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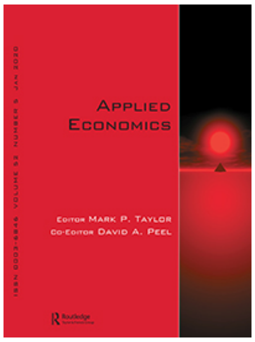

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Why do retired workers claim their social security benefits so early? A potential explanation based on the cumulative prospect theory

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ABSTRACT
Social Security provides longevity insurance for older Americans. According to expected utility theory models, rational households who are not liquidity constrained should delay claiming their Social Security benefits to insure consumption in late life. However, data shows that most retired workers claim soon after becoming eligible. This paper explains the early claiming behaviors using the cumulative prospect theory. We show that when making claiming decisions, individuals consider benefit gains and losses from delaying claiming relative to claiming immediately. Fear of receiving less lifetime benefits in the event of early death induces them to claim immediately.

KEYWORDS
Social Security benefits; claiming behaviors; behavioral model; cumulative prospect theory; loss aversion

JEL CLASSIFICATION
H55; D14

I. Introduction

In the United States, retired workers may claim their Social Security benefits as early as age 62. Those who postpone claiming receive increases in their benefits that are approximately actuarially fair.[1] Coile et al. (2002) present that a hypothetical single male born in 1930 suffers only a 0.2 percent loss in the expected present value (EPV) of his Social Security retired worker benefits by claiming at age 62 instead of postponing to his optimal claiming age. For a hypothetical married couple, similarly, if both spouses claim as early as possible, the couple would lose only 2.9 percent in the EPV of their household Social Security benefits relative to claiming at their optimal combination of claiming ages. Using the Health and Retirement Study (HRS) data, Sass, Sun, and Webb (2013) confirm that the average EPV loss of household Social Security wealth resulting from early claiming is small. Therefore, based on pure financial money's worth calculations, claiming decisions do not produce enormous gains or losses for older households.

However, Coile et al. (2002) and Sun and Webb (2011) show that simply calculating the EPV of Social Security benefits ignores the valuable longevity insurance provided by delaying claiming which protects against the risk of outliving one's wealth.[2] Using an expected utility theory (EUT) model, which assumes that the representative household is rational, Coile et al. (2002) show that the utility maximizing age of a hypothetical single male born in 1930 can be as high as 65. When Sun and Webb (2011) extend the calculations to married couples, they show that the optimal claiming ages are between age 67 and 70 for non-budget constrained married couples.[3] Both studies find that older households who claim early suffer substantial losses in expected utility terms and run the risk of low consumption if they live an unexpectedly long time.

Contradicting to the predictions of both EPV calculations – that households could claim their Social Security benefits at any age – and EUT models – that households should generally delay claiming for a few years – data shows that although most households have sufficient financial wealth to delay, they always choose to claim soon after becoming eligible. Using a clean sample of individuals who retired before age 62 from the New Beneficiary Data System (NBDS), Coile et al. (2002) find that

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[1]Social Security benefits are fixed in real terms after claiming. Three percent real interest rate and population average mortality are used in the actuarial calculations.
[2]The idea is in line with Mitchell et al. (1999) which show the value of annuity products.
[3]Married couples need to take spousal and survivor benefits into consideration when making claiming decisions.

over 80 percent of men claimed their benefits within one month of turning age 62.[4] They also show that retirement and claiming decisions are usually joint decisions for workers who are working at age 62 and older. Hurd, Smith, and Zissimopoulos (2004) find similar patterns using the HRS data.

The existing literature on claiming behaviors, briefly reviewed in a later section, has offered several plausible explanations for the reason why older households claim so early, but none is general enough to explain the prevalence of the early claiming behaviors. Using the cumulative prospect theory (CPT) model which describes how individuals make decisions under risk in the real world, this paper provides an alternative explanation for the early claiming puzzle. We show that when making claiming decisions, older households consider potential benefit gains and losses from delaying claiming relative to claiming immediately.[5] In the event of early death, households who delay claiming receive less lifetime benefits than if they had claimed immediately. Fear of such potential losses motivates older households to claim soon after becoming eligible. Under the CPT model, our benchmark calculations indicate that single individuals who delay claiming for one year at various decision-making ages require 0.3–5.3 percent increases in their Social Security benefits to be as well off as they would be if claimed immediately.

Our work falls into the broad context of individuals' financial decision making under uncertainty. The existing literature has provided both rational reasons and irrational motivations for many financial decisions that would impact households' wealth and consumption. For example, previous studies (Hurd, Rooij, and Winter 2011; Guiso, Sapienza, and Zingales 2008; Giannetti and Koskinen 2010; Ke 2018) find that personal characteristics, expectations and country-level factors have significant effects on households' stock market participations. Barberis, Huang, and Thaler (2006) and Dimmock and Kouwenberg (2010) find that the stock market participation decision is also influenced by loss aversion. In addition, researchers find individuals' income volatility, knowledge, information and preference could explain variations in households' portfolio diversification (Calvet, Campbell, and Sodini 2007; Merton 1987; Nieuwerburgh and Veldkamp 2009; Huberman 2001). Grinblatt and Keloharju (2001) and Goetzmann and Kumar (2008) show that the diversification decision is also subject to psychological biases.[6] Furthermore, existing studies have examined the factors that shape individuals' borrowing decisions, including the level of leverage (Mian and Sufi 2009, 2011; Barrot et al. 2016; Kumhof, Ranciere, and Winant 2015), the choice on types of borrowing (Campbell and Cocco 2003), and debt management (Amromin et al., 2018; Campbell 2006; Ausubel 1991; Stango and Zinman 2009). Finally, the literature has shown that individuals' consumption decisions are influenced by expected and unexpected income shocks (Jappelli and Pistaferri 2010; Imbens, Rubin, and Sacerdote 2001; Kuhn et al. 2011), borrowing constraints (Parker 1999; Johnson, Parker, and Souleles 2006), and behavioral factors (Angeletos et al. 2001; Shefrin and Thaler 1988), such as peer effects (Agarwal, Qian, and Zou 2017). Our study is particularly related to financial decisions made upon retirement, for example, wealth related decisions (Cocco, Gomes, and Maenhout 2005; Agnew, Balduzzi, and Sundn 2003; Addoum 2017) and consumption related decisions (Haider and Stephens 2007; Olafsson and Pagel 2017; Pagel 2017; Koszegi and Rabin 2009).

