Insper Instituto de Ensino e Pesquisa

Inspirar para Transformar

The Effect of Social Security, Health, Demography and Technology on Retirement

Pedro Cavalcanti Ferreiray

Marcelo Rodrigues dos Santos

Insper Working Paper

WPE: 274/2012

Insper Instituto de Ensino e Pesquisa

Inspirar para Transformar

The Effect of Social Security, Health, Demography and Technology on Retirement*

Pedro Cavalcanti Ferreira† and Marcelo Rodrigues dos Santos‡

Abstract

This article studies the determinants of the labor force participation of elderly American males and investigates the factors that may account for the changes in retirement between 1950 and 2000. We develop a life-cycle general equilibrium model with endogenous retirement that embeds Social Security legislation and Medicare. Individuals are ex ante heterogeneous with respect to their preferences for leisure and face uncertainty about labor productivity, health status and out-of-pocket medical expenses. The model is calibrated to the U.S. economy in 2000 and is able to reproduce very closely the retirement behavior of the American population. It reproduces the peaks in the distribution of Social Security applications at ages 62 and 65 and the observed facts that low earners and unhealthy individuals retire earlier. It also matches very closely the increase in retirement from 1950 to 2000. Changes in Social Security policy - which became much more generous - and the introduction of Medicare account for most of the expansion of retirement. In contrast, the isolated impact of the increase in longevity was a delaying of retirement.

Key words: Retirement; Social Security; Health Shocks; Medicare; Aging Population.

JEL classification: J2; E2; D5

*We wish to thank the editor Gianluca Violante, two anonymous referees, Flávio Cunha, Rodrigo Soares, Carlos Eugênio da Costa, Samuel Pessôa, Ricardo Cavalcanti, Luiz Braido and Cesar Santos as well as seminar participants at EPGE-FGV, at the 2011 SED meetings in Ghent, at the 2011 EEA annual Congress in Oslo and at the 2008 SBE meetings in Bahia for helpful comments. We are responsible for any remaining errors. The authors acknowledge the financial support of CAPES and CNPQ.

†Graduate School of Economics (EPGE), Fundação Getulio Vargas, Praia de Botafogo 190, 1125, Rio de Janeiro, RJ, 22253-900, Brazil. Email: ferreira@fgv.br.

‡Insper, Rua Quata 300, sala 419, São Paulo, SP, 04546-042, Brazil. Email: marcelors2@insper.edu.br.

1 Introduction

The reduction of the participation of elderly people in the labor force was one of most remarkable economic changes of the last century, particularly in the second half. In 1950, 46% of men aged 65 and over in the United States were working, but only 16.5% were in 2000. Just four out of every ten 66-year-old males were retired in 1950, but fifty years later almost seven out of ten were out of the labor force. This phenomenon is hardly exclusive to the United States. Blondal and Scarpetta (1998) and Gruber and Wise (1999) provide evidence that the workforce participation of the elderly population has declined in many countries of the OECD.

Currently, more than 50% of workers choose to retire at the age of 62, when they first become eligible for early retirement benefits under social security, although at a reduced level. In 1950, in contrast, there was no legal early retirement age and the minimum and normal retirement age coincided at 65. The decision to retire, and to do it early, is influenced by a number of factors in addition to age and the rules of social security such as health status, income, preference for leisure, etc. For instance, according to data from the Health and Retirement Survey, approximately 90% of individuals between 55 and 85 years of age who declared themselves in poor health were retired in 2000, compared with only 40% of those in excellent health.

This article develops and calibrates a lifeclycle general equilibrium model with heterogeneous agents to study the determinants of the labor force participation of elderly American males and to investigate the factors that may account for the changes in retirement between 1950 and 2000. We focus on the role of Social Security, health status and the introduction of Medicare, demographic factors (associated with higher longevity) and changes in the age-efficiency profile.

Our artificial economy is populated by agents who live for a realistic number of periods, have preferences over consumption and leisure and choose at each period whether to stay in the labor force or retire. Agents split their working hours between home production and working in the market. Individuals are ex ante heterogeneous with respect to their preferences for leisure and face uncertainty about their labor productivity, their health status and their out-of-pocket medical expenses. Agents can accumulate a single risk-free asset, which takes the form of capital. Savings may be precautionary and allow partial insurance against the idiosyncratic shocks.

