefits at age 64. The amount of social security payments you receive at age 62 is [Answer: 0] . The amount of social security payments you receive at age 64 is [Answer: 31657] . The amount of social security payments you receive at age 80 is [Answer: 15913].



Suppose you consumed 15,000, you earnings for current period is $ [Answer: 0.02].

Suppose you consumed 20,000, you earnings for current period is $ [Answer: 0.68].

Suppose you consumed 25,000, you earnings for current period is $ [Answer: 1.19].

Please answer the following questions.

If you get an answer wrong, you will be told so, and you will have the opportunity to correct your answer. Your performance on this quiz does not affect your payoff in any way, but you will not be able to proceed to the first task until you have correctly answered all of the quiz questions.

The interest rate is 2.7%. Suppose at the end of the current period, your savings is 10000, how much interest you will earn on this saving in the next period? [Answer: 270]

True or False: The length of the "living" periods depends on a sequence of random draws. Earnings will stop being accumulated once the draw is above the period specific cut-off (see the table below). But you will continue to make decisions until the end of 40 periods. [Answer: True]

Conditional on living to period 10, earnings will stop being accumulated after period 10 if you draw which one of the following numbers?

A. 94,95,96,97,98,99,100

B. 95,96,97,98,99,100

C. 96,97,98,99,100 [Answer]

D. 1,2,...,94

E. 1,2,...,95

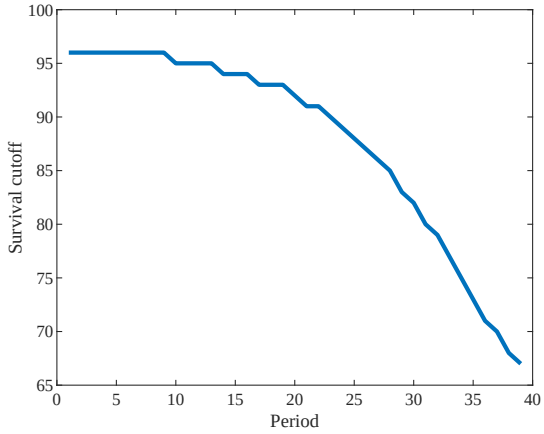
Life table is listed on the this quiz page but not copied here to save space.

Which one of the following formulae incorrectly describes the relationship between beginning period savings and ending period savings?

- For those who have claimed Social Security benefits: Savings at the end of current period = Savings at the beginning of the current period + Total Social Security payments - consumption
- For those who have not yet claimed Social Security benefits: Savings at the end of current period = Savings at the beginning of the current period - consumption
- Savings at the beginning of the next period = Savings at the end of current period $\times$ (1.027)
- Savings at the beginning of the next period = Savings at the end of current period [Answer]

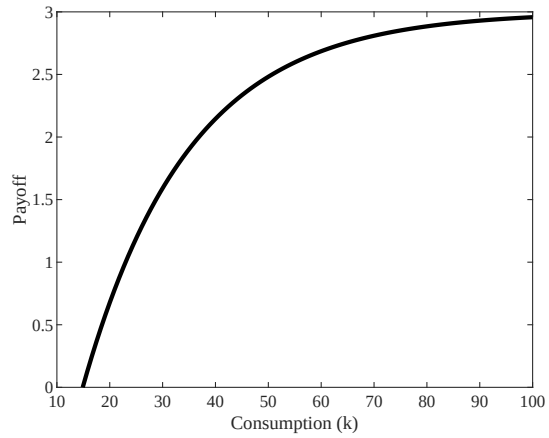
True or False: Your earnings will depend on your cumulative money earnings from one of the two tasks you play, but you will not know which task will be chosen until the end of the session. [Answer: True]

A.2 Handouts on continuation probability and utility function



Note: Period 40 is the last period, and it has a survival cutoff of 0 (not shown)

Figure 1: Survival cutoff



Note: Payoff function is $3 \times (1 - e^{-(c-14887)/20000})$, where c is the consumption choice.

Figure 2: Payoff function

Table 1: Survival cutoff

Period	Survival Cutoff	Expected periods remaining	Period	Survival Cutoff	Expected periods remaining
1	96	16.09	21	91	7.37
2	96	15.72	22	91	7.00
3	96	15.33	23	90	6.59
4	96	14.93	24	89	6.22
5	96	14.51	25	88	5.86
6	96	14.07	26	87	5.52
7	96	13.62	27	86	5.20
8	96	13.14	28	85	4.88
9	96	12.65	29	83	4.57
10	95	12.13	30	82	4.30
11	95	11.72	31	80	4.02
12	95	11.28	32	79	3.78
13	95	10.83	33	77	3.52
14	94	10.34	34	75	3.27
15	94	9.94	35	73	3.02
16	94	9.51	36	71	2.77
17	93	9.05	37	70	2.49
18	93	8.66	38	68	2.14
19	93	8.24	39	67	1.67
20	92	7.78	40	0	1.00

Note: "Expected periods remaining" is calculated based on the cutoffs and includes the current period. The displayed cutoff numbers reflect both real life mortality risk and intertemporal discounting of amounts received in the future.

A.3 Screenshots for T50

In task 2 we repeat task 1.

The rules are the same as before; that is, you make a series of consumption/savings decisions over 40 periods, not knowing how long you live over that period.
The survival chances from one period to the next are the same as before.
You also have to decide when to start claiming social security benefits in the first 9 periods (ages 62-70).
As in the first sequence of 40 periods, you will not know until the end, the period in which you "die". Your cumulative earnings up to that period will comprise your earnings for task 2.

After you complete task 2, we will randomly determine with equal probability, whether task 1 or task 2 is selected for payment.

You will then be asked to complete a questionnaire. After completing the questionnaire, you will be paid your total earnings for the experiment ($7.00 participation payment plus earnings from task 1 or task 2).

Next

Task 2, period 1

Your age is 62.
Your current saving is 145350.00 points points.

As shown in the below table, the amount of Social Security benefits you would receive each period will depend on when you claim the benefit. You will receive zero Social Security benefits before claiming, and receive the same annual benefits since claiming. The benefit formula is designed that on average, the Social Security system will neither lose nor make money no matter when benefits are claimed.

Claiming age	Claiming period	Annual Benefit after claiming	Lump Sum in claiming period	Total in claiming period
62	1	14887	0	14887
63	2	15376	7725	23101
64	3	15913	15744	31657
65	4	16502	24112	40614
66	5	17153	32812	49965
67	6	17873	41912	59785
68	7	18672	51449	70121
69	8	19564	61457	81021
70	9	20563	71999	92562

Do you want to claim benefits this period?

- ○ Yes
- ○ No

Next

Task 2, period 1

Your age is 62.
Your total available points for consumption: 145350.00 points

Use the slider or insert numbers below to choose and submit your choice of consumption in this period.

If you do not make a choice, the default value of 14887.00 points will be used. This default will be updated each period to match your choice in the previous period (unless this is not a feasible option).