This paper contributes to the long literature by examining the Social Security claiming decision, one of the most important financial decisions faced by retired workers. This is because Social Security benefits could be the only stable income source after retirement for most seniors and the claiming decision determines their Social Security income for the reminder of their life. Our paper provides a new perspective by examining the decision using the psychologically rich CPT model.

The remainder of this paper is organized as follows: Section 2 provides institutional background of the U.S. Social Security program. Section 3 reviews the literature that explains households' claiming behaviors. Section 4 presents how claiming decisions

[4] The sample is clean in the sense that it separates individuals' Social Security claiming decision from their retirement decision.
[5] Claiming immediately does not mean individuals always set claiming at age 62, the early entitlement age, as the reference claiming age. If they retire and make the claiming decision at age 63, then claiming immediately means they claim at age 63, compared with delaying claiming (claim at age 64 or older).
[6] Other related studies regarding household investment decisions include Odean (1998), Ben-David and Hirshleifer (2012), etc.

fit into the CPT framework. Section 5 interprets the results, and the last section concludes.

II. The U.S. social security program

Retired workers who have worked at least forty quarters are entitled to claim their Social Security retired worker benefits between age 62 and 70.[7] The amount of benefits they receive depends on their primary insurance amount (PIA) which is calculated based on their highest 35 years of earnings. If an individual claims her Social Security retired worker benefits at her full retirement age (FRA), her monthly benefits are 100 percent of her PIA.[8] If she claims earlier than her FRA, her monthly benefits are reduced 5/9 of one percent for each month before her FRA until 36 months. The percent switches to 5/12 of one percent each month after 36 months. Taking a worker who was born in 1952 as an example, her FRA is 66.[9] For each month she claims before her FRA, her monthly benefits are reduced 5/9 of one percent until age 63. Therefore, her benefits are reduced by 20 percent and she receives 80 percent of her PIA if claimed at age 63. If she claims earlier than age 63, her benefits are further reduced 5/12 of one percent each month until age 62, the early entitlement age (EEA). Therefore, her monthly benefits are only 75 percent of her PIA after reduction if she claims at age 62. If an individual claims after her FRA, she receives delayed retirement credit (DRC). Again, taking the worker who was born in 1952 as an example, her DRC is 2/3 of one percent per month. It means that for each year she delays claiming, her monthly benefits for the rest of her life increase 8 percent of her PIA until age 70 at which time the increases stop. Therefore, at most she could receive a 32 percent increase of her PIA by claiming at age 70, which is 76 percent higher than her benefits if claimed at age 62.

For married couples in retirement, they could claim two more types of Social Security – spousal benefits and survivor benefits. The spouse of an old worker is entitled to receive Social Security benefits based on earning's record of the worker if the spousal benefits exceed her own retired worker benefits. The spousal benefits of an individual can be claimed at any time after she turns 62, given her spouse has already claimed. If she claims at her FRA, she is entitled to monthly benefits of 50 percent of her spouse's PIA. If she claims before her FRA, her monthly benefits are reduced 25/36 of one percent each month for the first 36 months and further reduced by another 5/12 of one percent for each month after the first 36 months until age 62. There is no increase for her spousal benefits if she claims after her FRA. After the death of one spouse, the surviving spouse could claim survivor benefits if the benefits exceed her own retired worker benefits. The amount of the benefits depends on her spouse's monthly benefits, not PIA. Therefore, when a husband delays claiming, not only it increases his retired worker benefits for the remainder of his life, but it could also increase his surviving wife's monthly income for her remaining life. If the husband dies at or after the wife's FRA, the wife will receive 100 percent of her husband's monthly benefits, subject to a floor of 82.5 percent of her husband's PIA. If the husband dies and the wife claims before she attains her FRA, there's a reduction, subject to a floor of 71.5 percent of her husband's PIA.

III. Literature on claiming behaviors

Several studies have examined potential explanations of the early claiming behaviors. Using the NBDS data, Coile et al. (2002) find that individuals who believed that they can survive to age 70 with certainty are more likely to delay claiming. Hurd, Smith, and Zissimopoulos (2004) also present evidence that subjective survival probabilities are associated with claiming decisions using the HRS data. Gustman and Steinmeier (2005) estimate a structural model of individuals' retirement and claiming decisions using the HRS data. They show that individuals who have high time discount rate focus more on today's consumption and are therefore more likely to retire and claim early. Sass, Sun, and Webb (2007) examine the early claiming behaviors of married men and find that

[7]Workers can claim before retirement, but their income must pass an earning's test to receive full benefits at the time of claiming. Otherwise, their benefits will be reduced one to one dollar for the difference between their actual income and the benchmark of earning's test. This causes almost all individuals claim after retirement. In this paper, we assume individuals always retire before claiming.

[8]Individuals born in different years have different FRA. The FRA of the current retiring cohort is 66. The reduction and the DRC mentioned later in this paragraph are also depended on their birth cohort.

[9]The individual is at her FRA of 66 in 2018.

husbands with college degrees are more likely to delay claiming. However, they find that other potential explanatory variables, such as financial literacy, caddishness of the husband and household bargaining power, do not affect husbands' claiming decisions. Concerned with the Social Security shortfall, Benitez-Silva et al. (2006) build a dynamic life-cycle model incorporating uncertain future Social Security reforms. They conclude that individuals claim early because they would like to lock in the benefits before any prospective benefit cuts. Although all the above factors could explain part of the early claiming behaviors, none is general enough to explain the fact that most individuals claim their benefits soon after becoming eligible. For example, Hurd and McGarry (1995, 2002) find that individuals report reasonable subjective mortality beliefs, so it is unlikely that the early claiming behaviors are the results of systematic biases in forecasting life expectancy.

Brown, Kapteyn, and Mitchell (2016) is the first paper to point out that individuals may not behave completely rationally when making claiming decisions. Through a randomized experiment, the authors show that 'framing' could affect individuals' choices. Individuals are more likely to claim early if the claiming behavior is explained as a 'breakeven' frame rather than a 'symmetric' frame.

