Social Security Benefits, Life Expectancy and Early Retirement*

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VERY PRELIMINARY AND
VERY INCOMPLETE

Abstract

The Social Security Administration computes individual pension benefits using the average survival in the population. However, less educated individuals, and those with lower lifetime incomes, have lower life expectancies than their more educated and richer counterparts. We investigate how heterogeneity in longevity interacts with homogenous social security rules in shaping retirement patterns. In particular, the increase in Social Security benefits for each additional year of work after early retirement age is approximately actuarially fair for individuals with the average longevity. Thus, it is less than actuarially fair for individuals whose life expectancy is lower than average. As a result, individuals with below-average longevity have lower incentives to delay retirement past early retirement age. We estimate a structural dynamic programming model of retirement using microdata from the Health and Retirement Study. We then use the estimated model to simulate retirement behavior under a counterfactual social security system in which individual specific survival odds are used to compute individual benefits. This allow us to investigate the role of actuarial unfairness plays in shaping the observed patterns of early retirement.

*We thank comments by Eric French, Maurizio Mazzoco, Victoria Prowse, Steve Stern and participants at several conferences. All errors remain our own.
1 Introduction and Motivation

The Social Security Administration (SSA) is trying to give incentives for individuals to remain at work for longer. From a budgetary point of view, the SSA should be indifferent about the retirement age of an individual (as long as benefits are adjusted in a budget-neutral way, as they seem to be). The main benefit of these extra years of work seems to be for the individual, who will have income from his wage for one or two more years, and then higher benefits for the remainder of his life, i.e. higher lifetime income and a lower chance to end up in poverty in old age. This is particularly relevant for poor individuals, because they derive most of their income from social security. In this paper we investigate whether these individuals are actually being given more incentives for early retirement than their richer counterparts by the use of the same survival curve for everyone (the obligation to annuitize at a single price).

In particular, our research question is the following: Are poorer individuals discouraged from working past early retirement age because of their lower life expectancy? Before age 65, each extra year of early claiming work future benefits are reduced by 6.7%. This has been found to be approximately actuarially fair. But it is so for the average individual. By delaying retirement, individuals with lower-than-average life-expectancy would get increases in future benefits which are less-than-actuarially-fair, since they’ll get the higher benefits for a shorter amount of time. We use a model of retirement behavior to simulate their optimal retirement ages under an alternative social security regime where their benefits are annuitized using their own life-expectancy. This is a hypothetical system that would be actuarially fair for everyone, not just for the average person. We can then see if these individuals would work for longer.

The paper contributes to at least two strands of literature. First, our paper contributes to the literature on microeconometric dynamic programming models of retirement with uncertainty. Seminal papers include Lumsdaine et al (1992) and Berkovec and Stern (1991). Subsequent work by Rust and Phelan (1997) emphasize the need for uncertainty and the importance of borrowing constraints. French (2005) extends this framework by focusing on the interplay between health, savings and retirement. Blau and Gilleskie (2008) and French
and Jones (2011) introduce employer provided health insurance and Medicare whereas Blau and Gilleskie (2006) and Casanova (2010) model joint retirement decisions of spouses. van der Klaauw and Wolpin (2008) incorporate many of these extensions and focus on low income households. More recently, there’s been an effort to understand the interactions between retirement decisions and longevity. See, for example Prowse and Haan (2013).

More substantively, the paper contributes to the literature on the redistributive role of social security. See, among others, Cohen, Steuerle and Carasso (2000), Gustman and Steinmeier (2000) and Liebman (2001). While Social Security is on the whole fairly progressive, the use of a uniform survival curve induces some regressivity in the system.

The rest of the paper is organized as follows. Section 2 describes the data and presents some evidence linking subjective retirement probabilities with longevity expectations. Section 3 presents the model. Estimation Results and Counterfactual Experiments are presented in Section ?? . Conclusions follow.

2 The HRS Data


In our reduced form analysis we exploit subjective expectations about future choice probabilities. The question we use elicits the respondent’s subjective probability of working beyond age 62 from today’s (i.e time of interview) vantage point. The specific wording of the question is: What’s the probability that you will work full time after age 62?

The HRS also provides data on the observed states variables for our dynamic model (health, subjective longevity expectations, wealth, age, AIME) along with wages and out of pocket medical expenses.

We focus on married men. These are men who were original HRS respondents and those who were spouses of original female HRS respondents. We include all men in the HRS who
were married in 1992 and remained married throughout the sample period. We follow these respondents until they die.

