WHY ARE OLDER AMERICANS WORKING MORE?

ALEXEY FILATOV[1]

[1] Universitat Autònoma de Barcelona and Barcelona GSE

ABSTRACT

Since the mid-eighties, both labor force participation and hours per worker of seniors in US have been growing steadily after a long period of of decline. Thi paper uses data from the Health and Retirement Study to estimate a life-cycle model in order to explore the relative importance of factors that potentially affect the labor force participation and supply behavior of two different cohorts of the elderly. The paper focuses on the differences in mortality rates, health, out-of-pocket medical expenditures, wages as well as differential policies (changes in normal retirement age and eliminaion of earnings test) as the potential sources of changes. In the model economy, individuals, who differ by gender and teir education level and face earnings and health shocks, decide how much to work, how much to save and when to claim social security benefits.

JEL codes: J14, J22, J26

* *Author's e-mail:* alexey.filatov@uab.cat; alexey.filatov85@gmail.com

** *I would like to thank the **LaCaixa "Foundation"** for providing a "La Caixa- Severo Ochoa International Doctoral Fellowship" that makes my studies possible.*

*** *I'd like to express special gratitude to my supervisor, Nezih Guner, for his vast help and support. I also express personal gratitude to Joan Llull for his advice and encouragement.*

INTRODUCTION

Around three decades ago labor force participation of persons aged 65 and older in the US hit the historical minimum at 11%. Since then it has been growing steadily and reached almost 20% in 2014 (Figure 1). Furthermore, not only elderly participate in the labor force more, but they also work longer hours, with average number of hours worked per week increasing from 30 to 33 between 1984 and 2014. With the large cohort of Baby Boomers currently entering this age, the elderly will comprise more and more significant part of the labor force. The working seniors can alleviate the highly recognized problem posed by population ageing, namely the increasing Social Security system costs due to the decline of worker-to-beneficiary ratio. During the last decades, US governmat implemented series of policies that were intended to keep seniors on the workplace longer, such as elimination of Earnings Test at Normal Retirement age in 2000 and gradual increase of Normal Retirement Age. However, the effect is also driven by other forces, such as the increase in longevity and corresponding precautionary motive. Two interesting questions arise here. First, what are the most important driving forces behind the increased labor force activity of seniors? Second, how effective are the government policies in this regard? The main goal of the paper is to quantify the relative importance of these driving factors.

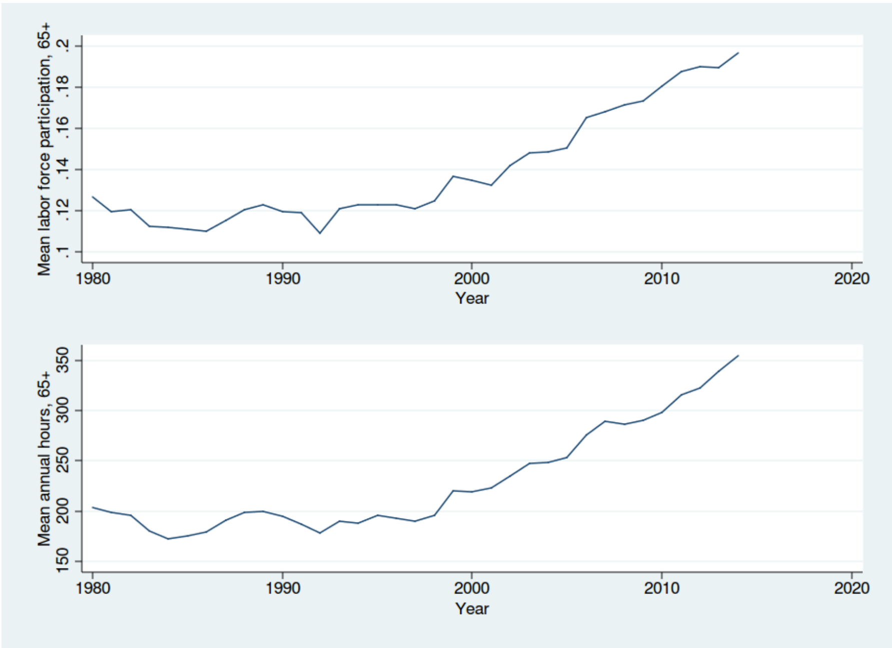

Figure 1: Labor force participation and mean annual hours of 65+ seniors (CPS data, 1980 to 2014).

The paper focuses on two relatively large cohorts of individuals: those born between 1915 and 1934 (post-WWI period and Great Depression) and those born between 1945 and 1964 ("Baby Boomers"). Figure 2 demonstrates the differences in annual labor supply between the two chosen cohorts observable in the March supplement of Current Population Survey.

It is well-known that persons of different gender, education level and marital status behave differently on the labor market upon approaching the age of retirement. Therefore, the paper discriminates between subgroups of population of different socio-economic status, as well as health status.

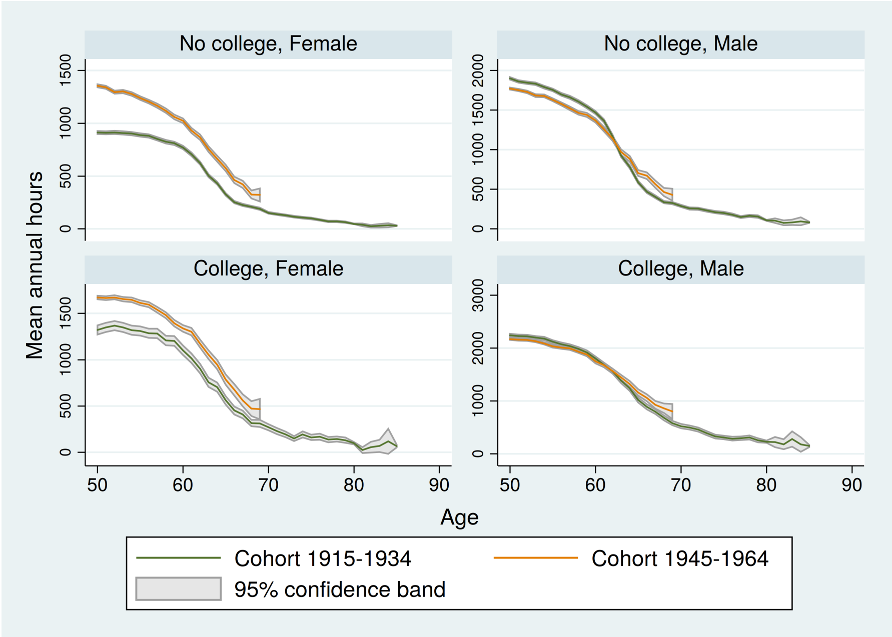

Figure 2: Mean annual working hours of the two cohorts (CPS data).