IV. Methodology

The cumulative prospect theory (CPT) model

This paper provides an alternative potential explanation for the early claiming behaviors, drawing on a psychologically rich model – the cumulative prospect theory (Tversky and Kahneman 1992).[10] Through a number of lab experiments, the authors find that when making decisions under uncertainty, individuals do not always perform rationally. They tend to evaluate outcome gains and losses relative to a reference state, rather than final values. In addition, there are three distinctive features that characterize the theory. The first feature is diminishing sensitivity, captured by the shape of the value function being concave in the domain of gains and convex in the domain of losses. This indicates that individuals are risk averse over gains but are risk seeking over losses, with diminishing marginal sensitivity. The second feature is loss aversion, characterized by the kink at the origin of the value function. It means that when individuals receive the same magnitude of gains and losses, the pain from losses dominates the happiness from gains. The third feature is probability weighting, which transforms probabilities with a weighting function that overweights outcomes associated with low probabilities and underweights outcomes associated with moderate and high probabilities.

To translate the descriptions into formal equations, consider a prospect that has m negative outcomes, $\{o_{-m}, o_{-m+1}, \cdots, o_{-1}\}$ and n positive outcomes, $\{o_1, o_2, \cdots, o_n\}$.[11] The corresponding probabilities are $p_{-m}, \cdots, p_n$ respectively. Based on Tversky and Kahneman (1992), the overall value of this prospect can be calculated as:

$$V_x = \sum_{i=0}^{n} \pi_i^+ v(o_i) + \sum_{i=-m}^{0} \pi_i^- v(o_i) \tag{1}$$

where $v(\cdot)$ is a value function measured by gains and losses relative to a reference point. It takes the following form:

$$v(o) = \begin{cases} o^\alpha & \text{if } o \geq 0 \\ -\lambda(-o)^\beta & \text{if } o < 0 \end{cases} \tag{2}$$

o represents the corresponding outcome gains and losses, α, β, λ capture the concave curve of gains, the convex curve of losses and the degree of loss aversion respectively. Lower α and β indicate higher degree of concavity/convexity. $\pi(\cdot)$ is a nonlinear decision weighting function of probabilities, representing weights associated with the outcomes. It takes the following form:

$$\begin{aligned} \pi_n^+ &= w^+(p_n) \\ \pi_i^+ &= w^+(p_i + p_{i+1} + \ldots + p_n) \\ &\quad - w^+(p_{i+1} + \ldots + p_n) \text{ if } 0 \leq i \leq n \\ \pi_i^- &= w^-(p_{-m} + p_{-m+1} + \ldots + p_i) \\ &\quad - w^-(p_{-m} + \ldots + p_{i-1}) \text{ if } -m \leq i \leq 0 \\ \pi_m^- &= w^-(p_{-m}) \end{aligned} \tag{3}$$

where the function $w(\cdot)$ is defined as:

[10] The CPT is an extension of the original prospect theory (Kahneman and Tversky 1979).
[11] Outcomes are ranked, i.e., $o_i > o_j$ iff $i > j$.

$$w^{+}(p) = \frac{p^{\gamma}}{\left(p^{\gamma} + (1-p)^{\gamma}\right)^{1/\gamma}}$$
$$w^{-}(p) = \frac{p^{\delta}}{\left(p^{\delta} + (1-p)^{\delta}\right)^{1/\delta}} \tag{4}$$

By design, the decision weighting function displays an inverted S shape which overweights small probabilities and underweights middle and large probabilities in both gain and loss domains.[12]

In our exercises, the outcome o represents the differences between the present values and the probability p represents the mortality rates in the following prospect:

$$\left(PV_{62|x} - PV_{62|y}, m_{62}; PV_{63|x} - PV_{63|y}, m_{63}; \ldots\ldots; PV_{100|x} - PV_{100|y}, m_{100}\right)$$

We discuss the details in the following subsection.

Apply the CPT model to claiming decisions

First, we identify the reference state. The claiming decisions can be viewed as financial decisions under risk, betting on how long individuals could live.[13] For individuals who delay claiming, they 'win' if they live long, but 'lose' if they die at an early age because they receive less lifetime benefits. For illustration purposes, we consider single individuals as our base case and return to married couples as a sensitivity analysis. We assume single individuals can claim their Social Security benefits only at their birthdays from age 62 to 70, nine potential claiming dates.[14] When individuals retire and become eligible at various ages to claim their benefits, they have two choices: claim immediately, or postpone claiming. Under this setting, it is natural to set the reference state to be the Social Security benefits they receive if claimed immediately. When postponing claiming, if they receive higher benefits than the reference case, they make gains. If they receive less benefits, they take losses. For instance, if an individual born in 1952 with a PIA of $1,000 claims at age 62, she receives $9,000 benefits annually ($750 each month) starting from age 62. If she delays claiming from age 62 to 63, she receives $9,600 ($800 per month) each year beginning at age 63. At age 62, she opens a mental account of her Social Security benefits in which claiming at age 63 generates gains and losses. She considers the $9,000 in foregone benefits at age 62 as a loss, because claiming immediately is her reference state. After claiming at age 63, she considers the $600 by which her annual benefits of $9,600 exceeds the reference of $9,000 as gains and she receives the $600 gain annually for the remainder of her life.

Next, we explain how prospects of claiming decisions are formed. Again, taking the claiming decision at age 62 as an example, an individual enters the model alive at age 62 and the terminal age T is set at 100. She could die at any year between age 62 and 100, 39 possibilities. The outcome associated with each possibility is the present value of lifetime Social Security benefits received before death, conditional on claiming at age x.[15] It can be calculated as:

$$PV_{d|x} = \sum_{t=62}^{d} \left(\frac{1}{1+r}\right)^{t-62} B_{t|x} \tag{5}$$

where $PV_{d|x}$ means the present value of lifetime Social Security benefits received if the individual dies at age d and claims at age x. r is the real interest rate. $B_{t|x}$ is the social security benefits that she receives at age t if she claims at age x. Therefore, the choices of claiming immediately at age 62 and delaying claiming for one year to age 63 can be presented as the following two prospects:

$$\left(PV_{62|62}, m_{62}; PV_{63|62}, m_{63}; \ldots\ldots; PV_{100|62}, m_{100}\right)$$

and

$$\left(0, m_{62}; PV_{63|63}, m_{63}; \ldots\ldots; PV_{100|63}, m_{100}\right)$$

where m_t is the probability of the individual dying at age$t$. Under the CPT model, individuals consider

[12]The rand- and sign- dependent decision weighting function is an extension of Quiggin (1982). It has been proved by various experiments in the literature, for example, Tversky and Fox (1995), Camerer and Ho (1994), Hey and Orme (1994), Lattimore, Baker, and Witte (1992) and Wu and Gonzalez (1996). Other forms of decision weighting functions include Segal (1989, 1993), Chew and Epstein (1989), Green and Jullien (1988), Starmer and Sugden (1989), Luce and Fishburn (1991), etc. See Starmer (2000) for a detailed review of non-expected utility theories with decision weights.