In addition, we model the U.S. Social Security system in detail and also allow agents to decide when to start collecting retirement benefits regardless of their employment status. This is consistent with the empirical evidence in Rust and Phelan (1997) and Benítez-Silva and Heiland (2008), who show that a large number of agents claim benefits while continuing to work, mainly among the nearly elderly ones.

We also take into account Medicare, which was introduced in 1965 and constitutes a federal health insurance program that provides subsidized health insurance coverage to virtually every American over age 65. Medicare provides generous insurance against medical expenditures shocks and could induce earlier retirement because of the limited need to accumulate precautionary savings. Conversely, because of eligibility requirements, it also encourages the delay of retirement until 65.

The model is calibrated to the U.S. economy in 2000, our benchmark year, and is able to reproduce very closely the retirement behavior of the American population. In particular, the model reproduces the peaks in the distribution of Social Security applications at ages 62 and 65 and the observation that unhealthy and poor individuals retire earlier.

The model is then simulated considering the changes in Social Security, Medicare, age-efficiency profile and demography between 1950 and 2000. We find that the simulated labor force participation of older individuals increases to levels similar to those in the data. We show that the incentives implied by the institutional factors concerning Social Security and Medicare legislation are very effective in influencing retirement behavior. For instance, a counterfactual experiment in which all parameters were kept at their 2000 values, but the rules of Social Security were changed to those of 1950, finds that the retirement rate drops for every age group. More importantly, the retirement peak at age 62 disappears, as in 1950 when there was no early retirement benefits.

This article extends and improves the previous literature in many aspects. Our model is related to Imrohoroglu, Imrohoroglu and Jones (1995), Huggett and Ventura (1999), Nishiyama and Smetters (2007), and Rojas and Urrutia (2008). These models provide a framework rich enough to deal with all the factors that potentially affect the retirement decision. Furthermore, this structure allows us to model more accurately the dynamic structure of a social security system. In these papers, however, the retirement decision is exogenous in contrast to our model.

Conde-Ruiz and Galasso (2003) endogenize retirement, but in a purely theoretical political-economy framework with no quantitative analysis. French (2005, 2011) estimates a partial equilibrium lifecycle model of retirement behavior in which health and wages are uncertain. He uses the model to simulate the impact on the labor supply of modifications to Social Security legislation. Diaz-Gimenez and Diaz-Savavedra (2009) use an overlapping generational model with an endogenous retirement decision to study pension system reform in Spain. Our model has many features in common with theirs; but as we study the American economy, the calibration and institutional details of the model are obviously very different as are the experiments we run. Finally, in Kopecky (2011) whereas the decision to leave the labor force is endogenous as in our article, hours worked are fixed in every period and there is no social security in the model, which plays an important role in our case.[1]

As for the channels we emphasize as affecting retirement behavior, the importance of higher Social Security benefits has been investigated in a number of articles using a variety of estimation methods.[2] Nevertheless, this literature has not come to a consensus. In fact, whereas Gustman and Steimeier (1986) and Rust and Phelan (1997) have found that Social Security benefits have had a strong negative effect on male labor supply, Burtless (1986), Stock and Wise (1990) and Krueger and Pischke (1992) concluded that it had little effect. These results suggest that either there are problems associated with the methods that have been used to investigate this relationship,[3] or there are other explanations that must be taken into consideration.[4] In this article, we bring together, in a single model, different explanations for the decision to retire.

The impact of health status and Medicare on retirement has also been investigated by Rust and Phelan (1997) and French and Jones (2005, 2011). However, they do not study the evolution of retirement over the last decades, which is a major goal of this paper. Additionally, none of these articles include home production, which is an important factor for the model to be able to reproduce the pattern of consumption over the lifecycle (Aguiar and

[1] Another related reference is Eisensee (2005) who uses a similar method to study how changes in the Social Security system in the U.S. affected retirement. His model, however, does not allow for idiosyncratic shocks - an important feature of our model - or health status, which we found to be important in the decision to leave the labor force.

[2] A recent survey of the literature can be found in Coile and Gruber (2007).

[3] Coile and Gruber (2007), for example, argue that some of these studies consider social security impacts at a point in time, but not the effects that arise from the time pattern of social security wealth accruals.

[4] Krueger and Pischke (1992) raise this point, after finding little effect of social security benefits on labor supply.

Hurst, 2005).[5]

Regarding the impact of the rise in longevity on the decision to leave the labor force, Kalemli-Ozcan and Weil (2010) show that an exogenous decrease in the probability of death, which allows people to better plan saving for old age, generates a longer retirement life. In contrast, Bloom et al. (2007) show that, depending on social security provisions, improvements in life expectancy may induce people to remain in the labor force to increase savings for old age. Our simulations show that the latter effect dominates.