In particular, I condition the results on gender (male vs female), college graduation (college vs non-college) and self-reported binary health status (either "good" or "bad")[1].

So what is different about current seniors that makes them work more than their predecessors few decades ago? This paper focuses on several potentially important explanations of the labor force participation trends that have been put forward in the literature.

- *Increased life expectancy.* Increase in life expectancy means longer post-retirement years to finance. Coupled with the fact that health condition gets worse with age, as well as medical expenditures grow rapidly at older age, this could lead to an incentive to stay on the job longer.

- *Evolution of health conditions.* Another possible source of differences between retirees of different cohorts is advances in medicine and differential evolution of health conditions of individuals with similar socioeconomic characteristics in different cohorts.

- *Increase in out-of-pocket medical expenditures.* Over the previous decades, the percentage of US GDP spent on health care has grown substantially. Although a part of individual medical expenditures is covered with insurance, or Medicare after the age of 65, out-of-pocket spendings of individuals might still constitute a significant part of individual's spendings. Coupled with the increased life expectancy, this could provide a strong incentive to stay on the job longer.

- *Differences in earnings and wages.* Higher real wages might provide the incentive to stay in the labor force longer.

- *Changes in government policies.* Changes in government policies might have an effect on labor force participation of seniors. The ones in the

1 Marital status, being an important dimension (see Schirle (2008), Casanova (2010)), is not in the model yet.

scope of this paper are increasing Normal Retirement Age (NRA) from 65 to average of 66.5, elimination of Earnings Test after NRA in 2000, and lowering effective income taxes.

The differences in labor force participation between the two cohort must at least to some extent emerge from the changes in the listed factors.

LITERATURE REVIEW

The paper relates to the two major strands of literature.

First, it is closely related to the papers that use life-cycle models to explore various aspects of behavior of seniors. Palumbo (1999) estimates a model of household consumption decisions under uncertain medical expenses. Gourinchas and Parker (2002) study the life-cycle saving and consumption behavior of households under stochastic labor income process. French (2005) models labour supply, retirement, and savings behaviour of seniors using PSID data. DeNardi, French and Jones (2010) model savings of retired singles under uncertain medical expenses and heterogenous life expectancies. French and Jones (2011) study the effects of employer-provided health insurance, Medicare, and Social Security on retirement behavior. Casanova (2010) studies the effects of leisure complimetarity in spousal retirement decision. However, these papers abstract from differences in behavior of different cohorts, which are in the core of current paper.

Second, it is related to empirical literature that investigates the increase in labor force articipation of elderly in US since mid-80's. A number of papers document the trend and put forvard possible explanations to the observed facts, e.g. Clark and Quinn (2002), Friedberg (2007), Juhn et al. (2006), DiCeccio et al. (2008), Maestas and Zissimopoulos (2010). Blau and Goodstein (2010) claim Social Security changes can account for 18-20% of the effect. Hurd and Rohwedder (2011) use HRS data to study the effect of pensions (in particular, moving from DB to DC pension plans) on labor force participation of elderly. Schirle (2008) identifies a coordination in retirement schedule among spouses as another important reason and finds that husband's response to wives' labor force participation can explain up to 25% of the increase in married males' participation.

MODEL

This is a partial equilibrium life-cycle model, an extention to French (2005). Individuals are heterogenous in several aspects: they differ by educational attainment (college/non-college), which is exogenous and given at the time agent enters the model. The agents are of different genders, and belong to one of the two cohorts. The combination of cohort, gender and education affects their wage schedule, health status, and medical expenses. Furthermore, survival hazard at certain age depends also on current health status. On top of that, wages, health and medical expenditures of an agent are subject to idiosyncratic uncertainty.

The model period is one year. An individual enters the model at age 50, which correpsonds to $t = 1$, and lives up to a maximum of 90 years. Therefore, the model spans for $J = 41$ period. There is a chance of death every period. Agents decide on consumption, savings (no borrowing), hours of work, and a timing of Social Security application.

Utility

Agents maximize expected lifetime utility. Individuals derive utility from consumption and leisure. Upon reaching early retirement age of 62 agent can irreversibly apply for Social Security benefits, applicatoin decision is binary $S_t \in \{0, 1\}$. The survival probability s_t at depends on individual's current health status h_t, cohort, gender and education (I suppress corresponding indices to avoid cluttering). If agent survive, she enjoys consumption and leisure. Upon death, an individual derives utility from leaving a bequest described by function $B(a)$ of assets at the time of death.

$$\max_{c_t, l_t, a_{t+1}, S_t} \mathbb{E} \sum_{t=1}^{J} \beta^{t-1} \left(\prod_{k=0}^{t-1} s_k \right) \left(s_t u(c_t, l_t, t) + (1 - s_t) B(a_t) \right)$$

The expectation is taken with respect to agent's wage, health status, and medical expenditure shock. Future is discounted by common discount factor β.