[13]Taking the experimental results of Brown et al. (2008) as given, this paper applies 'narrow framing' (Thaler 1985) and assumes individuals separate Social Security claiming decisions from other economic decisions, i.e., investment decisions on other financial assets.

[14]Social Security benefits are adjusted by month, but this simplification will not alter the conclusions of this paper.

[15]We assume individuals collect Social Security benefits before death at a certain age.

gains and losses relative to the reference state. Since claiming at age 62 is the reference state, the above two prospects could thus be translated to:

$$(0)$$

and

$$\left(-PV_{62|62}, m_{62}; PV_{63|63} - PV_{63|62}, m_{63}; \ldots\ldots; PV_{100|63} - PV_{100|62}, m_{100}\right)$$

The second prospect involves gains and losses relative to the reference state. Generalizing the example, individuals could make their claiming decision at any age y between 62 and 70.[16] They could choose to claim immediately at age y, or they could postpone claiming to age x. Claiming immediately at age y is now the reference state, and the prospect that is to be evaluated is:

$$\left(PV_{62|x} - PV_{62|y}, m_{62}; PV_{63|x} - PV_{63|y}, m_{63}; \ldots\ldots; PV_{100|x} - PV_{100|y}, m_{100}\right)$$

Finally, we apply the standard CPT model to calculate values associated with the prospects. The results are presented using Social Security Equivalent Income (SSEI), the factor by which the benefits payable at delayed claiming ages must be multiplied so that individuals are indifferent between claiming immediately and delaying claiming. By construction, if claiming immediately is better, SSEI is larger than one. Individuals who delay claiming would require their benefits multiplied by the factor, so they are indifferent to claiming immediately. If SSEI is smaller than one, delaying claiming is better. We again use the previous example to better clarify the concept. Recall that the female individual was born in 1952 and has population average mortality and a PIA of \$1,000. The real interest rate is 3 percent. If she claims at age 62, she receives \$9,000 benefits annually starting from age 62. The EPV of her lifetime benefits is \$123,072. If she delays claiming to age 63, she receives \$9,600 benefits annually beginning at age 63. The EPV of her benefits if claimed at age 63 is \$123,277, larger than her EPV of benefits if claimed at age 62. Thus, if she postpones claiming to age 63, she needs less than \$9,600 per year to obtain her age 62 EPV of benefits. Using numerical methods, we calculate that she only requires an annual benefit income of \$9,584.[17] Her SSEI in this case is 0.998, representing she only requires 99.8 percent of her age 63 benefits (\$9,600*0.998 ≈ \$9,584) to be indifference in EPV terms between claiming immediately at age 62 and postponing claiming for one year to age 63

V. Results

Base case

Table 1(a,b) report comparisons of SSEIs for three types of models for single women and single men respectively.[18] The SSEIs of the EPV model are reported in the upper panel. The middle panel reports the SSEIs of the EUT model, and the lower panel reports the SSEIs calculated using the CPT model. Individuals could retire at any age between age 62 and 70 which are recorded horizontally. They make their Social Security claiming decision right after retirement: either claim immediately at the retirement age or postpone claiming to a later age which are listed vertically.[19] The benchmark calculations assume that the female and male individuals were born in 1952. They have population average mortality and a PIA of \$1,000.[20] As is conventional in the literature, both the interest rate and the time discount rate are set at 3 percent. The coefficient of risk aversion in the EUT model equals five, in line with the previous literature (Chetty 2006).[21] The

[16]Because individuals cannot claim before their EEA, retiring before and at age 62 are the same. Also, individuals will not postpone after age 70 as the benefits increase stops at age 70. We assume individuals always retire before claiming.
[17]Note we can simply calculate SSEIs of the EPV model using the ratios of EPVs from two different ages, but we have to apply numerical methods for the EUT model and the CPT model to calculate corresponding SSEIs because the effects are no longer linear.
[18]The formal EPV model and EUT model compared in the paper are presented in the appendix.
[19]As discussed in the previous section, we assume that individuals do not claim benefits while working.
[20]In our exercises, PIA is simply a scaling factor, any arbitrary PIA will produce the same results.
[21]Chetty (2006) estimates the CRRA coefficient in the range between 2 and 10, depending in part on whether the estimates are derived from portfolio theory, purchases of insurance, economic experiments, or preferences over lotteries.

Table 1a. Social Security equivalent income – single women

Expected Present Value									
Retirement Age	62	63	64	65	66	67	68	69	70
Claiming Age									
62	1.000								
63	0.998	1.000							
64	0.983	0.985	1.000						
65	0.975	0.977	0.992	1.000					
66	0.974	0.976	0.991	0.999	1.000				
67	0.967	0.969	0.984	0.992	0.993	1.000			
68	0.968	0.969	0.985	0.992	0.993	1.000	1.000		
69	0.975	0.977	0.992	1.000	1.001	1.008	1.007	1.000	
70	0.988	0.990	1.006	1.014	1.015	1.022	1.021	1.014	1.000
Expected Utility Theory									
Retirement Age	62	63	64	65	66	67	68	69	70
Claiming Age									
62	1.000								
63	0.979	1.000							
64	0.945	0.965	1.000						
65	0.918	0.937	0.971	1.000					
66	0.897	0.916	0.950	0.978	1.000				
67	0.869	0.889	0.922	0.950	0.971	1.000			
68	0.846	0.867	0.902	0.929	0.950	0.979	1.000		
69	0.829	0.852	0.888	0.915	0.937	0.965	0.986	1.000	
70	0.820	0.843	0.880	0.908	0.930	0.958	0.980	0.994	1.000
Cumulative Prospect Theory									
Retirement Age	62	63	64	65	66	67	68	69	70
Claiming Age									
62	1.000								
63	1.017	1.000							
64	1.019	1.003	1.000						
65	1.031	1.015	1.012	1.000					
66	1.050	1.035	1.031	1.020	1.000				
67	1.061	1.046	1.045	1.034	1.015	1.000			
68	1.083	1.068	1.067	1.057	1.036	1.023	1.000		
69	1.113	1.094	1.094	1.085	1.067	1.054	1.031	1.000	
70	1.146	1.132	1.133	1.124	1.106	1.093	1.069	1.038	1.000

Notes: Population average mortality for the 1952 birth cohort. Interest rate and time discount rate both equal 3 percent. Coefficient of risk aversion equals five.