The HRS is biennial. We focus on households with no defined benefit pensions and those with defined contribution pensions only. Modeling households with defined benefit pensions involves additional complexities. In particular there are retirement incentives embedded in the accrual schemes of these pensions. Employer-sponsored defined benefit pension accrual schemes provide incentives for people to retire at a specific age window, usually not earlier than 55 and not later than 65.\(^1\) We exclude these households from the sample.\(^2\)

Data on Wealth. Our measure of financial wealth includes HRS variables for total household wealth\(^3\) including wealth held in IRAs and housing wealth. AIME as of 1992 is observed in restricted data from SSA and it is updated in the following years using the post-1992 earnings experience.\(^4\)

We also exploit data on earnings. We have before tax earnings but in the model we apply the appropriate tax rates to obtain after-tax income in the budget constraint.

We assign labor supply status using data on hours worked per week. If working 5 to 35 hours we classify the individual as working part-time. If working more than 35 hours we classify him as working full-time.

### 2.1 Reduced Form Evidence

Before going into the details of the model we provide some descriptive evidence that our proposed mechanism is at play. Indeed, if workers with low life expectancy are more likely to take up early retirement at 62 we should see a positive association between the probability of work at 62 and subjective longevity expectations. We use a specific measure of longevity:

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\(^1\)See Lumsdaine and Mitchell (1999).

\(^2\)See Blau and Gilleskie (2008), French and Jones (2011) and vande Klaauw and Wolpin for models of retirement with explicit modelling of defined benefit pension details in the budget constraint.

\(^3\)The net value of total wealth is calculated as the sum of all wealth components less all debt. This total include the value of IRAs and Keogh plans, as well as the value of any real estate (excluding second home), vehicles, or businesses. We use the variable HwTOTA.

\(^4\)AIME is available in restricted access data that links HRS respondents to their social security records. We have no access to the SSA restricted data. An approximation to AIME is constructed as follows: we use the observed benefits of people who already retired. Then we look when did they retire. With these two pieces of information and the function relating the the primary insurance amount (PIA) to benefits we recover PIA. Then we back out the AIME from PIA.
self-reported subjective probability of being alive at 75. Consider a linear model for the self-reported subjective probability of working at 62.

\[
\Pr(\text{Work Full Time After } 62_{ia}) = \beta_0 + \beta_1 \text{Subjective Probability Alive at } 75_{ia} \\
+ \beta_2 \text{Controls}_{ia} + \varepsilon_{ia}
\]

Multiple elicitations per HRS respondent regarding both, longevity beliefs and subjective probabilities of working full time after 62 allow us to estimate this model with fixed effects. We control for health status. We find a significant $\hat{\beta}_1 = 0.15$. The lower the life expectancy, the higher the chances that the individual will retire early, over and above the negative effects of health on labor supply. In particular, the results imply that a 1 percentage point increase in the subjective probability of being alive at 75 increases the subjective probability of working at 62 by 0.15 percentage points. This implies, for example, that a person who believes that his probability of being alive at 75 is 30% is 7.5 percentage point less likely to work full time after age 62 relative to a situation in which he believes this probability to be 80%. This reduced form estimate captures a net effect that is consistent with at least two mechanisms:

1. INCENTIVE MECHANISM: a reduction in longevity beliefs imply reduced (i.e. more actuarially unfair) rewards from delaying retirement after 62 and therefore reduced incentives to delay retirement beyond age 62.

2. PLANNING HORIZON MECHANISM: a reduction in longevity beliefs could change a person’s decision to work at earlier ages, even if social security benefits were adjusted to accommodate those changes in life expectancy. That is, even if current benefits and incentives to delay claiming both increased to reflect the shorter lifetime a person may find optimal to retire earlier as fewer years of work may be needed to finance his post-retirement years.

Another reason to observe a correlation between expected longevity and expectations about future labor supply is realted to health status. If a bad health shock increases the utility from leisure, it is somewhat persistent and induces a downwards revision regarding own
expected survival one would also see a positive correlation between subjective expectations of longevity and future labor supply. Our fixed effects estimates above control for health status and so this third mechanism is already controlled for. Moreover, these results highlight the potential importance of distinguishing longevity beliefs from current health in dynamic models of retirement.

3 The Model

3.1 Choices and Preferences

We focus on the retirement behavior of males between ages $A$ and $\bar{A}$. At age $a$, individuals can choose to work full-time ($d_a = 1$), part-time ($d_a = 2$) or not work at all ($d_a = 3$). In addition to the discrete labor supply choices we allow for a continuous choice of consumption to enter the utility function. Every period individuals choose whether to work (part time or full time) or not. Therefore retirement is not an absorbing state and individuals can re-enter the labor force or "unretire". We also allow for a post-retirement period before death in which the individual continues to make consumption and savings decisions at age $a = A, A + 1, \ldots$ until death.