At any given period, agent enjoys consumption, leisure and being in good health. Labor force participation is costly, and the cost of participation increases with age.

$$u(c, l, t) = (1 + h\delta) \frac{[c^{\gamma_c} (\bar{L} - l - I_{l>0}(\kappa + \xi t^{\nu})^{\gamma_l}]^{1-\sigma}}{1 - \sigma}$$

where $\bar{L}$ is total time endowment (in hours) available to the agent, $I_{l>0}$ is an indicator that takes value of 1 if an individual participates in the labor market, and 0 oterwise, κ is the fixed cost of participation, and function ξt^{ν} reflects the increase of participation cost with age. The dependence of utility on health status $\delta(h) = 1 + h\delta$, $h \in \{0, 1\}$ is modelled as a shifter following Palumbo (1999) and DeNardi et al. (2010), meaning simply that healthy agent enjoys life more. Furthermore, γ_c and γ_l are consumption and leisure weights respectively, and σ is relative risk aversion.

Bequest function $B(a)$ takes form that is common in the literature (see Fench (2005), De Nardi (2010)):

$$B(a) = \eta \frac{(a + d)^{(1-\sigma)\gamma_c}}{1 - \sigma},$$

where η is the magnitude of the bequest motivation, and d defines the exent to which bequests are "luxury" goods. According to Lockwood (2016), bequest motives for the seniors are roughly as important as precautionary motives in explaining slow wealth decumulation at old age.

I make the assumption that the set of following preference parameters $\Gamma = \{\gamma_c, \gamma_l, \sigma, \delta, \kappa, \xi, \nu, \delta, d, \eta\}$ depend on gender and education, but not on cohort (I suppressed corresponding superscripts for brevity). I fix labor endowment at age 50 to $\bar{L} = 5000$ and time discounting factor to $\beta = 0.95$.

Stochastic Processes

There are several sources of uncertainty in the model: health, wage and out-of-pocket (OOP) medical expenditure shocks.

I model the health h_t of individual following French et al. (2005), DeNardi et al. (2010). Every period of life an agent faces either of two possible health statuses: healthy ($h = 1$) and unhealthy ($h = 0$), which affect agent's contemporaneous utility. Health is one of the sources of idiosyncratic uncertainty in the model, with current status being dependent on cohort, previous health, gender, age and education. The evolution of individual health is governed by a Markov process:

$$\pi_{j,k}^{t,c,e,g} = \text{Prob}(h_{t+1} = k | h_t = j, t, c, e, g), \; j, k \in \{0, 1\},$$

where c refers to cohort, e is education status, g is gender and h is health status.

The wage and OOP mdical expenditure shocks are modeled as Markov processes that determine transitions between five quintile bins on top of average life-cycle profile of wages and OOP medical expenditures, respectively. This allows for individual wages and medical expenditures to be below of above the average. Furthermore, to pin down a particular value of deviation from the mean, I draw a random value from truncated normal distribution within a particlar quintile bin. I allow transition matrices to depend on age, cohort, gender and education level. On top of that, transition matrices for medical expenditures also depend on current health status.

I obtain survival hazard profiles from the data, following Pijoan-Mas and Rios-Rull (2014).

Social Security

Once individual achieved Early Retirement Age at the age of 62 ($t \geqslant 12$) he/she becomes eligible and can apply for retirement social security benefits, that are going to be paid to her/him throughout the rest of his/her life. Benefit application is irreversible: once an agent started to receive benefits, an individual can't withdraw it.

The exact amount of Social Security payments agent receives will depend on *individual history* of earnings througout the carreer before retirment. The base for calculation of Social Security benefits is Average Indexed Monthly Earnings of individual, an average earnings in the 35 highest earning years in the labor market.

The model starts at age 50, and I assume that everyone has 25 full working years (I don't observe full job history in the data). I update AIME using one of two formulas, given the actual additional working years generated by the model:

$$AIME_{t+1} = AIME_t + \frac{w_t l_t}{35}, \; \mathcal{T} < 35$$
$$AIME_{t+1} = AIME_t + \max\{0, \frac{w_t l_t - AIME_t}{35}\}, \; \mathcal{T} \geqslant 35$$

where $\mathcal{T}$ is actual number of individual working years.

Given AIME, *Primary Insurance Amount* (PIA) is calculated, which depends on actual age of retirement, Normal Retirement Age and two *AIME bendpoints*. AIME is capped with respect to *the contribution and benefit base*, which is equal to $90000 in 2005, so therefore the maximum amoutn of benefits one can receive is capped as well. In 2005, PIA was calculated acccording to:

$$\text{PIA} = \begin{cases} 90\% & \text{of the first \$627 of AIME, plus} \\ 35\% & \text{of AIME over \$627 and through \$3779, plus} \\ 10\% & \text{of AIME over \$3779} \end{cases}$$

PIA is an unajusted value of Social Security payment for those who claim Social Security benefits at Normal Retirement Age (65 for Great Depression Kids and an average of 66.5 for Baby Boomers). For each year before Normal Retirement Age that a person applies for benefits, they are reduced by 6.7% a year during three years prior to retirement, and by 5% for any additional year before that. On the other hand, for each year of not claiming benefits on top of NRA they increase by additional 4.5% on average for the older cohort, and by 8% for younger cohort.

The benefit accumulation (AIME update, PIA calculation, and benefit adjustment) in the model is captured by the function $\mathbb{F}(b_t, w_t l_t, t)$. Given current benefit level and age, this function first converts current benefit to AIME, then updates AIME, and then converts AIME back to updated benefits.

Earnings Test

Earnings test currently applies to individuals who receive Social Security benefits and work. For those who didn't yet attain NRA there is an exempt amount ($12000 in 2005) of earnings, over which earnings are taxed at 50% rate on top of all other taxes, until all benefits are taxed away. For individuals of NRA and older, higher exempt amounts until age 70 were established prior to 2000, when earnings test was eliminated for these individuals. This poses another distinction between the two cohorts. However, it is important to note that taxed benefits currently are just withholding until an individual reaches NRA for the Baby Boomers cohort, or until age 70 for older cohort. Upon reaching these age, monthly benefit is increased permanently to account for the time during which they were withheld, according to the formulas of Social Security for early and delayed retirement. Notably, for Baby Boomers cohort these formulas are roughly actuarially fair, whereas for older cohort they are actuarially unfair. The amound witheld by the earnings test at a certain age is calculated by

$$b_{ET}(t, b_t, w_t l_t) = \frac{w_t l_t - 12000}{2},$$

and the the updated benefits are calculated using the function

$$\mathcal{F}(b_t, t) = b_t(1 + \mathcal{P}),$$

where $\mathcal{P}$ is either early retirement penalty or delayed retirement premium, depending on age.