Social Security wealth accounts for 50 percent of households' total wealth (Munnell and Soto 2008), an amount that is sufficient to fund individuals' consumption from age 62 to 70 (Sun and Webb 2011).[22] The benchmark values of α, β, λ, γ and δ in the CPT model are set at 0.88, 0.88, 2.25, 0.61 and 0.69 respectively as estimated in Tversky and Kahneman (1992).[23] The SSEIs are always 1 on the diagonal because they are comparing claiming immediately with claiming immediately at various retirement ages.

Not surprisingly, SSEIs under the EPV model are close to 1 no matter when individuals make claiming decisions and how many years they delay, because Social Security is approximately actuarially fair. For example, SSEI is 0.998 if a single female delays claiming from age 62 to 63, indicating that she would require 99.8 percent of her age 63 Social Security income to achieve the same EPV of Social Security benefits as that obtained by claiming at age 62, a gain of merely 0.2 percent. If she continues to postpone claiming, the SSEIs in the column decrease until age 67. This is the age that she maximizes her EPV of benefits. She would require only 96.7 percent of her age 67 benefits to obtain her age 62 EPV of benefits. She would be slightly worse off if she keeps delaying after the EPV maximizing claiming age. If the single female individual retires and

[22] Note that this assumption only affects the SSEIs of the EUT model. The purpose of this assumption is to allow individuals to fund their consumption with financial wealth before receiving any Social Security income. In the results we do not report, we run tests assuming the financial wealth accounts for 75 percent or 125 percent of their SSW. We find that although the SSEIs change slightly, the optimal claiming ages remain the same, indicating that under the EUT model, individuals should always delay claiming to obtain additional longevity insurance provided by Social Security if they are not liquidity constrained. Under the CPT model, individuals separate their claiming decisions from other financial assets and make decisions only based on benefits gains and losses between claiming immediately and delaying claiming.

[23] We experiment with other parameter values in the decomposition and sensitivity analysis sections.

Table 1b. Social Security Equivalent Income – Single Men

Expected Present Value									
Retirement Age	62	63	64	65	66	67	68	69	70
Claiming Age									
62	1.000								
63	1.006	1.000							
64	0.999	0.993	1.000						
65	0.999	0.993	1.001	1.000					
66	1.007	1.001	1.009	1.008	1.000				
67	1.010	1.004	1.011	1.011	1.002	1.000			
68	1.020	1.014	1.022	1.021	1.013	1.010	1.000		
69	1.039	1.032	1.040	1.039	1.031	1.029	1.018	1.000	
70	1.065	1.058	1.066	1.066	1.057	1.054	1.044	1.025	1.000
Expected Utility Theory									
Retirement Age	62	63	64	65	66	67	68	69	70
Claiming Age									
62	1.000								
63	0.980	1.000							
64	0.947	0.966	1.000						
65	0.921	0.940	0.973	1.000					
66	0.902	0.921	0.954	0.980	1.000				
67	0.877	0.897	0.929	0.955	0.974	1.000			
68	0.859	0.879	0.912	0.938	0.957	0.983	1.000		
69	0.847	0.869	0.903	0.929	0.948	0.974	0.992	1.000	
70	0.845	0.867	0.902	0.928	0.949	0.975	0.993	1.002	1.000
Cumulative Prospect Theory									
Retirement Age	62	63	64	65	66	67	68	69	70
Claiming Age									
62	1.000								
63	1.027	1.000							
64	1.041	1.014	1.000						
65	1.064	1.038	1.024	1.000					
66	1.096	1.069	1.055	1.032	1.000				
67	1.120	1.094	1.082	1.059	1.027	1.000			
68	1.156	1.131	1.119	1.094	1.063	1.036	1.000		
69	1.202	1.173	1.162	1.140	1.108	1.082	1.045	1.000	
70	1.254	1.228	1.218	1.196	1.161	1.135	1.099	1.053	1.000

Notes: As previous tables.

makes her claiming decision at an older age, the EPV maximizing claiming age 67 for instance, the SSEIs in the retirement age 67 column are all higher than 1. This means if she delays claiming, she requires higher benefit income to reach the same EPV of benefits as that claimed at age 67.

We can also view the decision-making process from another angle. When individuals become eligible at various ages to claim their benefits, they have two choices: claim immediately, or postpone claiming for one year. If delayed, they repeat the same decision (claim immediately or delay claiming for one year) one year later. Therefore, we could examine the SSEIs right below the diagonal elements in each column to investigate their optimal claiming decision. For the same single female retired at age 62, the SSEIs are smaller than 1 until age 66, showing again that she maximizes the EPV of her Social Security benefits by claiming at age 67.

In contrast, under the EUT model, her expected utility is maximized at age 70. All SSEIs right below the diagonal elements are smaller than 1, so it is optimal for her to delay claiming until age 70. From the retirement age 62 column, the cumulative effect shows that a single female claiming at age 70 would only require 82.0 percent of her age 70 benefits to be as well off in EUT terms as she would be if claimed at age 62, compared with 98.8 percent under the EPV model, reflecting the high value placed on the additional longevity insurance acquired as a result of delaying claiming. Note that the SSEIs of the EUT model and the CPT model presented below cannot be multiplied together to calculate the effects of delaying claiming for multiple years because the effects are not linear.

Turning to calculations under the CPT model, the focus of this paper, all SSEIs right under the diagonal elements are larger than 1, indicating that it is always optimal for single women to claim their Social Security benefits immediately after becoming eligible at various retirement ages. Further, they experience larger losses if they delay claiming at a later age. A single female who delays claiming from age 62 to 63 would require a 1.7 percent increase in her age 63 benefits to be as well off in CPT terms as at the reference claiming age of 62. If she delays from age 69 to 70, she would require a 3.8 percent increase in her age 70 benefits to be as well off as the reference claiming age of 69. Finally, the cumulative effects show that individuals suffer larger losses if they delay for a longer period to claim their benefits. For example, if a single female retired at age 62 postpones claiming to age 66, her FRA, the SSEI is 1.050 and she would require a 5.0 percent increase in her age 66 benefits to be as well off in CPT terms as she would be if she claims at age 62. If she further delays until age 70, the corresponding SSEI is 1.146 and she would require a 14.6 percent increase in her age 70 benefits to be as well off as the reference claiming age of 62.