Consumption in this period: 30072 points.

If you consume that much, you will get a payoff this period of: **$1.60**
Your ending period savings is **115278.00 points** (available points – consumption).
After crediting interest, your savings for the next period is **118390.51 points** (ending balance * 1.027).
The highest payoff you could get from consumption this period is: **$3.00**

Submit Consumption Choice

Results of Task 2, period 1

Your beginning period savings:	145350.00 points
Your social security benefits:	0.00 points
Your consumption this period:	30072.00 points
Your ending period savings:	115278.00 points
Money earned this period:	$1.6
Money earned this sequence (assuming the sequence was not terminated):	$1.6

Next

History of results

Task	Period	Beginning Savings	Social Security Benefit	Consumption	Ending Savings	Period Payoff	Cumulative Payoff
2	1	145350.00 points	0.00 points	30072.00 points	115278.00 points	$1.6	$1.6

Task 2, period 2

Your age is 63.
Your current saving is 118390.51 points points.

As shown in the below table, the amount of Social Security benefits you would receive each period will depend on when you claim the benefit. You will receive zero Social Security benefits before claiming, and receive the same annual benefits since claiming. The benefit formula is designed that on average, the Social Security system will neither lose nor make money no matter when benefits are claimed.

Claiming age	Claiming period	Annual Benefit after claiming	Lump Sum in claiming period	Total in claiming period
63	2	15376	7725	23101
64	3	15913	15744	31657
65	4	16502	24112	40614
66	5	17153	32812	49965
67	6	17873	41912	59785
68	7	18672	51449	70121
69	8	19564	61457	81021
70	9	20563	71999	92562

Do you want to claim benefits this period?

- ○ Yes
- ○ No

Next

Task 2, period 2

Your age is 63.
Your total available points for consumption: 141491.51 points (Last period's ending balance of 115278.00 points * 1.027 + Social Security benefit of 23101.00 points including the annual benefit of 15376.00 points and a one-time lumpsum in this period of 7725.00 points).

Use the slider or insert numbers below to choose and submit your choice of consumption in this period.

If you do not make a choice, the default value of 30072.00 points will be used. This default will be updated each period to match your choice in the previous period (unless this is not a feasible option).

Consumption in this period: 32529 points.

If you consume that much, you will get a payoff this period of: **$1.76**
Your ending period savings is **108962.51 points** (available points – consumption).
After crediting interest, your savings for the next period is **111904.50 points** (ending balance * 1.027).
The highest payoff you could get from consumption this period is: **$2.99**

Submit Consumption Choice

Results of Task 2, period 2

Your beginning period savings:	118390.51 points
Your social security benefits:	23101.00 points
Your consumption this period:	32529.00 points
Your ending period savings:	108962.51 points
Money earned this period:	$1.76
Money earned this sequence (assuming the sequence was not terminated):	$3.36

Next

History of results

Task	Period	Beginning Savings	Social Security Benefit	Consumption	Ending Savings	Period Payoff	Cumulative Payoff
2	2	118390.51 points	23101.00 points	32529.00 points	108962.51 points	$1.76	$3.36
2	1	145350.00 points	0.00 points	30072.00 points	115278.00 points	$1.6	$1.6

Task 2, period 3

Your age:	64
Your savings (including interest):	111904.50 points points

You have already claimed your social security benefits.

Your social security amount per period:	15376.00 points points

Next

Task 2, period 3

Your age is 64.
Your total available points for consumption: 127280.50 points (Last period's ending balance of 108962.51 points * 1.027 + Social Security benefit of 15376.00 points).

Use the slider or insert numbers below to choose and submit your choice of consumption in this period.

If you do not make a choice, the default value of 32529.00 points will be used. This default will be updated each period to match your choice in the previous period (unless this is not a feasible option).

Consumption in this period: 33865 points.

If you consume that much, you will get a payoff this period of: **$1.84**
Your ending period savings is **93415.50 points** (available points – consumption).
After crediting interest, your savings for the next period is **95937.72 points** (ending balance * 1.027).
The highest payoff you could get from consumption this period is: **$2.99**

Submit Consumption Choice

Results of Task 2, period 3

Your beginning period savings:	111904.50 points
Your social security benefits:	15376.00 points
Your consumption this period:	33865.00 points
Your ending period savings:	93415.50 points
Money earned this period:	$1.84
Money earned this sequence (assuming the sequence was not terminated):	$5.2

Next

History of results

Task	Period	Beginning Savings	Social Security Benefit	Consumption	Ending Savings	Period Payoff	Cumulative Payoff
2	3	111904.50 points	15376.00 points	33865.00 points	93415.50 points	$1.84	$5.2
2	2	118390.51 points	23101.00 points	32529.00 points	108962.51 points	$1.76	$3.36
2	1	145350.00 points	0.00 points	30072.00 points	115278.00 points	$1.6	$1.6

B End of Experiment Tasks (All Treatments)

The experiment concluded with five additional tasks, reproduced here.

Task 1: Preferences

We now ask about your willingness to act in a certain ways. Please indicate your answer on the scale from 0 to 10, where 0 means you are "completely unwilling to do so" and a 10 means you are "very willing to do so".

1. In general, how willing are you to take risks?
2. How willing are you to give up something that is beneficial for you today in order to benefit more from that in the future?

Please answer the following questions.

1. At what age do you expect to die?
2. At what age do you plan to retire?
3. At what age do you plan to claim Social Security Benefits? (In answering this question, you may consult the table below which shows the benefit formula):

Claiming Age	Benefits
62	0.70*PIA
63	0.75*PIA
64	0.80*PIA
65	0.87*PIA
66	0.93*PIA
67	1.00*PIA
68	1.08*PIA
69	1.16*PIA
70	1.24*PIA

   where PIA stands for your primary insurance amount, which is determined by average earnings during your working years.

4. How confident are you that you will receive the Social Security Benefits that you are entitled to?
   - Not at all confident
   - Not very confident
   - Somewhat confident
   - Very confident

- Completely confident

Task 2: Lotteries

In this task you make 10 choices over pairs of "lotteries". Each pair of lotteries is labeled lottery A and lottery B. Each lottery describes two different possible dollar amounts that you could earn with an equal (50%) probability.
For each pair of lotteries, you must choose whether you prefer lottery A or lottery B for possible payment. You may choose lottery A for some choices and lottery B for other choices and you may change your decisions or make them in any order that you want. Once you have made a lottery choice for all 10 pairs and clicked the Next button, the computer program will randomly select one of the 10 lottery pairs and implement your choice for that pair. It will then randomly determine whether you got the lower amount or the higher amount for that lottery, each with a 50% chance.