We parameterize the utility function with a vector of parameters $\theta_u = \{\alpha, \rho, \phi\}$. Household utility is given by

$$u^{d_a}(c_a, l_a, \theta_u) = \frac{1}{1 - \rho} \left( c_a^\alpha l_a^{1-\alpha} \right)^{1-\rho} \tag{2}$$

where $c_a$ denotes consumption, $l_a$ denotes leisure, $\rho$ is the coefficient of relative risk aversion and $\alpha$ parameterizes the intra-temporal consumption-leisure tradeoff. Effective hours of leisure are given by

$$l_a = L - h(d_a) - \phi \{H_a = 1\} \tag{3}$$

where $L$ is the annual leisure endowment and $h(d_a)$ is the number of annual hours worked when choosing discrete work alternative $d_a$ at age $a$ and $\phi$ captures the loss of time endowment hours due to bad health ($H_a = 1$).
The timing of decision making is as follows. In each period (age) \( a = A, ..., A \) in which he is still alive, the agent first chooses a discrete labor supply alternative \( d_a \) for that age. A shock affecting his own wage \( \varepsilon_w \) is realized after the labor supply decision has been made but before consumption decisions are made. This shock is i.i.d. and continuously distributed with \( \varepsilon_w \sim G_{\varepsilon_w}(\varepsilon_w) \). After observing these shocks and given the labor supply decision \( d_a \) made at the beginning of period \( a \), the continuous household consumption choice for age \( a, c_a(d_a) \) is determined optimally.

Let \( a^D \) be the age of death. Any unspent assets remaining at age \( a^D \) are valued according to a bequest function

\[
b(W_{a^D}; \theta_b, \kappa) = \theta_b \frac{(W_{a^D} + \kappa)^{1-\rho}}{1 - \rho}
\]

(4)

with additional parameters \( \theta_b \) and \( \kappa \).\(^5\)

### 3.2 Budget Constraint

We allow for savings by having a state variable keep track of wealth \( W_a \) and a budget constraint that connects assets at age \( a \) with assets at age \( a + 1 \) given consumption \( c_a \) at age \( a \) and interest rates \( r \). We follow French (2005) in assuming \( W_a \geq 0 \) holds at every age. That is, we allow individuals to save and deplete assets, but we do not allow them to borrow against future labor or social security income. Allowing for savings allows individuals in the model to protect against several sources of uncertainty (wage, health, longevity).\(^6\) The budget constraint is given by

\[
c_a + s_a = W_a + Y_\tau(rW_a, w_a h(d_a), y_a^f) + B_a \times s s b_a + T_a
\]

(5)

for \( a = A, A + 1, ..., a^D \) where \( a^D \leq A^* \) is age of death, \( c_a \) is consumption, \( W_a \) denotes asset wealth at age \( a \), \( Y_\tau() \) is a function with policy parameters \( \tau \) that converts before-tax into after-tax income, \( w_a \) is the hourly wage and \( h_a \) are annual work hours for the individual.

\(^5\)\( \kappa \) has been used in the literature to explain the frequent occurrence of zero bequests. \( \kappa \) has been found to be sizable. Indeed if \( \kappa = 0 \), the terminal value associated with \( W_{a^D} = 0 \) would be \( -\infty \).

\(^6\)Another source of uncertainty, which we abstract away from, is out of pocket health care costs.
$B_a$ is an indicator for whether the individual is receiving social security benefits at age $a$, $ssb_a$ denotes income from social security benefits at that age and $T_a$ is a transfer. \(^7\)

Individual wages are treated as within period outcomes that influence the savings decision.\(^8\) Wages for individual $i$ depend on a permanent component $\mu_i^w$, age $a_i$ and the i.i.d. shock $\varepsilon_{ai}^w \sim N(0, \sigma_w^2)$

$$
\log(w_{ai}) = \mu_i^w + \mu_1^w a_i + \mu_2^w a_i^2 + \mu_3^w \{h_{ia}^m = PT\} + \varepsilon_{ai}^w \tag{6}
$$

where $\mu_3^w$ captures a wage penalty associated with part-time work, $h_{ia}^m = PT$.