Single men exhibit very similar patterns under all three types of models as single women. Under the EPV model, a single male maximizes his benefits if he claims at age 64, and he would only be slightly worse off claiming at other ages. For example, if he delays claiming until age 66, his FRA, he would only require a 0.9 percent increase in his benefits to obtain the EPV of benefits claimed at his optimal claiming age of 64. Under the EUT model, the SSEIs of delaying claiming for one year (the SSEIs right below the diagonal elements) are smaller than 1 until age 69, indicating his expected utility is maximized if he claims at age 69. A single male who delays claiming from age 62 to 69 would only require 84.7 percent of his age 69 benefits to be as well off as he would be if claimed at age 62. Under the CPT model, the SSEIs of postponing claiming for one year at various retirement ages range from 1.014 to 1.053, showing that it is always optimal for him to claim immediately after becoming eligible. Those who delay claiming for one year at various retirement ages would require 1.4–5.3 percent increases in benefits to be as well off as claiming immediately.

Thus, we show that, although an actuarially fair Social Security system is attractive for the rational EUT individuals who would like to insure their consumption at advanced ages, it would not attract the CPT individuals.

Decomposition of the CPT model effects

As introduced at the beginning of the methodology section, the CPT model has three unique features: 1) diminishing sensitivity; 2) loss aversion and 3) probability weighting. In this section, we decompose the effects of the CPT model to examine which feature is the most important in generating the patterns of early claiming. We first re-calculate the SSEIs with all three features of the CPT model closed, meaning that the value function is linear (by setting both parameters α and β to 1), there is no loss aversion (by setting parameter λ to 1), and the value of the prospect is calculated with probabilities directly (by setting $\pi_i = p_i$). The SSEIs are reported in the second column of Table 2, with the SSEIs of the base case (full CPT model) in the first column for comparison. To save space, we only report SSEIs for delaying claiming for one year at various decision-making ages.[24] The upper panel is for single women and the lower panel is for single men. We show that, with all three features closed, the case is equivalent to the EPV calculations. The only difference is that this case evaluates benefit gains and losses from delaying claiming relative to claiming immediately, rather than the amount of benefits. As expected, the SSEIs are the same as the EPV model.

We next consider the effect of each of the three features. The third to the fifth column in Table 2 report the SSEIs for the CPT model with only diminishing sensitivity (D.S.), loss aversion (L.A.), and probability weighting (P.W.) feature at work respectively. The feature of diminishing sensitivity marginally decreases SSEIs compared with the EPV equivalent case. This is because when individuals delay claiming for one year, they suffer a sizable loss in the decision-making year but obtain incremental gains in the years thereafter. The feature of diminishing sensitivity reduces the magnitude of the extreme outcomes and the costs of delaying claiming. However, the effect is very small. The features of loss

[24]The cumulative effects are available upon request.

Table 2. Social Security equivelent income – decomposition of the CPT model effects.

Retirement Age	Base Case	EPV Equivalent	Only D.S.	Only L.A.	Only P.W.	No P.W.	No L.A.	No D.S.
				Single Women				
62	1.017	0.998	0.998	1.007	1.002	1.007	1.001	1.017
63	1.003	0.985	0.984	0.994	0.988	0.993	0.987	1.003
64	1.012	0.992	0.992	1.002	0.996	1.002	0.995	1.012
65	1.020	0.999	0.998	1.009	1.003	1.009	1.002	1.020
66	1.015	0.993	0.992	1.004	0.996	1.004	0.996	1.014
67	1.023	1.000	1.000	1.012	1.004	1.012	1.003	1.022
68	1.031	1.007	1.007	1.019	1.011	1.019	1.010	1.031
69	1.038	1.014	1.013	1.027	1.017	1.027	1.016	1.038
				Single Men				
62	1.027	1.006	1.005	1.018	1.008	1.018	1.008	1.027
63	1.014	0.993	0.992	1.005	0.995	1.005	0.994	1.014
64	1.024	1.001	1.000	1.014	1.003	1.014	1.002	1.023
65	1.032	1.008	1.008	1.022	1.010	1.022	1.009	1.031
66	1.027	1.002	1.002	1.017	1.004	1.017	1.004	1.026
67	1.036	1.010	1.010	1.026	1.012	1.026	1.011	1.035
68	1.045	1.018	1.017	1.034	1.019	1.034	1.019	1.043
69	1.053	1.025	1.025	1.042	1.026	1.043	1.025	1.052

Notes: As previous tables.

aversion and probability weighting both significantly increase SSEIs compared with the EPV equivalent case. When individuals are loss averse, the magnitude of the loss that individuals suffer from not receiving any benefits in the decision-making year would be greatly magnified, inducing individuals to claim immediately. When individuals overweight small probabilities, they overestimate the chance that they could die early in which case they receive less lifetime benefits and suffer losses. Therefore, the feature of probability weighting also encourages individuals to claim immediately. We show that the feature of loss aversion has a stronger effect. Taking delaying claiming for one year at age 62 for example, if the CPT model only has the loss aversion feature, a single female and male would require 0.7 and 1.8 percent increases in their age 63 benefits respectively to be as well off as the reference claiming age of 62. The increases reduce to 0.2 and 0.8 percent if the CPT model only has the feature of probability weighting.

We then consider two features at work each time and report their respective SSEIs in the last three columns of Table 2. Column 8 shows that the combined effect of loss aversion and probability weighting features significantly increases the SSEIs compared with the EPV equivalent case. A single female and male who delay claiming from age 62 to 63 would require 1.7 and 2.7 percent increases in their age 63 benefits to be as well off in CPT terms as they would be if claimed immediately at age 62, which is the same magnitude as the full CPT model with all three features. This is not surprising, as the two features both significantly motivate individuals to claim early while the feature of diminishing sensitivity only has a negligible effect.

We have thus demonstrated that for the CPT model, the main feature that leads to early claiming is loss aversion. Probability weighting comes the second. Together, fear of receiving lower lifetime benefits in the case of early death induces the CPT individuals to claim immediately after becoming eligible.