1. Lottery A: 50% chance of \$0.75, 50% chance of \$0.83; Lottery B: 50% chance of \$0.15, 50% chance of \$1.16: Choose: A, B
2. Lottery A: 50% chance of \$0.75, 50% chance of \$0.91; Lottery B: 50% chance of \$0.15, 50% chance of \$1.32: Choose: A, B
3. Lottery A: 50% chance of \$0.75, 50% chance of \$0.99; Lottery B: 50% chance of \$0.15, 50% chance of \$1.47: Choose: A, B
4. Lottery A: 50% chance of \$0.75, 50% chance of \$1.07; Lottery B: 50% chance of \$0.15, 50% chance of \$1.63: Choose: A, B
5. Lottery A: 50% chance of \$0.75, 50% chance of \$1.15; Lottery B: 50% chance of \$0.15, 50% chance of \$1.8: Choose: A, B
6. Lottery A: 50% chance of \$0.75, 50% chance of \$1.23; Lottery B: 50% chance of \$0.15, 50% chance of \$2.01: Choose A, B
7. Lottery A: 50% chance of \$0.75, 50% chance of \$1.31; Lottery B: 50% chance of \$0.15, 50% chance of \$2.29: Choose A, B
8. Lottery A: 50% chance of \$0.75, 50% chance of \$1.39; Lottery B: 50% chance of \$0.15, 50% chance of \$2.69: Choose A, B
9. Lottery A: 50% chance of \$0.75, 50% chance of \$1.47; Lottery B: 50% chance of \$0.15, 50% chance of \$3.65: Choose A, B
10. Lottery A: 50 chance of \$0.75, 50% chance of \$1.55; Lottery B: 50% chance of \$0.15, 50% chance of \$3.85: Choose A, B

Task 3 Quiz [Cognitive Reflection Test] Questions [with Answers not provided to subjects.]

Please answer the following questions.

1. If John can drink one barrel of water in 6 days, and Mary can drink one barrel of water in 12 days, how many days would it take them to drink one barrel of water together? [Answer: 4 days]
2. Jerry received both the 15th highest and the 15th lowest mark in the class. How many students are in the class? [Answer: 29]
3. A man buys a pig for $60, sells it for $70, buys it back for $80, and sells it finally for $90. How many dollars has he made? [Answer: $20]
4. Simon decided to invest $8,000 in the stock market one day early in 2008. Six months after he invested, on July 17, the stocks he had purchased were down 50%. Fortunately for Simon, from July 17 to October 17, the stocks he had purchased went up 75%. As of October 17, Simon has: [Answer: a]

    a lost money in the stock market

    b broken even in the stock market

    c made money in the stock market

Task 4 [Financial Literacy] Quiz Questions [With answers not shown to subjects]

1. Suppose you had $100 in a savings account and the interest rate was 2% per year. After 5 years, how much do you think you would have in the account if you left the money to grow?

    a More than $102

    b Exactly $102

    c Less than $102

    d Do not know

    e Refuse to answer.

    [Answer: a]

2. Imagine that the interest rate on your savings account was 1% per year and inflation was 2% per year. After 1 year, how much would you be able to buy with the money in this account?

    a More than today

    b Exactly the same

    c Less than today

    d Do not know

    e Refuse to answer.

    [Answer: c]

3. Please consider whether this statement is true or false. "Buying a single company's stock usually provides a safer return than a stock mutual fund."

   a True

   b False

   c Do not know

   d Refuse to answer.

   [Answer: False]

Task 5: Questionnaire

What is your age?

What year were you born?

What is your gender?

What is your race?

What is your personal annual income?

What is your highest level of education completed?

What is your ZIP or postal code?

Please enter any comments about the experiment, or suggestions for improvement.

C Additional Tables and Figures

Table C1: Comparison of T1 with Social Security rules for 1960 and later birth cohorts

Claiming age	62	63	64	65	66	67	68	69	70
T1	0.71	0.76	0.81	0.87	0.93	1.00	1.08	1.16	1.26
SS rules	0.70	0.75	0.80	0.87	0.93	1.00	1.08	1.16	1.24

Note: Table reports the benefit levels for different claiming ages relative to FRA of 67.

D Numerical method

Numerical method for estimating the behavioral model

1. Guess a vector of model parameters $\theta = [\eta, p_0, \alpha_1, \alpha_2, \alpha_3, \alpha_{T0}, \alpha_{T50}, \sigma]$
2. Given the guess of η, p_0 solve the revised consumer problem described in Section 5.
3. Utilizing the value functions solved in the previous step and the experimental data a_{ij}, k_i for subject i in period j, determine the conditional optimal consumption $\{c^*_{ij}\}$ and the heuristic rule $\{c^h_{ij}\}$
4. Calculate the likelihood of observing subject i choose consumption c_{ij} in period j, using the following formula:

$$\mathcal{L}(c_{ij}) = \frac{\mu^t_j}{\sigma}\varphi(\frac{\log c_{ij} - \log c^*_{ij}}{\sigma}) + \frac{1-\mu^t_j}{\sigma}\varphi(\frac{\log c_{ij} - \log c^h_{ij}}{\sigma})$$

   where φ denotes the standard normal probability density function. The log likelihood of the entire sample is the sum of the logs of the likelihood across periods and across subjects:

$$\hat{\theta} = \arg\max_{\theta} \sum_i \sum_{j=1}^{J} \log \mathcal{L}(c_{ij})$$

5. Find $\hat{\theta}$ that maximizes this log likelihood, providing the point estimate for the behavioral model parameters
6. 95% confidence intervals are produced using bootstrapping method. Generate 200 bootstrap resamples from the data of sequence 1, and repeat steps 1-5 on each sample. Confidence intervals are constructed as the 2.5th and 97.5th percentiles from the distribution of the estimates based on bootstrap resamples.

Numerical method for simulating behavioral model predictions

Table C2: Predicted Mean and median claiming age using four alternative approaches

	Data	R	B	R mp	B mp
Panel A: Mean claiming age					
T0	66.1	67.1	68.6	65.0	66.7
T50	65.9	66.7	67.9	65.2	65.6
T100	65.2	65.9	65.6	65.2	64.5
Panel B: Median claiming age					
T0	66	67	69	65	67
T50	65	67	68	65	66
T100	65	66	66	65	64

Table C3: MSE of Log Consumption from Optimum | Claiming

	62-69	70-79	80-89	90-101	62-101
	(1)	(2)	(3)	(4)	(5)
Cons	0.11***	0.05***	0.03***	0.05***	0.06***
	(0.02)	(0.01)	(0.01)	(0.01)	(0.01)
T50	0.08***	0.08***	0.01	-0.01	0.04***
	(0.03)	(0.02)	(0.01)	(0.01)	(0.01)
T100	0.08**	0.06***	0.01	-0.03***	0.02**
	(0.03)	(0.02)	(0.02)	(0.01)	(0.01)
S2	-0.01	-0.01	0.00	-0.02***	-0.01*
	(0.02)	(0.01)	(0.01)	(0.01)	(0.01)
R^2	0.11	0.15	0.04	0.16	0.16

Note: This table presents estimates from Equation (5) by replacing the dependent variable with the MSE of log consumption from the optimum conditional on claiming age. The number of observations is 192. Standard errors are clustered at the subject level. *** p<0.01, ** p<0.05, and * p<0.10.