Social Security Taxation

If an individual is not a subject to Earnings Test anymore, but still continues to work, benefits are subject to income taxation. Up to 85% of benefits can be taxed, if "provisional income" (earnings plus half of SS benefits) exceed either of two statutory tresholds, which were introduced in 1983 and their nominal values didn't change since then (which means their real values decreased).

Budget Constraint

Per-period budget constraint of an agent reads:

$$\begin{aligned} c_t + a_{t+1} + m_t = a_t + T(r_c a_t + w_t l_t + b_t) + b_t^{ma} \\ a_{t+1} \geqslant 0 \\ c_t > \underline{c} \\ b_t^{ma} = \max\{0, \underline{c} + m_t - (a_t + T(ra_t + w_t l_t + b_t)\} \end{aligned}$$

Agent consumes c_t, makes a saving decision for next period a_{t+1} and have to cover exogenous stochastic OOP medical expenditure m_t. Agent's balance consists of her savings from the previous period a_t, after-tax income, and, possibly, government transfer b^{ma}. Agent's taxable income consists from returns on savings $r_c a_t$, labor income $w_t l_t$ and Social Security benefits b_t, if an agent has applied for them. Ttaxation function $T(\cdot)$ is a function mapping agents' income into a disposable income. There is is a government-provided consumption floor $\underline{c}$ and b^{ma} is corresponding lump-sum transfer. A way to think of the "consumption floor" b_t^{ma} is as of Medicaid insurance for poor or impoverished agents: one is eligible only if all other resources are exhausted[2]. In order to calculate income taxes, I use the parametic estimates of effective tax functions from Guner et al. (2014). Namely, I use the following function to calculate effective average tax rate:

$$\tau(y) = b[1 - (sy^p + 1)^{-\frac{1}{p}}],$$

where y is income in $2005, τ is effective tax rate, and b, s and p are known numbers, different for the two cohorts. Then,

$$\begin{aligned} y = r_c a_t + w_t l_t + b_t \\ T(y) = (1 - \tau(y))y \end{aligned}$$

Dynamic Programming Problem

The problem of indvidual in recursive formulation is presented below. Social Security application $S \in \{0, 1\}$ is modelled as a binary irreversible decision, that become available to eligible agents (namely, those who attained Early Retirement Age (ERA) of 62, or $t = 13$ in model terms ($t = 1$ corresponds to age of 50). Denote a current exogenous *joint shock* of wage, OOP medical spending and health $z_t = \{w_t, m_t, h_t\}$.

$$\begin{aligned} V(t, a_t, b_t, S_t, z_t) = \max_{c_t, l_t, S_t, a_{t+1}} \{u(c_t, l_t, t) + \\ \beta\big(s_t[E_{z_t} V(t+1, a_{t+1}, b_{t+1}, S_{t+1}, z_{t+1})] + (1 - s_t)B(a_{t+1})\big)\} \\ \text{s.t.} \\ c_t + a_{t+1} + m_t = a_t + T\big(ra_t + w_t l_t + S_t \times [b - b_{ET}(t, b_t, w_t l_t)]\big) + b_t^{ma} \\ b_{t+1} = S_t \times \mathcal{F}(b_t, t) + (1 - S_t) \times \mathbb{F}(b_t, w_t l_t, t) \\ S_t = 0,\ t < 13 \\ S_t \geqslant S_{t-1},\ t \geqslant 13 \\ a_{t+1} \geqslant 0 \\ b_t^{ma} = \max\{0, \underline{c} + m_t - (a_t + T(\cdot))\} \end{aligned}$$

2 The model currently does not distinguish between individual savings and employer-provided pensions, despite the illiquidity of the latter until certain age plays a potentially important role.

A note of clarification is required here. There is a very important distinction between functions $\mathcal{F}(b_t, t)$ and $\mathbb{F}(b_t, w_t l_t, t)$ here. The latter models a possible benefit gain of not applying to Social Security for one more year, while the former models the changes in benefits due to the Earning Test. Further, $b_{ET}(t, b_t, w_t l_t)$ is a withheld part of benefits due to the Earnings Test. I solve for the policy finction backwards, starting from last period and going back in time.

THE DATA AND EXOGENOUS PROFILES

The Health and Retirement Study is an individual level panel data collected every two years from 1992 to 2013. It follows individuals from age 50 until their death. The data consists of several waves of respondents starting from age 50, as well as their spouses regardless of age. The dataset contains very detailed individual information on demographic characteristics, employment history, income, medical expenditures, health status and education attainment among others. I use version O of the RAND files of the HRS, which covers 13 waves of respondents from 1992 to 2013[3].

In the sample, I keep individuals born between 1915 and 1934 (post-WWI, Great Depression) and between 1945 and 1964 (post-WWII, Baby Boomers), aged 50 to 90. The choice of cohorts is not arbitrary. First, they have to be large enough to be able to capture intended heterogeneity with enough data. Second, they have to be separated in time enough for the between-cohort differences to be significant. In the sample,i observe the Great Depression kids aged between 58 and 90, while the youngest Baby Boomers are 50 and the oldest are 68.

In the sample, I only keep individuals for whom I observe either self-reported age of Social Security application or the age at which Social Security benefit is first received.

I keep individuals whose assets do not exceed $1000000, because the fortunes this size are often inherited. (I use total non-housng financial wealth from HRS as a measure of assets.

I create a dummy variable "college", that takes value of 1 if an individual has at least college degree, and 0 otherwise.

In order to make medical expenditures and wages comparable across years, I deflate nominal dollars reported in the data by corresponding Consumer Price Indices, and express everything in terms of 2005 US dollars[4], and the indices for medical and non-medical nominal units are distinct.