Finally, technology change may modify age-earnings profiles and hence the decision to leave the labor force, as shown by Ferreira and Pessôa (2007)[6]. In fact, Heckman, Lochner and Todd (2003) provide evidence that older workers have become less productive relative to younger workers over the second part of the last century. This trend could induce people to work more intensively in the first part of their productive life, increase savings and retire earlier[7].

The article is organized as follows. Some retirement facts are presented in Section 2. The model is presented in Section 3 and the calibration procedures and data are presented in Section 4. In Section 5 results are presented and discussed; Section 6 concludes.

2 Retirement Facts

This section presents the main facts that serve as outputs in our analysis. In particular, we document the changes in retirement between 1950 and 2000, the pattern of labor force participation by health status and by labor productivity, the distribution of applications for Social Security benefits, as well as the pattern of consumption over the life-cycle.

Panel A in Figure 1 presents the retirement profile by age for the years 1950 and 2000, which were constructed using data from the Integrated Public Use Microdata Series (IPUMS) for men aged 50 and over. The retirement rate is the ratio of the number of men who are retired to the number of men either in the labor force or retired. To be classified as retired a

[5] In addition, aside from being partial equilibrium models, in Rust and Phelan (2007), individuals are not allowed to save and, due to data restrictions, French and Jones (2005, 2011) considere a much shorter life-cycle.

[6] Note, however, that Ferreira and Pessôa (2007) use a representative agent economy and do not include social security in their model.

[7] Graebner (1980) argues that in periods of rapid technological innovation, such as the last thirty years, the elderly tend to become increasingly obsolete due to their slower learning, which would affect their relative income.

man must be completely out of the labor force. Thus, men who are working part-time or part-year are counted as working and not retired. The retirement rates for each age are computed by observing that: % retired = (% not in the labor force − % never participating)/(1 − % never participating).[8]

The figure displays the increase in retirement observed in the second half of the last century. It can be seen that the share of individuals out of the labor force is significantly larger in 2000 than in 1950, mainly among those aged 60 and over. In 2000, there were very few people still working at age 75 - less than 10% - but in 1950 approximately 25% of the individuals of that age were still in the labor market. The main goal of this paper is to understand the causes of the changes presented in Panel A of Figure 1.

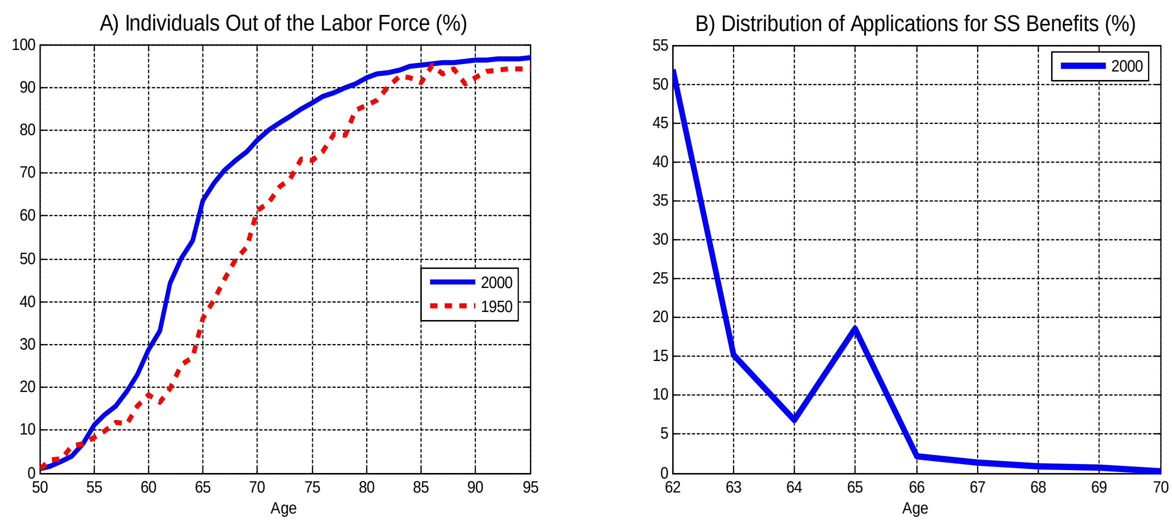

Figure 1: Individuals out of the labor force (IPUMS, 1950 and 2000), distribution of Social Security benefit claims (SSA, 2002).