Sensitivity analysis

As the calibrated parameters may affect individuals' claiming decisions, we illustrate the robustness of the proposed hypothesis by assigning alternative plausible parameter values. Coile et al. (2002) and Hurd, Smith, and Zissimopoulos (2004) find that individuals with higher self-reported mortality rates are more likely to claim their benefits early. We therefore consider an alternative in which individuals have the average mortality rates of a low mortality socio-economic group (white with four or more years of college education) estimated by Brown, Liebman, and Pollet (2002). Individuals with higher life expectancy could place a higher value on the additional benefits. Further, the value of delaying claiming depends on what rates individuals use to discount their future benefit gains. We thus experiment an alternative real interest rate of 1 percent to reflect the current low interest rate environment. With a lower interest rate, the benefit gains in the future become more valuable. Finally, there are studies (Camerer and Ho 1994; Wu and Gonzalez 1996)

Table 3. Social Security equivelent income – sensitivity analysis.

Retirement Age	Base Case	Low Mortality Rates	Low Real Interest Rate	Greater Concavity/ Convexity
			Single Women	
62	1.017	1.013	1.000	1.016
63	1.003	0.999	0.987	1.003
64	1.012	1.008	0.996	1.012
65	1.020	1.015	1.003	1.020
66	1.015	1.010	0.998	1.015
67	1.023	1.018	1.006	1.024
68	1.031	1.026	1.014	1.033
69	1.038	1.034	1.021	1.040
			Single Men	
62	1.027	1.021	1.010	1.030
63	1.014	1.008	0.997	1.018
64	1.024	1.017	1.006	1.027
65	1.032	1.025	1.014	1.037
66	1.027	1.020	1.009	1.032
67	1.036	1.029	1.018	1.042
68	1.045	1.038	1.026	1.051
69	1.053	1.046	1.034	1.061

Notes: Low mortality rates are the group average mortality rates of white who have completed four or more years of college. The group-specific mortality rates are calculated by multiplying male and female mortality rates of the 1952 birth cohort by the relative mortality factors reported in Brown, Liebman, and Pollet (2002). Low real interest rate is 1 percent, comparing with 3 percent in the base case calculations. The experiment of greater concavity/convexity assumes both values of parameters α and β are 0.5.

estimate lower values of α and β which govern the degree of concavity/convexity of the value function under the CPT model. We therefore experiment a lower parameter value of 0.5 to illustrate the robustness of our results over degrees of concavity/convexity.

Table 3 reports the results of the sensitivity analysis. Again, to save space, we only report the SSEIs for the CPT model and only for delaying claiming for one year at various decision-making ages. The upper panel is for single women and the lower panel is for single men. In turn, we consider the effects of low mortality rates, a low real interest rate and a higher degree of concavity/convexity in the second to the fourth column. The SSEIs of the base case are also presented in the first column for comparison.

As expected, individuals who have lower mortality rates receive a higher value on the additional benefits acquired because of delaying claiming. The SSEIs at all ages are lower than the base case. For example, the SSEI of a single female who delays claiming from age 62 to 63 is 1.013, indicating that she would require a 1.3 percent increase in her age 63 benefits to be as well of as she would be if claimed at age 62, compared with 1.7 percent in the base case. More interestingly, if a single female makes the claiming decision at age 63, she now should delay claiming for one year even under the CPT model, as the corresponding SSEI is less than 1. She would only require 99.9 percent of her age 64 benefits to be as well off in CPT terms as claiming immediately at age 63. At all other ages, claiming immediately remains to be her optimal choice, reflecting individuals fear of suffering benefit losses even when there are only very small probabilities of early death.

For the low real interest rate environment, individuals place greater weights on their benefit gains at advanced ages. Although the magnitudes are small, it becomes optimal for a single female to delay claiming for one year at age 63, 64 and 66. The corresponding SSEIs are 0.987, 0.996 and 0.998 respectively, showing that by delaying claiming for one year, she only requires 98.7 percent, 99.6 percent and 99.8 percent of her delayed benefits respectively to be as well off as she would be if claimed immediately.

For the experiment with a higher degree of concavity/convexity, individuals in general have a larger incentive to claim early. For single females who delay claiming from age 62 to age 66, their full retirement age (FRA), the SSEI is 1.054, indicating they would require 5.4 percent increase in their age 66 benefits to be as well off as they would be if claimed at age 62, compared with 5.0 percent in the benchmark case.

Again, single men display very similar patterns as single women. Because men usually live shorter than women, they place a lower value on delaying claiming. All SSEIs, except men at age 63 under the 1 percent real interest rate scenario, are larger than 1, indicating claiming immediately is their optimal choice under the CPT model.

To sum up, although the costs of delaying claiming vary with alternative assumptions regarding mortality risks, real interest rates and value function curvatures, the conclusion is robust: the optimal choice of majority individuals is to claim immediately after becoming eligible under the CPT model.

Married couples

As most individuals are married at the time of retirement, we consider the results of married couples another important sensitivity analysis. The calculations for married couples are more complex than single individuals, because spousal and survivor benefits are involved. Delaying claiming by the husband increases the value of his retired worker benefits and the wife's survivor benefits because the wife's survivor benefits are based on his benefits, not PIA. But it conversely decreases the value of the wife's spousal benefits as the wife can only claim her spousal benefits after the husband claims. In the base case of married couples, we consider a one-earner couple. Both spouses are at the same age and have population mortality of the 1952 birth cohort.[25] Previous literature shows that even with the EUT model, it is optimal for the wife to claim as soon as possible in most scenarios (Sun and Webb 2011). Thus, we assume that the wife always claims as early as possible.

The first column in Table 4 reports SSEIs for the hypothetical couple. SSEIs range from 1.000 to 1.049, all larger than 1. It indicates that claiming immediately after becoming eligible is the optimal choice at all ages for the married couple under the CPT model. As in the base case of the singles, the losses are greater at older ages. If the husband delays claiming from age 62 to 63, the couple would require a 2.6 percent increase in benefits to be as well off as if he claims at the reference age of 62. If the husband delays from age 69 to 70, the couple would require a 4.9 percent benefit increase to be as well off.