The sample summaries for some variables are reported in the Table 1.

Survival Rates

In the data, I can identify whether an individual has died since the previous interview. Given this information, I estimate biannual survival rates using logit. Here, $z = \{\text{cohort}, \text{college}, \text{gender}, \text{health}_{age}\}$:

$$s_t^2 = \text{Prob}(alive_{age+2} = 1 | age, z) = \frac{e^{f_s(age|z)}}{1 + e^{f_s(age|z)}},$$

3 http://hrsonline.isr.umich.edu/modules/meta/rand/index.html
4 The source of Consumer Price Indices is Bureau of Labor Statistics website: http://data.bls.gov/cgi-bin/surveymost?cu

Table 1: Sample summary statistics, HRS data, 1992-2013

Variable	1915-1934	1945-1964
Male	0.447	0.424
College degree	0.165	0.289
In labor force, age 57-68	0.467	0.718
Mean (SD) annual hours worked, age 57-68	803.67(1066.4)	1394.22(1115.24)
Mean sample age	73.96547	56.37101
Healthy	0.775	0.80
Median OOP medical exp (USD2005), 57-68	891.73	1152.95
N of observations	71538	33282
N of individuals	11599	9908

I use the following specification for $f_s(age|z)$:

$$f_s(age|college, male, health_{age}) = \beta_{coh} D_{coh} + \beta_1 age + \beta_2 age^2$$

Thus, I run eight separate logistic regressions for each combination of education, gender and health status. The specification is not rejected neither by Pearson χ^2 test, nor by Hosmer-Lemeshow test.

To construct annual survival rates s_t from biannual s_t^2, I follow Pijoan-Mas and Rios-Rull (2014) and simply take a square root of biannual rates.

Health Evolution

Self-reported health in HRS is coded into 5 categories: excellent, very good, good, fair and poor. I create a binary variable that takes value of 1 ("healthy") if self-reported health either excellent, very good or good, and 0 ("unhealthy") othervise. The HRS is biannual survey, so for any given individual I can identify health status biannualy. I estimate biannual rates of transition between healthy and unhealthy states using logit.

$$\text{Prob}(h_{age+2} = 1|age, z) = \frac{e^{f_h(t,z)}}{1 + e^{f_h(t,z)}}.$$

I use the following specification for $f_h(age|z)$:

$$f_h(age|college, male, health_{age}) = \beta_{coh} D_{coh} + \sum_{i=1}^{4} \beta_i age^i$$

Thus, I run eight separate logistic regressions for each combination of education, gender and health status. The specification is not rejected neither by Pearson χ^2 test, nor by Hosmer-Lemeshow test.

In order to annualize health transition rates and obtain $\pi_{j,k} = \text{Prob}(h_{t+1} = k|h_t = j)$ that I use in the model, I solve a system of equations for each age, such that calculated annual transition rates exactly correspond to biannual ones over the two-year period.

OOP Medical Expenditures

I assume that out-of-pocket medical expenditures are exogenous in the model. I focus on OOP medical expenditures to avoid the additional complication of modelling medical insurance. I model OOP medical expenses as an exogenous stochastic process, conditional on cohort, education, gender (the *type* of individual) and current health. To be precise, the model is:

$$\log M_t = \log \bar{M}_t + z_t$$

The process is the combination of age profile $log\bar{M}_t$, conditional on type, and a stochastic process υ_t. I obtain $log\bar{M}_t$ from the data running the following regression[5]:

$$\log M_t = \beta \times age + D_c \times coh + D_m \times male + D_e \times col + D_h \times h + \upsilon_t$$
$$\log \bar{M}_t = \hat{\beta} \times age + \hat{D}_c \times coh + \hat{D}_m \times male + \hat{D}_e \times col + \hat{D}_h \times h$$

The residuals are then

$$\hat{\upsilon}_t = \log M_t - \log \bar{M}_t$$

I assume that $\upsilon_t | t \sim \mathcal{N}(\mu_t, \sigma_t)$, and use sample average $\hat{\mu}_t$ and sample standard deviation $\hat{\sigma}_t$ of residuals $\hat{\upsilon}_t$ as the estimators of μ_t and σ_t. I then sort residuals for each age into 5 quintile bins and run a multinomial logit regression for conditional transition probabilities between bins:

$$Prob(bin_{t+2} = x | age, bin_t = y) = \Lambda(\sum \beta_{bin_y} D_{bin=bin_y} + \beta_t t)$$

Calculated rates of transition serve as a probability transition matrices (one 5-by-5 matrix for each age). I then annualize these transition rates. To provide additional heterogeneity to simulated medical expenditure, I make a draw from truncated normal distribution with truncation boundaries corresponding to bin boundaries, once log medical expenditure deviation landed to one of the bins described above.

Wages

Wage profiles and wage evolution is calculated very similarly to the calculation of medical expenses. I have much fewer observations here, since I only observe wages for those who work, as compared to OOP medical expenses, which I observe for almost everyone in the sample. This is why I don't have health as a regressor for the wage profile. The assumed wage process is:

$$\log W_t = \log \bar{W}_t + \zeta_t$$

Regression is[6]:

$$\log W_t = \beta \times age + D_c \times cohort + D_m \times male + D_e \times college + \zeta_t$$

Then I build the quintile bins and caculate the conditional transition probabilities between bins in the same way as for the OOP medical expenditures.

Controlling for Wage Selection Bias

The well-known problem with the type of wage profiles I'm using in this paper is that they are subject to selection bias. To be precise, in the data we only observe the wages of those who work, and we don't observe potential wages for non-workers. At older ages, this bias becomes extremely significant, given the small fraction of working individuals. Thus, it is crucial to

5 I tried various specifications
6 I tried various specifications.

correct for this bias to get any credible results from the model. I employ the procedure following French (2005). First, assume that bias is similar in the HRS and in the data created by calibrated model. Then, I simulate data using (incorrect) profiles. After that, I calculate wage profiles from simulated data for workers and both workers and non-workers, and the difference between the two gives a sense of a profile upward bias. I update HRS profiles using the difference, calibrate the model using updated wage profiles and get updated set of structural parameters. Repeat the procedure until consequent profiles converge.