### 3.2.1 Social Security and Private Pensions

Social security benefits are given by

$$
ssb_a = \begin{cases} 
B^{SS} \left( \text{PIA} \left( \text{AIME}_a \right), a^B, \left\{ \text{PIA}_{a=62} \right\}_{a=63}, d_a \right) & \text{if } a \geq 62 \\
0 & \text{if } a < 62 
\end{cases} \tag{7}
$$

We choose parameters to capture the rules prevailing in 1992. First, individuals are ineligible for Social Security benefits before the early retirement age of 62. After age 62 the level of benefits depend (in a progressive fashion) on Average Indexed Monthly Earnings, AIME$_a$, the average monthly earnings in the 35 highest earnings years.\(^9\) The function $B^{SS}$ also depends on the age $a^B$ at which the individual started drawing benefits ($a^B \geq 62$). Indeed, if the individual applies for benefits year before the normal retirement age of 65 his benefits are permanently reduced by 6.7% for each year of early (i.e. pre-65) retirement. For example, if someone begins collecting benefits at 62, his checks will be 20% lower. As discussed,

\(^7\)We abstract from the Social Security application decision and follow Casanova (2010) and van der Klaauw and Wolpin (2008) in assuming that collection of social security benefits begins as soon as the individual retires (i.e. during the first age $a \geq 62$ at which he chooses $d_a = 3$. If the individual unretires, he continues to claim his SS benefits but it is then subject to the social security earnings test by which some of his benefits are taken away. However, the individual regains part of these lost benefits in the future once he retires again. There are no incentives to postpone collection after age 70 because the adjustment factors for delayed claiming no longer apply after age 70. Therefore, in our model every individual begins collecting benefits at age 70 at the latest.

\(^8\)The wage shocks are realized after labor supply has been determined but before consumption decisions have been made.

\(^9\)After the first 35 years, AIME is only updated upwards if the current earnings are greater than earnings in a previous year of work.
this is roughly actuarially fair for the individual with the average survival curve after 62 years of age, \( \pi_{a=63}^{SSA} \), the one used by the SSA to come up with these discounts. On the other hand, these discounts are not actuarially fair for those with lower life expectancy. In addition to discounts for early retirement, there are increments in benefits for delaying claiming beyond age 65. For every year between ages 65 and 70 that benefit application is delayed, benefits rise by 4.5%. This is actuarially unfair and thus generates an incentive to draw benefits by age 65 even for the individual with average survival. Defined contribution pension wealth held at age \( a \) is included in \( W_a \). We abstract away from the Social Security application timing decision. Instead we follow Casanova (2010) and van der Klaauw and Wolpin (2008) and assume that whenever a worker goes for the first time through a period of no work (i.e. neither full nor part time) at or after age 62, that’s the periods in which he files the application with SSA and begins collecting benefits.

### 3.3 Evolution of State Variables

Given the observed state \( z_a = \{a, H_a, W_a, \text{AIME}_a, \mu^w, \pi_{15|a}^e\} \) at age \( a \) and the choices \( d_a, c_a \), what’s the distribution of the state variables at age \( a + 1 \)?

**Health.** Health status at age \( a \), \( H_a \) affects the utility of leisure. It transitions exogenously. We consider a very simple good/bad specification for the exogenous health state: \( H_a = 2 \) if health is good, \( H_a = 1 \) if health is bad. The transition probability is given by \( \Pr(H_{a+1}|H_a, a, \lambda_H) \). Since the HRS is biennial, to estimate this probability we actually specify logit models for the probability of good health two periods ahead with parameters \( \lambda_H \). We then recover one-period ahead transitions.

**Wealth.** The transition for the state variable that keeps track of the individual’s wealth is stochastic as it depends on the realization of the wage shocks. Conditional on a labor supply choice, a given shock to wages and the consumption, its evolution is deterministic and given by the budget constraint

**AIME.** The Average Indexed Monthly Earnings, \( \text{AIME}_a \) is a key state variable as it constitutes the key input to derive the primary insurance amount (PIA) and ultimately the level of benefits, \( \text{ssb}_a \). Since AIME keeps track of the highest 35 years of earnings it only gets updated whenever earnings in a given year are higher than those in the 35th highest year.
year of earnings.

**Aging and Survival.** Survival is uncertain. We assume that whenever they have survived until age 89, individuals die with probability one at the beginning of age $A^* = 90$. Trivially, if an individual of age $a$ survives until next period, age next period is $a + 1$.