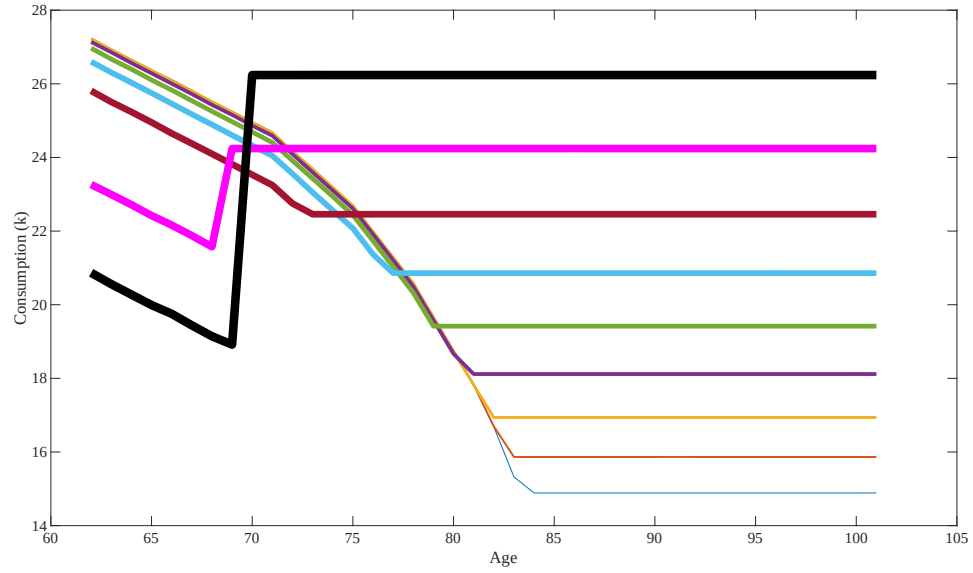
		Alternative spec.	
	Baseline	1	2
	(1)	(2)	(3)
η	0.0000	0.0000	0.0000
p_0	0.8175	0.8049	0.7966
α_1	1.3660	1.9012	1.8452
α_2	-0.2726	-0.3487	-0.3470
α_3	0.0064	0.0083	0.0083
α_{T0}	-1.9869	-2.3638	-2.6964
α_{T50}	-1.1869	-1.5632	-1.6213
ζ_1		0.0493	0.0349
ζ_2			0.0007
ζ_3			0.0321
σ	0.1723	0.1727	0.1736
Log Likelihood	689.30	691.78	693.88
AIC	-1362.59	-1365.55	-1365.76
BIC	-1312.57	-1309.28	-1296.98

Table C4: Model Estimates Under Alternative Heuristic Rules

		95% CI		Subsample that delete			
	Baseline	Lower	Upper	1/3	defaults	$< 1k$	$< 10k$
	(1)	(2)	(3)	(4)	(5)	(6)	(7)
η	0.0000	0.0000	0.1033	0.0788	0.0000	0.0000	0.0000
p_0	0.8175	0.7174	0.8532	0.7104	0.8156	0.8042	0.8042
α_1	1.3660	1.1030	1.8501	1.3127	1.7091	1.5349	1.4279
α_2	-0.2726	-0.3387	-0.2326	-0.3263	-0.2723	-0.3173	-0.2999
α_3	0.0064	0.0053	0.0082	0.0077	0.0066	0.0075	0.0072
α_{T0}	-1.9869	-2.5079	-1.6869	-1.7117	-2.2987	-2.3135	-2.4371
α_{T50}	-1.1869	-1.7239	-0.8774	-1.2858	-1.4939	-1.2927	-1.3382
σ	0.1723	0.1635	0.1812	0.1814	0.1644	0.2133	0.2412
Obs	7680			6400	6074	5209	3984

Table C5: Model Estimates for Various Sub-samples

1. Utilize the point estimates of behavioral model parameters to simulate the decisions for 100,000 individuals for each treatment and each claiming age, resulting in a total of 2.7m simulated individuals.
2. Compute the expected lifetime utility associated with different claiming age using the four alternative approaches detailed in Section 5. Utilize expected lifetime utility to calculate the CDF of claiming age and plot Figure 11 .
3. Apply the distribution of claiming age by treatment from sequence 1 and simulate the decisions for 100,000 individuals for each treatment. These are consistent with the data distribution of claiming age and the behavioral model predicted decisions conditional on claiming age.
4. Calculate the average life-cycle consumption path (shown in Figure **??**) and the expected lifetime utility (reported in Table 8) using the sample generated in the previous step.
5. Generate 95% confidence intervals using the bootstrapping method. Create 200 bootstrap resamples from our sample generated in step 1, ensuring that the number of observations for treatment and claiming age matches that observed in the data. Calculate the average life-cycle consumption path and the expected lifetime utility for each resample. Confidence intervals are constructed as the 2.5th and 97.5th percentiles from the distribution of the estimates based on bootstrap resamples.