Initial Distributions

Individuals enter the model at age 50. In order to start simulation, I need to know at age 50 joint distribution of AIME, assets,wage, health and medical expenses. I will then be able to draw initial individual starting values from this distribution. For Baby Boomers, I directly observe assets, wage, health status and medical expenses at age 50. I do not directly observe AIME for anybody in the sample. However, I recover initial AIME for Baby Boomers from the Social Security payments for retired individuals and *predicted* SS wealth at age 62, 65 or 70 for pre-retirees, as well as observing their earning histories down to age 50.

I assumme that AIME, assets, wage and OOP medical expenses are jointly lognormal at age 50, conditional on type of individual. I then calculate sample mean vector and variance-covariance matrices, which I subsequently use to launch the model smulations.

I cannot directly recover this distribution for older cohort. The strategy therefore is to calibrate the structural paprameters of the model to the Baby Boomers cohort (I assume that tstructural parameters are the same for both cohorts), and to make the above mean vector and variance-covariance matrix a calibration target for older cohort.

CALIBRATION AND ESTIMATION

The general assumptions are:

1. The preference parameters of the agents of two cohorts are similar.
2. The source of change in agent's behavior are changes in exogenous processes: survival hazard, medical expenditures, wages, Social Security policies, elimination of Earnings Test at NRA, shift in Normal Retirement Age, tax regime.

The problem at hand is to model the labor supply behavior of 50+ year old individuals on intensive (hours worked per week) and extensive (participation decision) margins under different conditions with regard to differences in cohort-specific exogenous processes. I am approaching the problem in several steps.

1. From the HRS data outside the model, obtain exogenous objects: wage and OOP medical expenditure profiles and transition matrices, survival rates, health evolution matrices.
2. Using Method of Simulated Moments, fully calibrate the model to fit the labor force participation behavior of individuals belonging to

younger cohort (the Baby Boomers). In particular, this includes the estimation of individual preference parameters, that will be used in further calculatons.

3. Once preference parameters are calibrated, I can retrieve parameters of the initial age-50 distribution for older cohort, as well as correct upwards bias in their wage profiles and annualize the biannual processes.

4. When this is done, I can simulate a large number of individuals of the two cohorts with respect to the exogenous processes specific to them. In an ideal case, this will allow me to see which part of the change in labor force participation decisions can be explained by these exogenous factors.

5. I can also conduct counterfactual experiments, shutting down certain channels of influence and comparing the results.

Model Simulation

The model allows to simulate individual life cycle. I solve for value function on multidimensional grid on assets (11 gridpoints, nonequally spaced between $0 and $1000000), benefit value (11 gridpoints, nonequally spaced between $0 and $34670, the upper value corresponds to AIME cap), 50 gridpoints for joint shock (2 health statuses, 5 wage statuses corresponding residual bin means, 5 medical expense statuses) and $J = 41$ life period. Grid is sparse, so I resort to multidimensional linear interpolation between gridpoints during the simulation.

Moment Conditions and Identification

Table 2 shows the fixed and estimated structural parameters of the model for non-college, male Baby Boomers.

Currently, I'm trying to match the following moments, for Baby Boomers cohort, age 50-67, conditional on individual type:

- Mean labor force participation, for every age 50 to 67, to identify κ, θ_p and ξ.
- Mean labor force participation conditional on having zero assets, for every age 50 to 67, to identify $\underline{c}$.
- Mean labor supply (in hours), for every age 50 to 67, to identify γ_l, γ_c and σ.
- Mean labor supply (in hours), by health status, for every age 50 to 67, to identify δ.
- Mean assets, for every age 50 to 67, to identify η and d.

Given the initial guess on structural parameters, I solve for the optimal value function and agents' decisions. I then simulate a large number of individuals (currently 3000) and calculate simulated moments. The distance between data and simulated moment is calculated. Currently, I use the inverse of variance-covariance matrix of the data moments as the weighting matrix. I try to minimize this distance by adjusting the model parameters. I rely on Nelder-Mead search algorithm in doing this.

Parameter	Value	Explanation
Fixed Parameters		
$\hat{L}$	5000	Individual annual labor endowmwnt (in hours)
β	0.95	Time discount factor
Calibrated Utility Parameters		
κ	900	Fixed cost of work (hours)
γ_l	0.5	Leisure weight
γ_c	0.5	Consumption weight
σ	1.75	Relative risk aversion
θ_p	1.4	Participation cost due to age (shifter)
ξ	2.0	Participation cost due to age (convexity)
δ	0.2	Utility health shifter
Calibrated Bequest Utility Parameters		
η	1.8	Strength of bequest motive
d	10^5	Determinant of how "luxurious" are bequests
Calibrated Initial Distribution Parameters for Great Depression Kids		
Σ_{init}		Variance-covariance matrix of joint initial distribution
μ_{init}		Mean vector of joint initial distribution
Other Calibrated Parameters		
$\underline{c}$	2600	Consumption floor

Table 2: Structural fixed and estimated structural parameters of the model for non-college, male Baby Boomers.

Model Fit

Currently, the model is calibrated to non-college, male Baby Boomers. The model under this calibration fits labor force participation (Figure 3) and supply reasonably well (Figure 4).

A few counterfactual exercises are conductod and show that indeed chosen driven factors can explain a significant part of labor force increase of the elderly. As an example, Figures 5 and 6 show the difference in participation rates if Baby Boomers were given survival rates, wages and medical expenses of the older cohort. Only these driving factors can explain a significant part of the difference between the two cohorts.

CONCLUSIONS

The data inspection done within the current project shows important differences in labor force attachment of seniors in US, as well as the differences in factors that could led to these differences. Namely, changes in government polisies, life expectancies, OOP medical expenditures, wages and health are all important contributors. In order to disentangle the relative inputs of these factors, a structural model of retirement has been built. On the current stage the project already provide interesting results. It can be safely said that the chosen driving factors are indeed shape the labor participation and supply decisions of US elderly. Both natural and policy factors are important, however it's too early to do statements about their relative importance. The full calibration and decomposition exercises are the nearest further goals.