A novel feature of our model is that we include a feature of the subjective survival curve of each individual \( \{ \pi^{s}_{a+t|a} \}_{t=1}^{A^*-a} \) from the perspective of age $a$ as an additional observed state. Moreover, we allow this state to transition non-trivially over time as the individual receives new information and updates his longevity beliefs. Including the whole survival curve into the state space would amount to the inclusion of 30 continuous state variables for a 60 year old individual. We of course need to impose some substantial structure to handle this complex object. To move forward we first discretize the subjective beliefs $\pi^{s}_{a+t|a}$ onto ranges and only allow them to take $G_\pi$ possible values for each $t$. For example if $G_\pi = 3$ we could have $g_\pi = 1, 2, 3$

<table>
<thead>
<tr>
<th>$g_\pi$</th>
<th>subjective probability range</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>$[0, 0.10)$</td>
</tr>
<tr>
<td>2</td>
<td>$[0.10, 0.49)$</td>
</tr>
<tr>
<td>3</td>
<td>$[0.49, 1]$</td>
</tr>
</tbody>
</table>

Moreover, we leverage our observation of the respondents subjective assessment at age $a$, regarding the probability of being alive at age 75, $\pi^{s}_{75|a,i}$ for each individual $i$ and focus our modeling of transitions for the survival curve on this object. Finally, we provide a parsimonious model for the evolution of the (discretized) pivotal belief, $\pi^{s}_{75|a}$.

\[
\text{Pr} \left( \pi^{s}_{75|a+1} | \pi^{s}_{75|a}, a; \lambda^\pi \right) \tag{8}
\]

Again, a fully flexible modeling for this would entail an unrestricted $G_\pi \times G_\pi$ transition matrix with each element giving the probability of holding a given belief range next period $\pi^{s}_{75|a+1}$ given the one held today $\pi^{s}_{75|a}$. Age enters by construction, as $\pi^{s}_{75|a+1}$ is mechanically increasing in $a + 1$, as the probability of being alive at 75 should approach one, as the person
approaches age 75. The mechanical effect of age should be fairly smooth and could be captured parametrically. We then propose a multinomial logit model with parameters $\lambda^\pi$ for the evolution of this longevity belief. In this model an outcome is a category $\pi^{s^a}_{75a+1}$ whose probability is modeled as a function of $\left(\pi^{s^a}_{75a}, a\right)$. This gives a parsimonious representation for the evolution of survival beliefs, a key feature of our model. Note that the parameters of this model can be estimated separately in a first stage and therefore do not substantially increase the computational burden of estimation for preference parameters.

While the entire individual specific survival curve is relevant for current behavior, when solving the model via backwards recursion we only need the one-period-ahead survival probability. We combine longevity expectations and actual mortality data from the HRS as follows.\textsuperscript{10} At any age $60 \leq a < 75$ the one-period-ahead survival probability is given by

\begin{equation}
\pi^{s^a}_{a+1|a} = 1 - \Pr \left(\text{death}_{a+1} = 1|a, \pi^{s^a}_{75a}\right)
\end{equation}

where

\begin{equation}
\Pr \left(\text{death}_{a+1} = 1|a, \pi^{s^a}_{75a}\right) = \Lambda \left(\pi^{s^a}_{75a}, a\right)
\end{equation}

where $\Lambda \left(\pi^{s^a}_{75a}, a\right)$ is a logit in $\left(\pi^{s^a}_{75a}, a\right)$ as sample size limitations prevent a fully non-parametric estimation of 1-period ahead death probabilities for each of the $\left(\pi^{s^a}_{75a}, a\right)$ cells.\textsuperscript{11} In this specification survival probabilities are only lower than one after age 60. For ages beyond 65 we extrapolate the one-periods ahead death probability using the parametric structure of the logit model.

### 3.4 Value Functions

The value function can be written as

\begin{equation}
V(z_a) = \max_{d \in \{1, 2, 3\}} \left[v^d_a(z_a)\right]
\end{equation}

\textsuperscript{10}Alternatively, one could try to recover the 1 period ahead survival from an interpolated survival curve.

\textsuperscript{11}In this specification survival probabilities are only lower than one after age 60.
and the alternative specific value functions \( v^d_a \), at the time the labor supply choice must be made are given by

\[
v^d_a(z_a) = E\left[ \max_c \left\{ u^d(c, z_a) + \beta \left[ \pi^s_{a+1|a} E[V_{a+1}(z_{a+1}) | z_a, c, d] + \left( 1 - \pi^s_{a+1|a} \right) E[b(W_{a+1}) | z_a, c, d] \right] \right\} \right]
\]

subject to \( s_a \geq 0 \) and the budget constraint above

where the outer expectation is taken with respect to the distribution of the shocks to the individual’s wage \( \varepsilon_{wa} \).