Age differences between the husband and the wife increase the value of delaying claiming of the husband. This is because age differences increase the number of years the wife is expected to outlive her husband and hence increases the value of her survivor benefits. It also reduces the costs of delaying claiming to her spousal benefits. If the husband is t years older than the wife, then delay by the husband from 62 to $62 + t$ can never result in any loss of spousal benefits. We thus conduct analysis for a couple in which the husband is 3 years older than the wife, which is the average age difference reported in the HRS data. The second column in Table 4 reports the SSEIs for this couple. We show that the costs of delaying claiming in CPT terms are reduced and the SSEIs are lower than the married couple base case at all ages. It even becomes optimal for the husband to delay claiming for one year if he makes the claiming decision at age 63. The SSEI is 0.998, meaning that the couple would require 99.8 percent in benefits to be as well off claiming at age 64 as they would be were they to claim immediately at age 63. At all other ages, claiming immediately remains to be the optimal choice of the couple under the CPT model.

Relative PIAs between the husband and the wife also has an impact on the couple's optimal claiming decisions. In the one-earner case, delay by the husband in claiming his retired worker benefits can prevent the wife from claiming her spousal benefits. However, if the wife is entitled to her own retired worker benefits, she can claim her own benefits at 62 and switch to spousal benefits when her husband claims and thus the costs of delaying claiming of the husband is decreased. We consider an exercise that the wife's PIA is 50 percent of the husband's PIA, entitling her to claim her own benefits. The SSEIs of the two-earner couple are reported in the third column in Table 4. Again, we show that the costs of delaying claiming of the husband in CPT terms are reduced at all ages. In addition, at age 63, 64 and 66, it becomes optimal for the husband to postpone claiming for one year. However, the benefits from delaying are very small. The SSEIs at age 63, 64 and 66 are 0.995, 0.996 and 0.999 respectively, showing that the couple would require 99.5, 99.6 and 99.9 percent of the delayed benefits to be as well off as claiming immediately.

Table 4. Social security equivalent income – married couples.

Retirement Age	Base Case	Wife 3 Years Younger	Two-earner Couple
62	1.026	1.016	1.014
63	1.000	0.998	0.995
64	1.003	1.001	0.996
65	1.013	1.017	1.003
66	1.030	1.002	0.999
67	1.036	1.010	1.005
68	1.043	1.018	1.011
69	1.049	1.042	1.016

Notes: The base case is a one-earner couple, both the same age, with population average mortality for the 1952 birth cohort. The husband has a PIA of $1,000. Interest rate and time discount rate both equal 3 percent. As age difference has an impact on the value of both spousal and survivor benefits, we consider an alternative in which the wife is 3 years younger than the husband and has population mortality for the 1955 birth cohort. We finally consider married couples in which the wife is entitled to her own retired worker benefits. The last column reports SSEIs for two-earner households in which the wife's PIA is 50 percent of that of her husband."

[25]All the other parameter values are the same as in the base case of singles.

Although at some ages of certain scenarios, it is optimal for the married couple to delay claiming for a short period of time, our conclusion holds in general: under the CPT model, majorities of couples should claim their Social Security benefits immediately after being eligible.

VI. Conclusion

Some households have little choice but to claim their Social Security benefits immediately on retirement because they lack the liquid financial wealth to separate their retirement from their claiming decision. But many households who have sufficient financial resources also claim their benefits soon after becoming eligible. We show that the CPT model can explain the prevalence of early claiming among well-informed households with plausible preference parameters. We calculate that households who delay claiming suffer significant value losses in CPT terms compared with claiming immediately. Fear of receiving a smaller amount of lifetime benefits motivates them to claim immediately after becoming eligible.

Using data from the Health and Retirement Survey (HRS), a national representative panel of older individuals, we further perform empirical analysis on claiming behaviors of retired workers.[26] We find that, after controlling for all rational factors that could affect claiming decisions under the EUT model, i.e. age, gender, marital status, self-reported probability of living to age 75, income, net worth (defined as financial wealth plus the value of primary residence minus debts if applicable), degree of risk aversion and financial planning horizon (proxy for time preference), individuals with less years of education have a significantly higher probability of claiming their Social Security benefits within one year of becoming eligible.[27] Because previous studies (Gachter, Johnson, and Herrmann 2010; Johnson, Gachter, and Herrmann 2006) have shown that individuals with less education are more likely to have a higher degree of loss aversion under the CPT model, our empirical results provide indirectly evidence that the early claiming behaviors could be associated with the CPT model. To keep the paper compact and to focus on the theoretical predictions, we choose not to report the empirical results. All empirical results are available upon request.

It seems that older households may not make rational optimal claiming decisions because of psychological biases, a dynamic that holds important policy implications. Reductions in Social Security replacement rate and the shift from defined benefit pensions to 401(k) and other defined contribution plans have increased older households' exposure to longevity risk. Thus, if older households claim their Social Security benefits early because of psychological biases, the Social Security Administration may need to consider ways in which these biases can be countered. The optimal policy response could be appropriate financial education to guide retired workers to view delaying claiming as the purchase of valuable longevity insurance, rather than as a risky gamble.

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[26]First interviewed in 1992, the HRS originally includes individuals born between 1931 and 1941 and their spouses at any age. Respondents are re-interviewed every two years. Younger cohorts were added to the survey in 1998, 2004 and 2010. The latest wave being available is 2014. The dataset contains considerable details on household demographic and socio-economic characteristics, including self-reported retirement date and Social Security claiming date, making it suitable for our purpose.

[27]The results are consistent with Hurd, Smith, and Zissimopoulos (2004) and Sass, Sun, and Webb (2007).

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Appendix

A.1. *The Expected Present Value (EPV) model*

The EPV of an individual's social security benefits claimed at age x can be calculated as:

$$EPV_x = \sum_{t=62}^{T} s_t \left(\frac{1}{1+r}\right)^{t-62} B_{t|x} \tag{A1}$$

Where s_t is the probability that the individual remains alive at age t. r is the real interest rate. $B_{t|x}$ is the social security benefits received at age t if claimed at age x. T is the terminal age

A.2. *The Expected Utility Theory (EUT) model*

The rational individual maximizes her expected discounted lifetime utility:

$$U_x = \sum_{t=62}^{T} s_t \beta^{t-62} \frac{C_t^{1-\sigma}}{1-\sigma} \tag{A2}$$

Subject to the following budget constraint:

$$W_{t+1} = \left(W_t + B_{t|x} - C_t\right)(1+r) \tag{A3}$$

where s_t, $B_{t|x}$ and r are the same as in the EPV model. β is the time discount factor. σ is the coefficient of risk aversion. C_t denotes the individual's consumption at age t. W_t is the non-annuitized financial wealth at age t. Each period, the individual receives her Social Security benefits, and decides how much of un-annuitized wealth to consume. The problem is solved using dynamic programming.