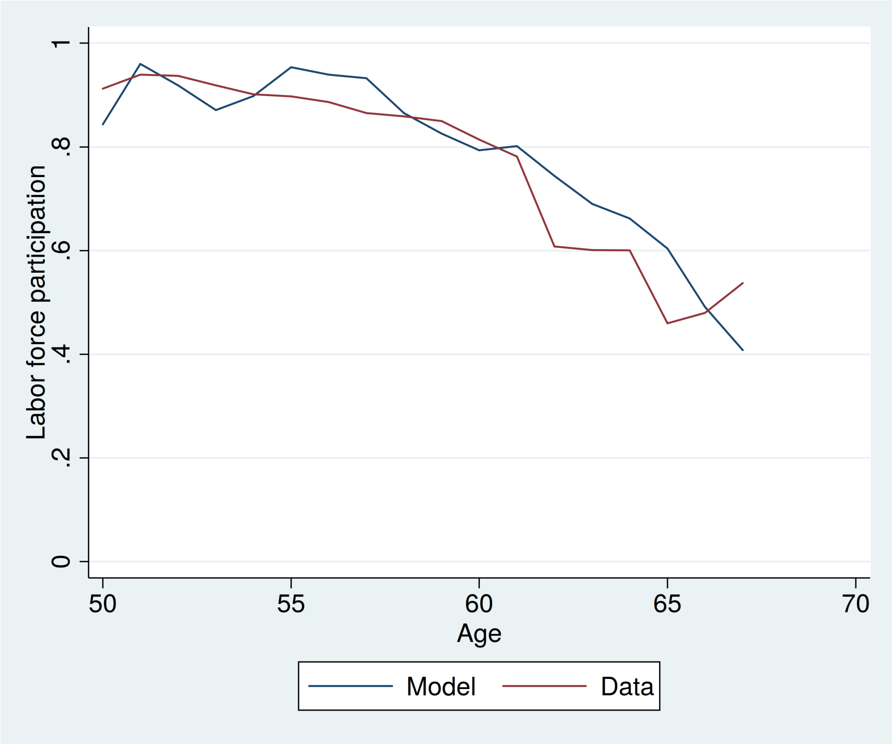

Figure 3: Labor force participation: baseline model fit (non-college, male, Baby Boomers).

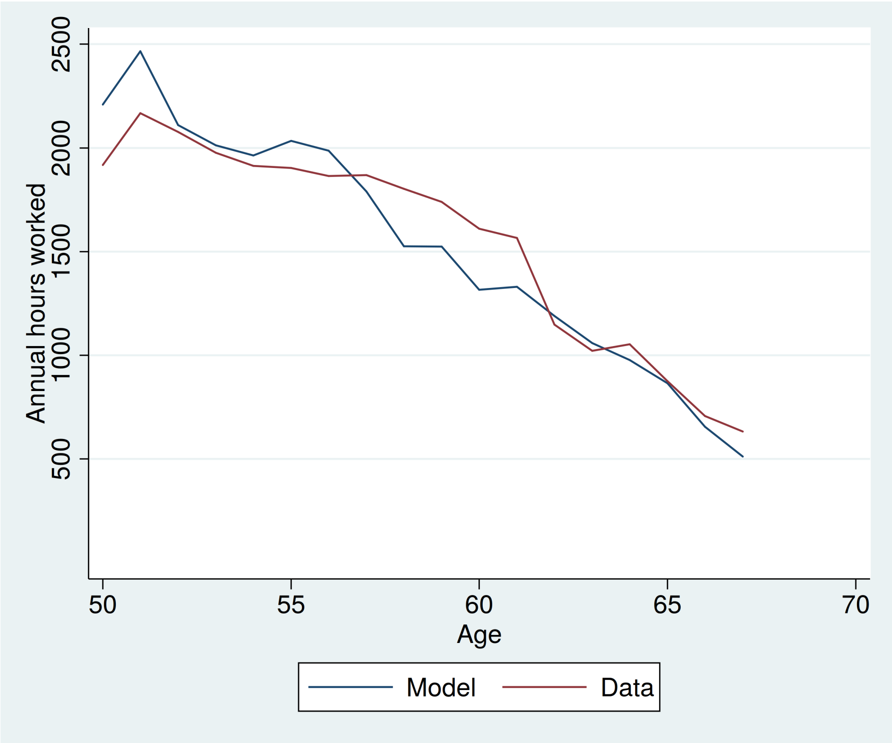

Figure 4: Average annual hours: baseline model fit (non-college, male, Baby Boomers).

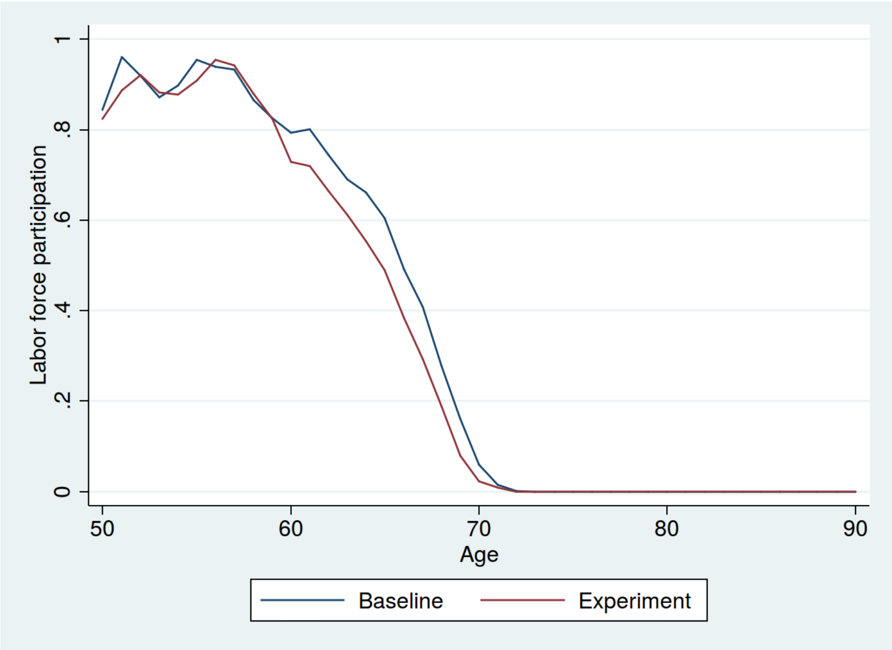

Figure 5: Average lfp: baseline vs counterfactual.