For a given vector of structural parameters, the model can be solved via backwards recursion. The age-specific policy function for discrete choices \( \delta(z_a) \) is given by

\[
\delta(z_a) = \arg \max_{d} \left\{ v^d_a(z_a, \theta) \right\}
\]

and the policy function for consumption is given by

\[
\psi(z_a, d_a, \varepsilon_w) = \arg \max_{c} \left\{ u^d(c, z_a) + \beta \pi^s_{a+1|a} V_{a+1}(z_{a+1}) + \beta \left( 1 - \pi^s_{a+1|a} \right) b(W_{a+1}) \right\}
\]

s.t. \( W_{a+1} = W_a + Y_a \left( rW_a, w_a h(d_a), y_a^d \right) + B_a \times s s b_a - c \)

where optimal consumption solves the Euler equation conditional on discrete labor supply choice. The Euler equation is the first order condition associated with the above problem.

For tractability, instead of solving for optimal consumption using the Euler equation we discretize possible consumption choices on a grid and pick the one delivering the highest values. A government transfer \( T_a \) provides a consumption floor, \( c \) for households with very low resources. It is given by

\[
T_a = \min \left\{ c; \max \left\{ 0; c - [W_a + Y_{\tau_a} + B_a \times s s b_a] \right\} \right\}
\]
4 The Estimation Strategy

We estimate the model using cohorts that are between 52 and 61 years old in 1992. There are $N$ individuals in our sample. We observe these individuals every two years in 1992, 1994, 1996, 1998, 2000, 2002, 2004, 2006 and 2008. We adopt a two step approach. In the first step with estimate

$$\Pr(H_{a+1} = 2|H_a, a, \lambda^H) , \Pr(\pi_{75|a+1}|\pi_{75|a}, a, \lambda^\pi) , \pi_{a+1|a} (a, \pi_{75|a}, \lambda^s)$$

as well the wage process. Appendix A provides detailed parameterizations of all the structural primitives of the model that are estimated in the first step. The following table summarizes the parameters to be estimated\textsuperscript{12}

<table>
<thead>
<tr>
<th>First Step</th>
<th>Second Step</th>
</tr>
</thead>
<tbody>
<tr>
<td>Health Transition</td>
<td>Utility Function</td>
</tr>
<tr>
<td>$\lambda^H_1, \lambda^H_2, \lambda^H_3$</td>
<td>$\theta_u = {\alpha, \rho, \phi}$</td>
</tr>
<tr>
<td>Age 75 Survival Belief Transition</td>
<td>Bequest Function</td>
</tr>
<tr>
<td>$\lambda^\pi$</td>
<td>$\theta_b$</td>
</tr>
<tr>
<td>1 period-ahead Survival</td>
<td></td>
</tr>
<tr>
<td>$\lambda^s$</td>
<td></td>
</tr>
<tr>
<td>Wage Process ${\mu_i^w}_{i=1}^N, \mu_1^w, \mu_2^w, \mu_3^w, \sigma_w^2$</td>
<td></td>
</tr>
</tbody>
</table>

We now describe the two steps in some detail

4.0.1 Step 1: Processes and Transitions

**Wage Process.** We estimate the wage process for our sample of HRS men using a fixed effect estimator.

We recover $\{\hat{\mu}_i^w\}_{i=1}^N, \hat{\mu}_1^w, \hat{\mu}_2^w, \hat{\mu}_3^w, \hat{\sigma}_w$. We use $\min_i \{\hat{\mu}_i^w\}_{i=1}^N$ and $\max_i \{\hat{\mu}_i^w\}_{i=1}^N$ to bound our discrete grid for the permanent component of wages. The empirical distribution

\textsuperscript{12} The discount factor is set at $\beta = 0.98$. $\kappa$ is fixed at $k = 300,000$. The leisure endowment is set at $L = 350$ as it is measured in days per year.
of the estimated fixed effects $\{\hat{\mu}_i^w\}_{i=1}^N$ is later used in step 2 as an initial condition for the simulation based estimation of structural parameters.

**Transition Probabilities.** Here we estimate the primitive transition probabilities for the state variables that feature stochastic evolutions: health, age 75 survival beliefs and one-period ahead survival probabilities. We obtain estimates $\hat{\lambda} = \{\hat{\lambda}^H, \hat{\lambda}^\pi, \hat{\lambda}^s\}$ that allow us to compute $\Pr(z_{a+1}|z_a, d_a)$ for all $a$.

The transition for health status is complicated by the fact that while we only observe health every other year, our choice of annual time unit for the model requires an annual transition for the state variables. However, it is not difficult to convert 2-year ahead transitions $\Pr(H_{a+2}|H_a)$ into 1-year ahead transitions $\Pr(H_{a+1}|H_a)$,$^{13}$ Same issue applies to survival expectation transitions. We estimate 1-period ahead survival probabilities for each age $a = 52, \ldots, 74$ for three groups according to strength of their age 75 survival beliefs. We extrapolate 1-period ahead survival probabilities beyond age 75.