Panel B in Figure 1, which shows the distribution of Social Security benefit claims, suggest that institutional factors are very important in influencing retirement behavior. The minimum age for eligibility for Social Security benefits in 2000 was 62, whereas the normal age for retirement benefits (without discount) was 65. The latter is also the age at which eligibility for Medicare starts. There are two peaks in the distribution of applications to

[8]This calculation is similar to that used in Kopecky (2011). Following Rust and Phelan (1997) we considered any individual who worked less than 300 hours per year to be out of the labor force.

social security benefits at these ages in 2000, as shown in Figure 2. Fifty-two percent of all applications occur at age 62, and 18% occur at age 65, twice as large as the number of applications at age 64. In 1950, however, the most common retirement age was 65.[9]

Table 1, which was constructed using U.S. Census data from 2000, presents evidence that low earners retire earlier. In the first column, we show earnings for individuals who worked at least 35 hours per week in the previous 12 months, whereas in the other columns we show the share of agents out of the labor force for different ages in 2000. It can be seen that labor force participation increases with earnings. In particular, more than 23% of individuals aged 65 with earnings up to $25000 in the previous year had already left the labor force in 2000, which is nearly twice as much as the share of agents with the same age and with earnings from $75000 to $100000.[10]

Table 1: Individuals Out of the Labor Force by Past Earnings (%) - 2000

Earnings (US$)[1]	Age					
	60	61	62	63	64	65
0-25000	13.6	14.0	23.6	20.4	21.2	23.5
25000-50000	7.5	7.2	12.6	11.9	9.2	17.2
50000-75000	6.8	5.1	11.3	8.0	8.5	13.3
75000-100000	3.4	5.3	5.8	4.8	7.2	11.5

[1]Received by individuals in the past 12 months who worked at least 35 hours per week.

Further evidence on the effect of earnings on retirement can be found in Burkhauser, Couch and Phillips (1996). These authors use data from the Health and Retirement Survey (HRS) to compare those who take Social Security retirement benefits at age 62 with those who do not. They found that those who retired at the minimum age had a median income in 1993 of $31000 and those who postponed retirement had a median income of $41000. They found similar results when using the 1991 survey.

Although in the present article we do not deal with education, data on retirement by schooling level can be used as an indirect evidence of retirement by income level, given the strong positive correlation between income and education. In 2000, 57.4% of male

[9]Data on the distribution of Social Security benefit claims is from the SSA's Annual Statistical Supplement, 2002

[10]According to the Census questionnaire, labor force status is determined by asking individuals whether they worked in the week prior to the interview, which took place in April 1 2000.

individuals aged 55-64 years with less than a high education were out of the labor force, but only 27% of those with a college degree or more were retired. For those aged 65-74 years, the corresponding figures were 87.5% and 69%, respectively.

Studies of health status and retirement tend to indicate that those in poor health retire earlier, although there are complications in this case related to the fact that health status is not directly observable. For instance, McGarry (2004) found that poor health has a large effect on labor force attachment: being in fair or poor health is associated with an expected probability of continued work that is 8.2 percentage points lower than for someone in excellent health. This result is consistent with the conclusions of many other studies that have used subjective health measures. Dwyer and Mitchell (1999) - who also used more objective measures - found that the influence of health problems on retirement plans is stronger than that of economic variables. Moreover, men in poor health are expected to retire one to two years earlier that those in good health[11]. Rust and Phelan (1997) founds that unhealthy individuals are roughly twice as likely as healthy individuals to apply for social security benefits at the early retirement age, and French (2005) estimates that the labor force participation rate of healthy individuals is above that of unhealthy individuals aged 40 and over. He also founds that healthy individuals work more hours.

Panel A of Figure 2 presents retirement profiles by age and health status, using 2000 data from the Health and Retirement Study (HRS). The percentage of individuals who report that they are in fair or poor health ("Poor health" in the figure) and are retired is uniformly higher than that of retired individual in good, very good and excellent health ("Good health"). Moreover, almost 90% of all individuals in poor health between 55 and 85 years of age are retired, compared with only 43% of those in excellent health.