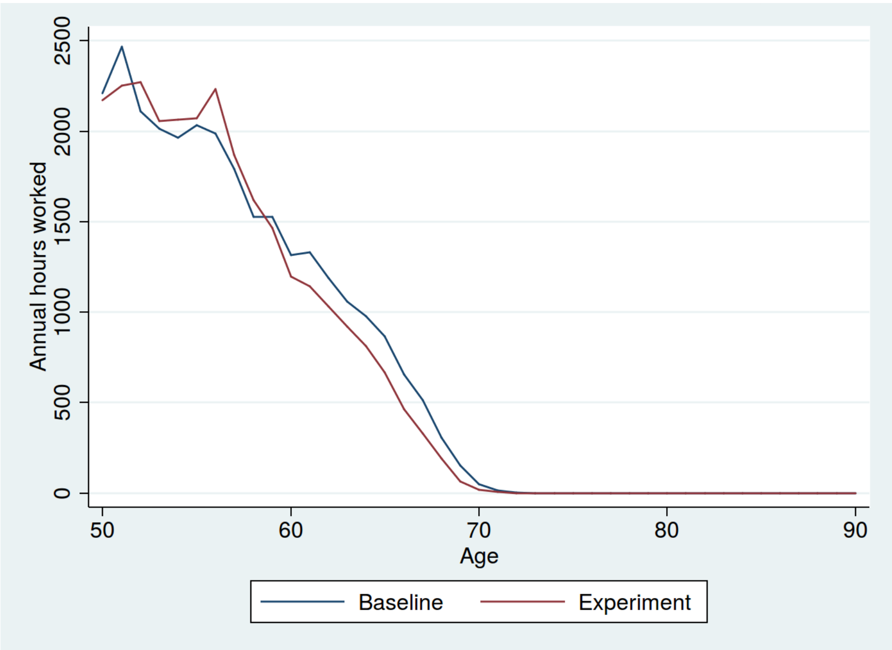

Figure 6: Average annual hours: baseline vs counterfact.

REFERENCES

[1] Blau, D. M. and Goodstein, R. M. (2010). Can social security explain trends in labor force participation of older men in the united states? *The Journal of Human Resources*, 45(2):328–363.

[2] Burtless, G. (2013). The impact of population ageing and delayed retirement on workforce productivity. *Working Paper*.

[3] Casanova, M. (2010). Happy together: A structural model of couples' joint retirement choices.

[4] Clark, R. L. and Quinn, J. F. (2002). Patterns of work and retirement for a new century. *Generations*, 26(2):17–24.

[5] De Nardi, M., French, E., and Jones, J. B. (2010). Why do the elderly save? the role of medical expenses. *Journal of Political Economy*, 118(1):39–75.

[6] DiCecio, R., Engemann, K. M., Owyang, M. T., and Wheeler, C. H. (2008). Changing trends in the labor force: A survey. *Federal Reserve Bank of St. Louis Review*, 90(1):47–62.

[7] French, E. (2005). The effects of health, wealth, and wages on labor supply and retirement behavior. *The Review of Economic Studies*, 72(2):395–427.

[8] French, E. and Jones, J. B. (2004). On the distribution and dynamics of health care costs. *Journal of Applied Econometrics*, 19(6):705–751.

[9] French, E. and Jones, J. B. (2011). The effects of health insurance and self-insurance on retirement behavior. *Econometrica*, 79(3):693–732.

[10] Friedberg, L. (2007). The recent trend towards later retirement. *Brief*, 9.

[11] Gourinchas, P.-O. and Parker, J. A. (2002). Consumption over the life cycle. *Econometrica*, 70(1):47–89.

[12] Guner, N., Kaygusuz, R., and Ventura, G. (2014). Income taxation of u.s. households: Facts and parametric estimates. *Review of Economic Dynamics*, 17:559–581.

[13] Hurd, M. and Rohwedder, S. (2011). Trends in labor force participation: How much is due to changes in pensions? *Journal of Population Ageing*, 4(1-2):81–96.

[14] Juhn, C. and Potter, S. (2006). Changes in labor force participation in the united states. *Journal of Economic Perspectives*, 20(3):27–46.

[15] Kitao, S. (2015). Fiscal cost of demographic transition in japan. *Journal of Economic Dynamics & Control*, 54:37–58.

[16] Lockwood, L. M. (2016). Incidental bequests: Bequest motives and the choice to self-insure late-life risks.

[17] Maestas, N. and Zissimopoulos, J. (2010). How longer work lives ease the crunch of population aging. *Journal of Economic Perspectives*, 24(1):139–160.

[18] Palumbo, M. G. (1999). Uncertain medical expenses and precautionary saving near the end of the life cycle. *Review of Economic Studies*, 66(2):395–421.

[19] Pijoan-Mas, J. and Rios-Rull, J.-V. (2014). Heterogeneity in expected longevities. *Demography*, 51(6):2075–2102.

[20] Rupert, P. and Zanella, G. (2015). Revisiting wage, earnings, and hours profiles. *Journal of Monetary Economics*, 72:114–130.

[21] Schirle, T. (2008). Why have the labor force participation rates of older men increased since the mid-1990s? *Journal of Labor Economics*, 26(4):549–594.

[22] Tang, F., Choi, E., and Goode, R. (2013). Older americans employment and retirement. *Ageing Int*, 38:82–94.