**Step 2: Preference Parameters**

Here we recover the structural parameters $(\theta_u, \theta_b)$ by matching moments simulated with the model to moments in the data. The initial conditions for the simulation involve an artificial sample with the same distribution of initial state variables as our HRS sample. The specific age specific moments we attempt to match are the following:

- % working full-time at $a$ \hspace{1cm} $\E[d_{1a} = 1|a]$
- % not working at $a$ given health status \hspace{1cm} $\E[d_{3a} = 1|a, H_a]$ for $H_a = \text{bad, good}$
- % not working at $a$ given survival beliefs \hspace{1cm} $\E[d_{3a} = 1|a, \pi_{75|a}]$ for $\pi_{75|a} = \text{low, high}$
- Mean Assets at ages $a$ \hspace{1cm} $\E[W_a|a]$

**5 Results**

The next figure show striking differences between the one-year ahead death probability curves of those with low and high expected longevity.

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$^{13}$See Nartova (2005)
• TO BE COMPLETED: HERE DISCUSS OTHER FIRST STAGE RESULTS.

– WAGE PROCESS
– TRANSITION PROBABILITIES FOR HEALTH
– TRANSITION PROBABILITIES FOR LONGEVITY BELIEFS.

The next table presents preliminary estimation results for the structural parameters:

<table>
<thead>
<tr>
<th>Preference Parameters</th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td>$\alpha$</td>
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</tr>
<tr>
<td>$\rho$</td>
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<tr>
<td>$\phi$</td>
<td>23.23</td>
</tr>
<tr>
<td>$\theta_b$</td>
<td>8.87</td>
</tr>
</tbody>
</table>

Despite model parsimony, we are able to fit the profiles of labor supply and assets fairly well. The following figures compare profiles estimated from the data and those simulated based on the estimated model.
6 Policy Experiments

In this section we further explore retirement behavior under an alternative social security incentive scheme for delayed retirement. In particular, we consider adjusting the benefit \( b(a) \) a person is entitled to by applying adjusting factors \( \omega \) for delayed retirement beyond ERA, that are actuarially fair in the sense that they are computed using the person’s own (group) survival curve. In particular \( \omega = 1.067 \) is actuarially fair for delay between 62 and
63 because using the same life tables as the Social Security Administration, \( \{ \pi_{a|62}^{SSA} \}_{a=63}^{A^*-1} \) we have

\[
P_{D|62}(B_{62}^{SS} | a = 62, \{ \pi_{a|62}^{SSA} \}_{a=63}^{A^*-1}) = P_{D|62}(B_{63}^{SS} | a = 63, \{ \pi_{a|62}^{SSA} \}_{a=63}^{A^*-1}, \omega) \quad (17)
\]

More generally, one can find the actuarially fair delay factor \( \omega_{62} \) from 62 to 63, associated with any survival curve \( \{ \tilde{\pi}_{a|62} \}_{a=63}^{A^*-1} \), not necessarily the one used by SSA. To find this adjustment factor, consider a flow of one dollar of benefits and note the person dies for sure at the beginning of age \( A^* \). Therefore his last benefits are collected at age \( A^* - 1 \) and therefore one needs to consider the probability of surviving up to that age. Then \( \omega_{62} \) solves

\[
1 + 1 \times \frac{\pi_{63|62}}{(1 + r)} + 1 \times \frac{\pi_{64|62}}{(1 + r)^2} + \ldots + 1 \times \frac{\pi_{A^*-1|62}}{(1 + r)^{A^*-1-62}} = \omega_{62} \times \left[ 1 \times \frac{\pi_{63|62}}{(1 + r)} + 1 \times \frac{\pi_{64|62}}{(1 + r)^2} + \ldots + 1 \times \frac{\pi_{A^*-1|62}}{(1 + r)^{A^*-1-62}} \right]
\]

\[
1 + 1 \times \frac{\pi_{63|62}}{(1 + r)} + 1 \times \frac{\pi_{64|62} \times \pi_{63|62}}{(1 + r)^2} + \ldots + 1 \times \frac{\pi_{A^*-1|62} \times \pi_{A^*-2|62} \times \pi_{A^*-3|62} \times \ldots \times \pi_{63|62}}{(1 + r)^{A^*-1-62}} = \omega_{62} \times \left[ 1 \times \frac{\pi_{63|62}}{(1 + r)} + 1 \times \frac{\pi_{64|62} \times \pi_{63|62}}{(1 + r)^2} + \ldots + 1 \times \frac{\pi_{A^*-1|62} \times \pi_{A^*-2|62} \times \pi_{A^*-3|62} \times \ldots \times \pi_{63|62}}{(1 + r)^{A^*-1-62}} \right]
\]