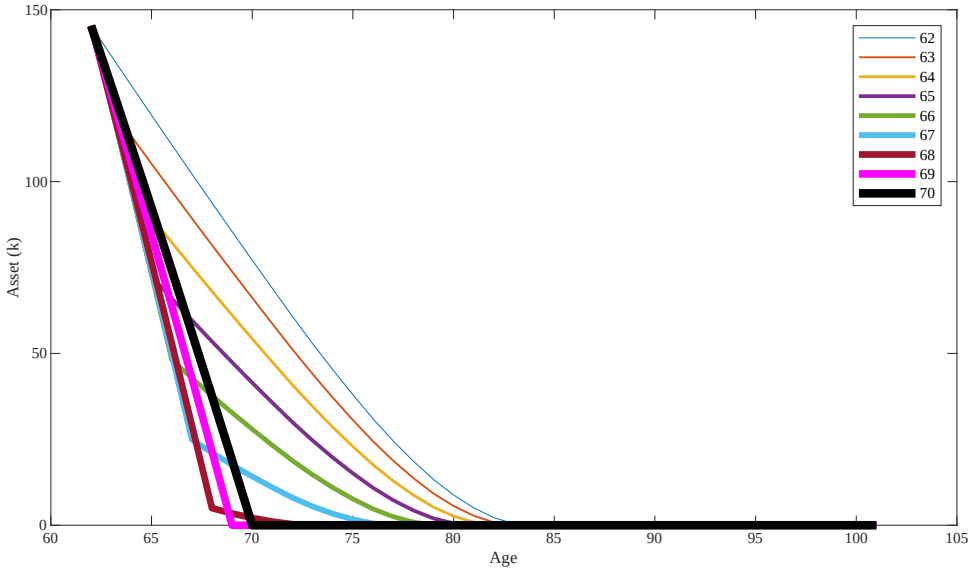
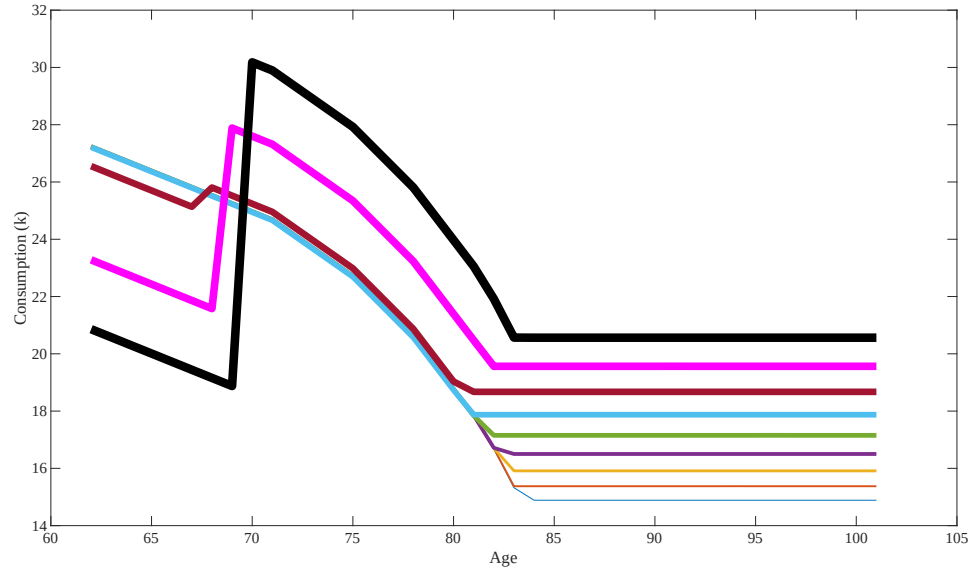