Finally, it is well documented that lifecycle consumption expenditures have a hump shape with a steep drop after retirement (Banks et al., 1998). Aguiar and Hurst (2005, 2008) show that the consumption drop at retirement is a fall in expenditures not associated with a fall in consumption because of the substitution between market goods and home production at retirement. People earn less income after leaving the labor force but they have more (non-market) time, so that they can spend more time shopping, preparing meals, etc. In other words, as the relative price of their time falls, individuals will substitute away from market

[11] Both studies, for methodological reasons, are not subject to "justification bias" (Anderson and Burkhauser (1985)), which is the fact that estimated health effects using subjective self-assessment of health may be misestimated if individuals use health as an excuse to leave the labor force.

expenditures and use more of their time to produce consumption goods. Hence, once one considers home production, the lifecycle consumption profile is much smoother. Panel B of Figure 2 presents consumption estimates from Aguiar and Hurst (2008).

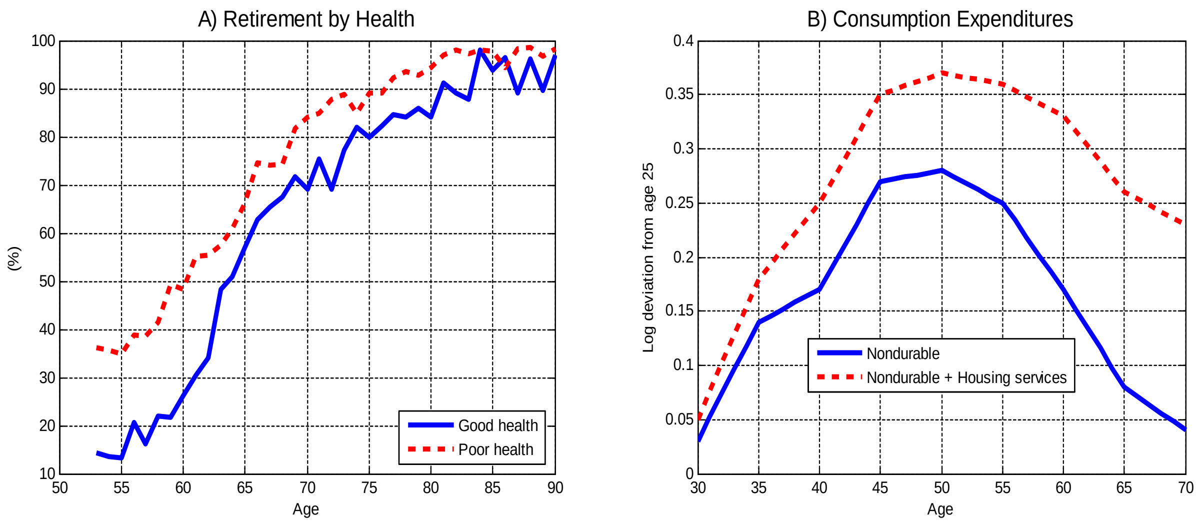

Figure 2: Retirement by health status (HRS, 2000) and Consumption Profile (Aguiar and Hurst, 2008)

3 The model

3.1 Demography

The economy is populated by a continuum of mass one agents who may live at most T periods. There is uncertainty regarding the time of death in every period so that everyone faces a probability ψ_{t+1} of surviving to the age $t+1$ conditional on being alive at age t. This lifespan uncertainty entails that a fraction of the population leaves accidental bequests, which, for simplicity, are assumed to be distributed to all surviving individuals in a lump-sum basis. The age profile of the population, denoted by $\{\mu_t\}_{t=1}^{T}$, is modeled by assuming that the fraction of agents at age t in the population is given by the following law of motion $\mu_t = \frac{\psi_t}{(1+g_n)}\mu_{t-1}$ and satisfies $\sum_{t=1}^{T}\mu_t = 1$, where g_n denotes the population growth rate.

Individuals in our economy also face uncertainty with respect to their health status, which is denoted by a binary variable hs that assumes a value of 1 if an agent is in good health and

0 otherwise. They know hs at the beginning of each period, but future health outcomes are uncertain. Indeed, an individuals' health status is assumed to evolve over time according to a first-order Markov process with transition probability matrices $\Pi_t = [\pi_t(hs_t, hs_{t+1})]$, where $\pi_t(hs_t, hs_{t+1}) = \Pr(hs_{t+1}|hs_t)$.