so in general an actuarially fair factor for age \( a \), \( \omega_a \), is given by

\[
\omega_a \left( \{ \pi_{\tau|a} \}_{\tau=a+1}^{A^*-1} \right) = 1 + \frac{\sum_{\tau=a+1}^{A^*-1} \left( \frac{1}{(1 + r)^{\tau-a}} \times \left( \prod_{t=a}^{\tau-1} \pi_{t+1|t} \right) \right)}{\sum_{\tau=a+1}^{A^*-1} \left( \frac{1}{(1 + r)^{\tau-a}} \times \left( \prod_{t=a}^{\tau-1} \pi_{t+1|t} \right) \right)} \quad (20)
\]

We then explore how much of actual retirement patterns observed in the data can be explained by actuarial unfairness. To do so we simulate the model under counterfactual social security benefit formulas that apply actuarially fair delay factors for each group (low, medium, high longevity) using their own survival curve. The basic idea is to give those with lower survival curves higher increases in benefits, since they will collect those increased benefits for a shorter time. Under the current system an individual with the average life expectancy who begins claiming benefits at 62 will collect approximately 80% of the PIA. We take this as the baseline benefit for everyone and work out the appropriate increment factors (for de-
layed retirement) that should be assigned to people with different survival curves so that the expected discounted flow of benefits is the same for everyone. Then, to preserve actuarial fairness, those with low survival probabilities will be given larger increment factors. Those with high survival, will be assigned lower increment factors. We emphasize we don’t think of this exercise as an actual policy that could be implemented in practice. Rather we view it as a thought experiment that allows us to get a sense of the role actuarial unfairness plays in shaping retirement patterns under current benefit computation rules.\footnote{Note that this implies not everyone will collect 100\% of the PIA at age 65. Those with low life expectancy will reach 100\% earlier than 65, those with high life expectancy will do so at later ages.}

The next figure highlights the impact of actuarial unfairness for the low survival group. As can be seen, the percentage not working declines substantially between the ages of 62 and 65. Once given fair incentives for delay these workers do seem to delay retirement at higher rates.

Next we use the model to shed more light on our reduced form results.

What’s the main driving force behind $\beta_1 > 0$?

1. Incentive Effect

2. Planning Horizon Effect

We estimate the reduced form on the simulated data twice

1. without changes to $B^{SS}$
2. with changes to \( B^{\text{SS}} \) that compensate each individual for his lower perceived life expectancy

The resulting difference in \( \beta_1 \) is a measure of the importance of the incentive effect.

Finally, we explore the distributional impact of current policies that expand the normal age of retirement from 65 to 67. Of course everyone is affected by the policy but it is of interest to quantify how the negative impact differs across the distribution of expected longevity. By postponing the normal retirement age by two years, the reduction factors applied to early retirement ages from 62 to 67 are now much larger and have a potentially large effect on those with low life expectancy.

7 Conclusions

to be written...
References


[16] Stock and Wise (1990)


Appendix A

- Transition Probability for Health Status:

\[
\Pr (H_{a+2} = \text{Good}|H_a, a) = \Lambda \left( \lambda_1^H + \lambda_2^H \{H_a = \text{Good}\} + \lambda_3^H a \right)
\]  (21)

where \( \Lambda(x) = \frac{\exp(x)}{1+\exp(x)} \) is the logistic distribution. Then back out \( \Pr (H_{a+1} = \text{Good}|H_a, a) \)

- Multinomial Logit Model for Evolution of (Ranges of) Survival Expectations up to age 75:

\[
\Pr \left( \pi_{75|a+1}|\pi_{75|a}, a; \lambda^\pi \right)
\]  (22)

Here \( \pi_{75|a} \) enters as a set of indicator functions for the possible belief ranges. We also include a linear age trend and interactions of this age trend with indicators for each \( \pi_{75|a} \) category.

- Logit Model for 1-period ahead Death Probability

\[
\Pr (\text{death}_{a+1} = 1|a, \pi_{75|a}^s) = \Lambda \left( \pi_{75|a}^s, a \right)
\]  (23)

Here we again allow for a quadratic age trend as well as indicators for each \( \pi_{75|a}^s \) category and interactions of these categories with linear age trends.