Figure C1: T0 optional decisions conditional on claiming age



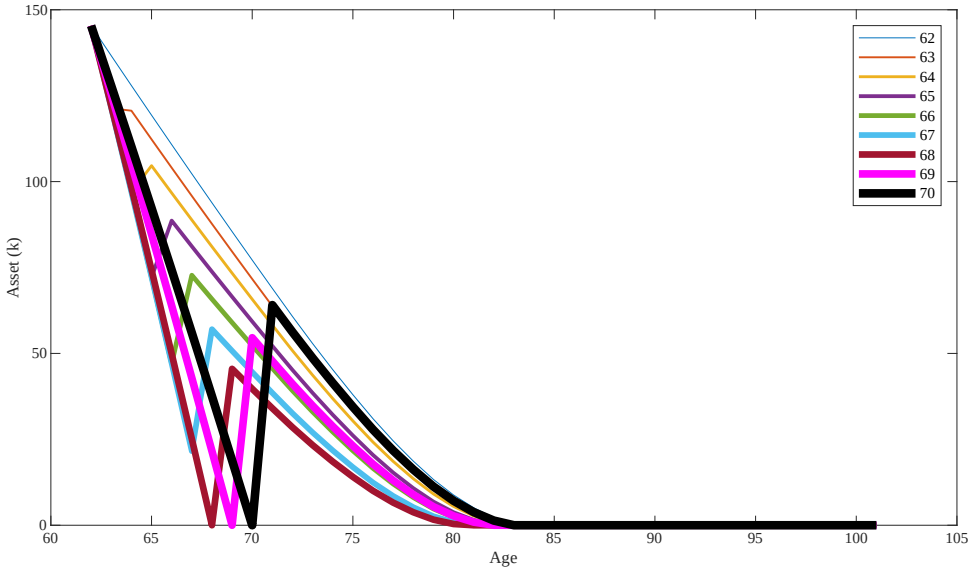


Figure C2: T50 optional decisions conditional on claiming age

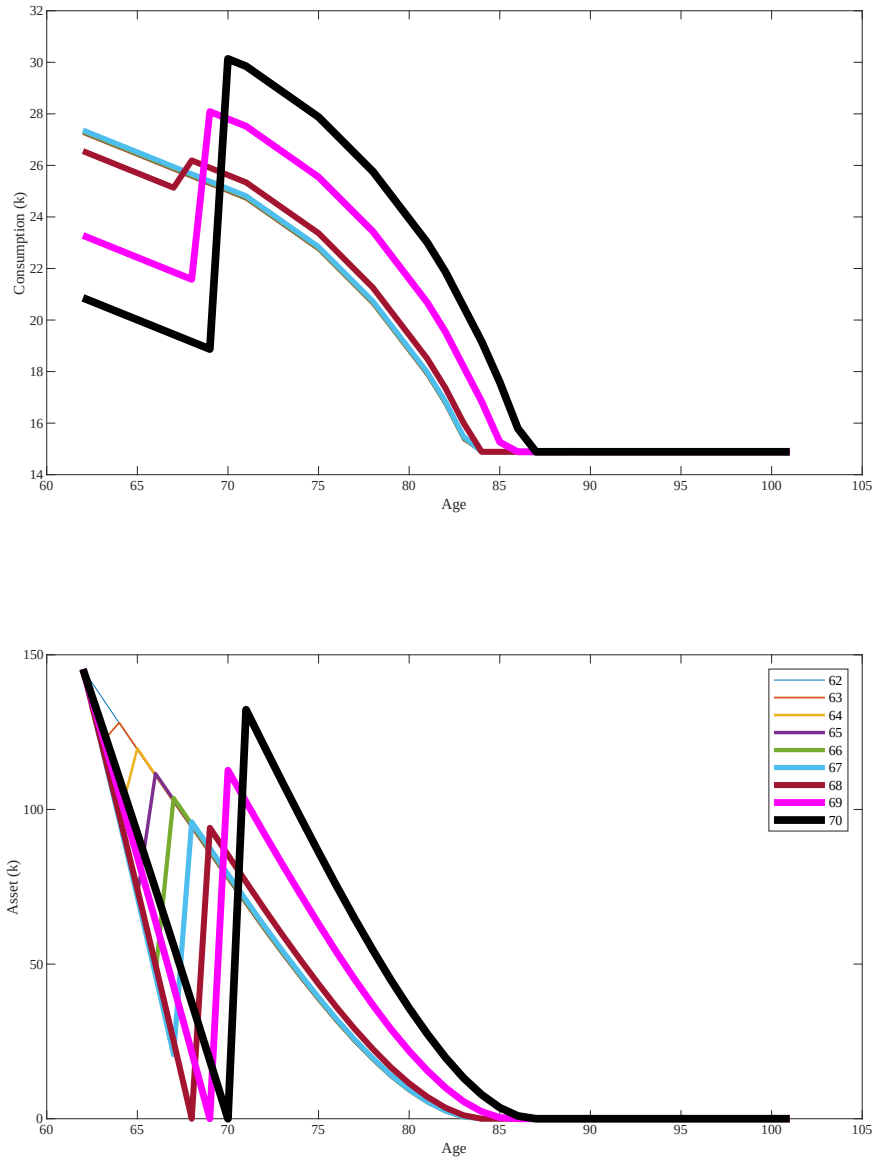


Figure C3: T100 optional decisions conditional on claiming age

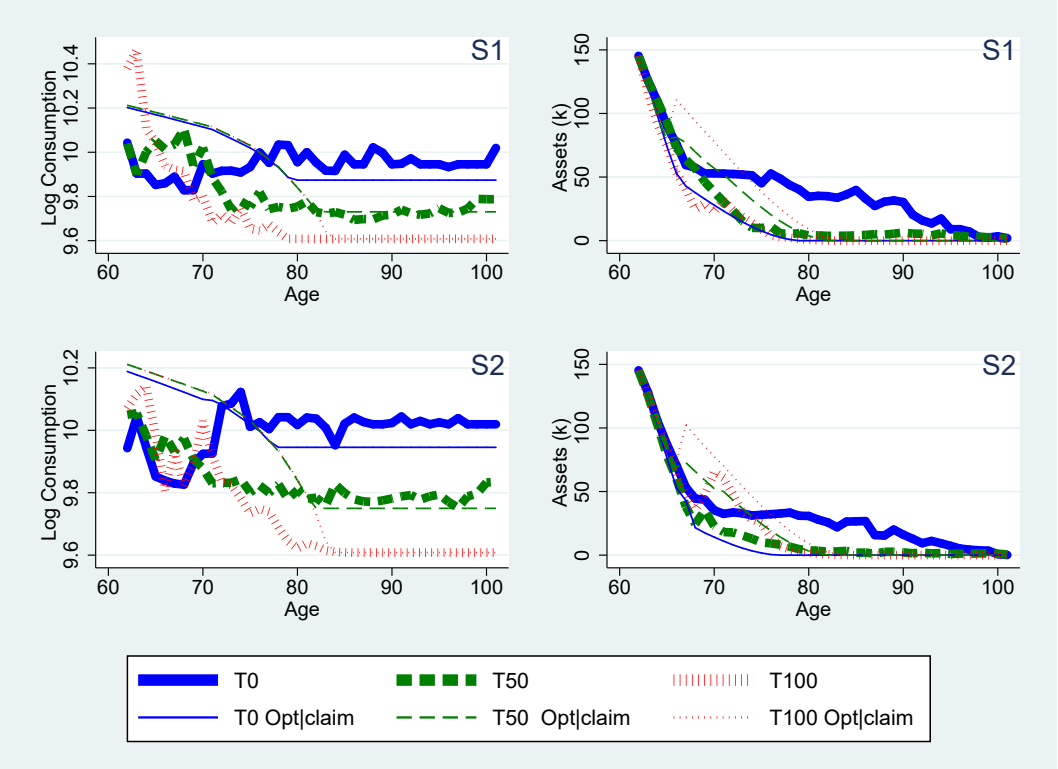


Figure C4: Median log consumption and assets by treatment

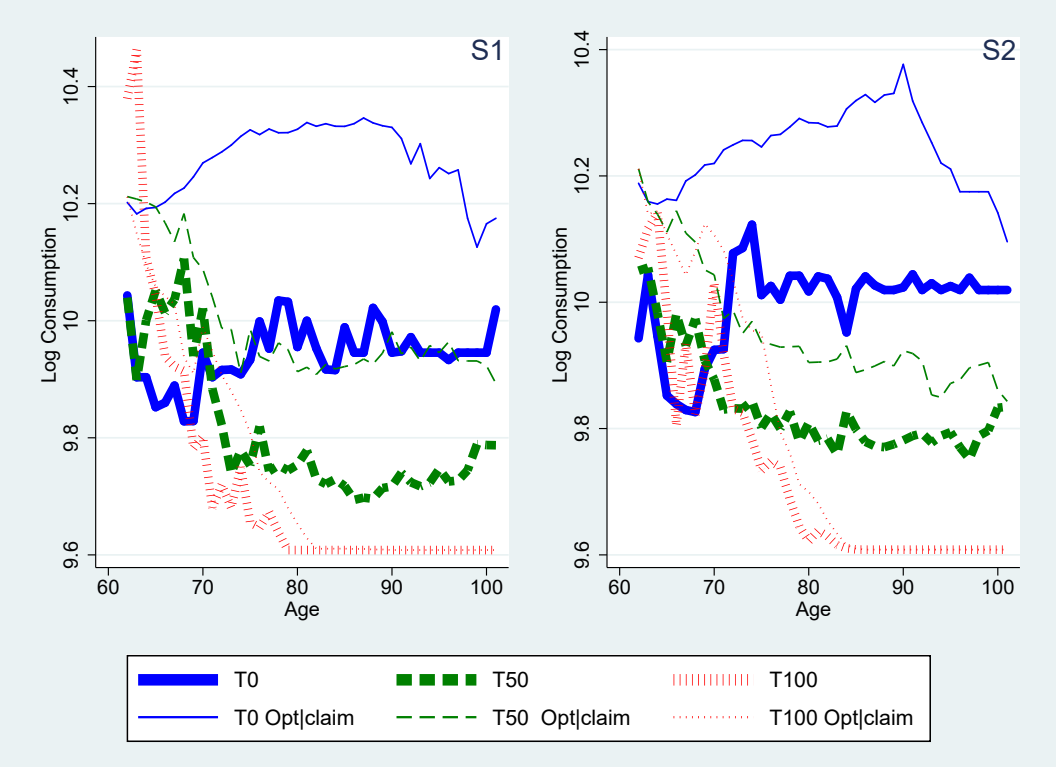
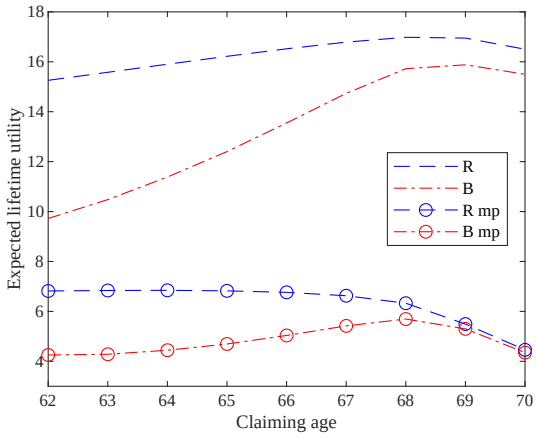
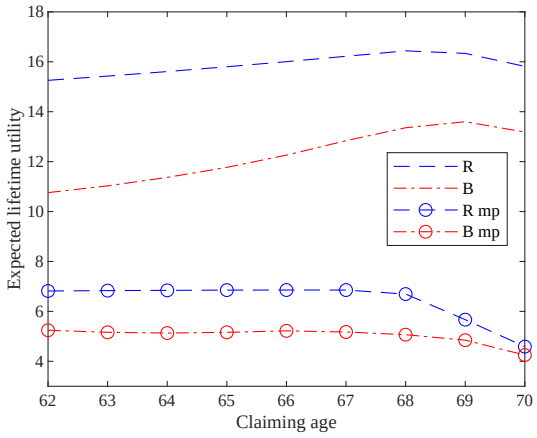


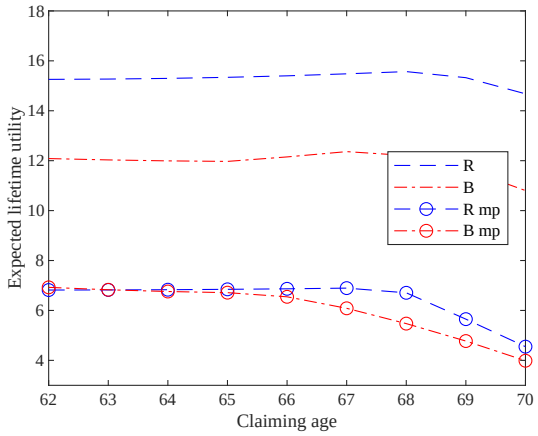
Figure C5: Median log consumption and median prediction by rational choice theory conditional on both claiming age and current period starting assets



(a) T0

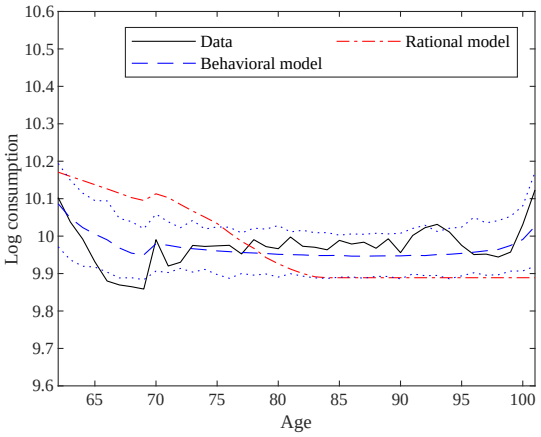


(b) T50

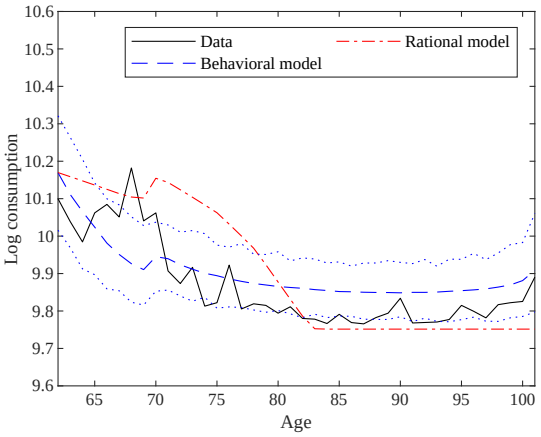


(c) T100

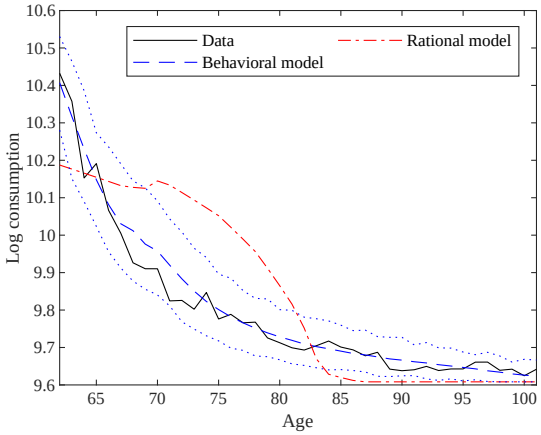
Figure C6: Expeced lifetime expectancy by claiming age predicted under four approaches



(a) T0



(b) T50



(c) T100

Note: This figure displays the data average log consumption (solid line) and that predicted by two alternative models. The dotted lines represent the 95% confidence interval, constructed using the bootstrap method explained in Appendix D.

Figure C7: S1 Data Log Consumption and Model Predictions | Claiming

E Decomposition

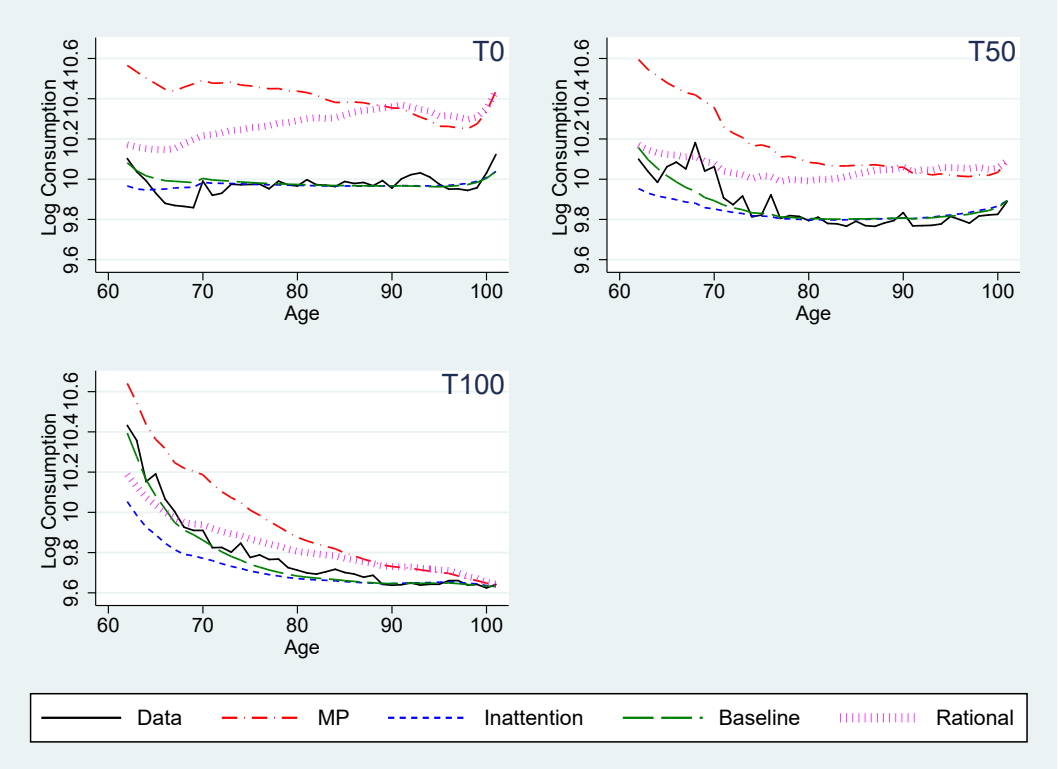


Figure E1: Model predictions with Fixed Parameters

To discern the relative importance of inattention and probability misperception (hereafter referred to as "MP") in helping to match the lifecycle consumption profile conditional on claiming age, we conduct two decomposition exercises. Initially, using the point estimates about attention rule and misperception from our baseline model (see Table 7), we compute the counterfactual consumption path with only one operating mechanism at play. Specifically, under the inattention model, predicted consumption is the weighted average of the heuristic rule and the solution to the rational choice model under objective continuation probabilities; under the MP model, predicted consumption is the solution to the revised intertemporal problem under misperceived continuation probabilities. As depicted in Figure E1, without re-estimation, the fit of the MP model fares even worse than the rational choice model for the majority of periods in all three treatments. Conversely, the fit of the inattention model subtaintially surpasses that of the rational choice model, aligning closely with the baseline model's fit for T0, and only marginally underperforming it for T50 and T100.

We proceed by re-estimating these two alternative models using maximum likelihood

Table E1: Re-estimated Parameters for Alternative Models

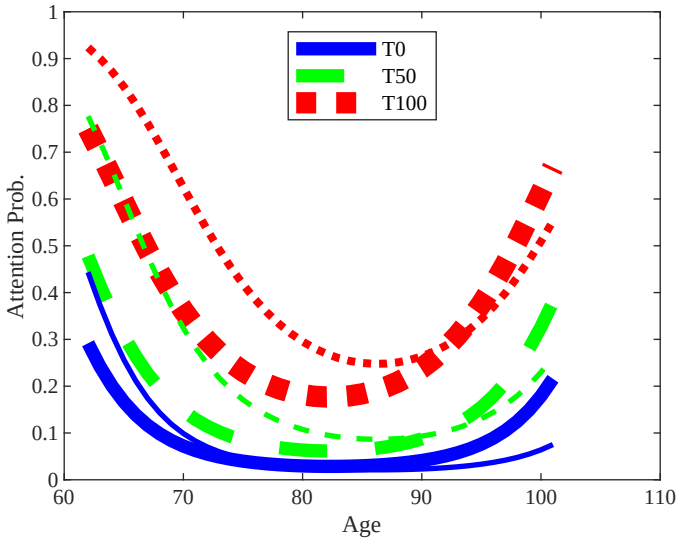
	Baseline	Inattention	MP
	(1)	(2)	(3)
η	0.0000		0.0000
p_0	0.8175		0.9665
α_1	1.3660	2.7969	
α_2	-0.2726	-0.3091	
α_3	0.0064	0.0061	
α_{T0}	-1.9869	-2.7205	
α_{T50}	-1.1869	-1.2467	
σ	0.1723	0.2079	0.3006
Log Likelihood	689.30	189.49	-833.23
AIC	-1362.59	-366.98	1672.46
BIC	-1312.57	-329.46	1691.22

estimation. For the inattention model, the likelihood function remains identical to the baseline model, with c^*_{ij} replaced by the solution to the rational choice model. For the MP model, the likelihood of observing subject i in period j choosing consumption c_{ij} is revised to:

$$\mathcal{L}(c_{ij}) = \frac{1}{\sigma}\varphi(\frac{\log c_{ij} - \log c^*_{ij}}{\sigma})$$

Table E1 presents the re-estimated parameters, and Figure E2 compares the attention rules between the baseline model and the inattention model. To match the data, the absence of MP mechanism necessitates higher attention in early periods and lower attention in later periods. The absence of inattention mechanism leads to a constant perceived probability that is greater than the objective probability for all periods. Notably, the removal of either mechanism results in a large percent increase of the standard deviation (σ), and substantially worse values for both Akaike information criterion (AIC) and Bayesian information criterion (BIC), underscoring the necessity of incorporating both mechanisms.

Figure E3 illustrates the fit of alternative models with re-estimated parameters. In this instance, the MP model generally outperforms the rational choice model in matching the data. The fit of the inattention model also shows slight improvement compared to that depicted in Figure E1. In conclusion, both decomposition exercises indicate that the inattention mechanism holds greater importance than the MP mechanism in elucidating the observed consumption data and thereby explaining the phenomenon of slow decumulation of assets.



Note: Thicker lines represent the baseline model, and thinner lines represent the attention only model.

Figure E2: Attention rule for the Baseline and the Inattention Models

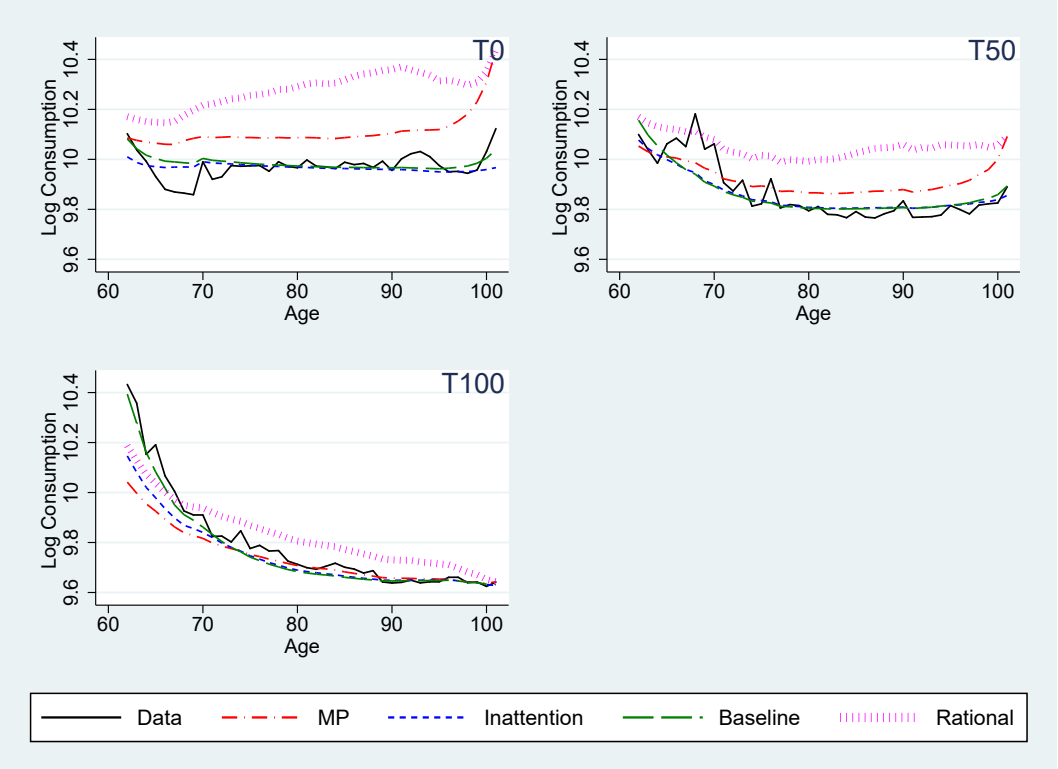


Figure E3: Model predictions with Re-estimated Parameters