3.2 Preferences

In each period of life, individuals are endowed with one unit of time, which can be split among leisure, time spent in the labor market, $l_{w,t}$, and time spent in home production, $l_{h,t}$. Individuals enjoy utility over consumption, $\widetilde{c}_t$, and leisure, $1 - l_{w,t} - l_{h,t}$, and maximize the discounted expected utility throughout life:

$$E\left[\sum_{t=1}^{T}\beta^{t-1}\left(\prod_{k=1}^{t}\psi_k\right)u\left(\widetilde{c}_t, 1 - l_{w,t} - l_{h,t}\right)\right] \tag{1}$$

where β is the intertemporal discount factor and E is the expectation operator. The period utility is assumed to take the form of a standard Cobb-Douglas utility function:

$$u\left(\widetilde{c}_t, 1 - l_{w,t} - l_{h,t}\right) = \frac{\left[\widetilde{c}_t^{\rho}(1 - l_{w,t} - l_{h,t})^{1-\rho}\right]^{1-\gamma}}{1-\gamma} \tag{2}$$

where ρ denotes the share of consumption in the utility and γ determines the risk aversion parameter.[12]

Following Becker (1965), home production in our model is such that the consumption that individuals care about, $\widetilde{c}_t$, is an aggregation of market purchased goods, c_t, and time spent in home production, where the aggregator is given by a CES function parameterized as follows:

$$\widetilde{c}_t = \left[\varsigma c_t^{\phi} + (1-\varsigma) l_{h,t}^{\phi}\right]^{\frac{1}{\phi}} \tag{3}$$

We allow for preference heterogeneity in time devoted to work at constant consumption and wage levels. In particular, we follow Kaplan (2011) and assume that $\rho = \frac{1}{1+\xi-\varkappa hs}$, where ξ follows a log-normal distribution with mean $\bar{\xi}$ and variance σ_{ξ}^2.[13] The shock ξ is realized at birth and retained throughout live. This additional source of heterogeneity is intended to take into account variations in work hours that are independent from the variations observed

[12] The coefficient of relative risk aversion with this utility specification is given by: $-cu_{cc}/u_c = \gamma\rho + 1 - \rho$.

[13] Kaplan (2011), however, does not take into account health shocks.

in wages, which may be important for the study of retirement since it allows individuals with similar earnings and shocks history to exhibit different patterns of retirement behavior.

Note that individuals' health status affects preference for leisure. Indeed, it says that, on average, healthy agents (i.e., $hs = 1$) have stronger preference for work than do unhealthy ones (i.e., $hs = 0$). This relationship between the health condition of individuals and their willingness to work is useful to allow the model to replicate the difference in the pattern of hours worked observed in the data between healthy and unhealthy agents.

3.3 Individuals' problem

3.3.1 Budget Constraint

In our model economy, individuals make decisions about labor supply and asset accumulation. Because labor is endogenous, employment status is defined in terms of how many hours an individual works. In particular, individuals are considered to be participating in the labor force at age t if they supply at least 5% of their time endowment to the labor market and as not working or out of the labor force if they spend less than 5% of their time endowment in the market.[14] In addition, as they reach the age of T_r and older, they may decide whether to apply for retirement benefits. Thus, the age T_r is the earliest age at which a worker can start collecting social security benefits in our model.

Individuals' labor productivity is determined by an age-efficiency index denoted by $e(z_t, \kappa_t) = \exp(z_t + \kappa_t)$, in which κ_t is a deterministic experience profile for the mean of earnings, and z_t is a random component, which evolves according to an AR(1) process given by $z_t = \varphi_z z_{t-1} + \varepsilon_t$ with innovations $\varepsilon_t \sim N(0, \sigma_\varepsilon^2)$, and thus accounts for the persistence in lifecycle earnings. Labor productivity shocks are independent across agents and, as a consequence, there is no uncertainty over the aggregate labor endowment even though there is uncertainty at the individual level.

All workers in this economy pay labor income taxes (τ_w, τ_{ss}), where the revenue from τ_{ss} is used to finance the benefit payments to the retirees, and τ_w finances overall government expenditures not related to the social security system. Given that there is a maximum benefit that a retired agent may receive, we consider an upper limit $y_{\max}$ on the taxable income,

[14] Considering one model period as one year, the threshold of 5% is equivalent to 300 hours a year, assuming an actual time endowment of 6000 hours (24 hours a day times 5 days a week times 50 weeks a year). This specification is consistent with other papers in the literature (see, for example, Rust and Phelan, 1997).

following the Social Security legislation. Thus, after-tax labor income for an individual who supplies labor $l_{w,t}$ is given by:

$$y_t = (1 - \tau_w) w l_{w,t} e(z_t, \kappa_t) - \tau_{ss} \min \{ w l_{w,t} e(z_t, \kappa_t), y_{\max} \} + \vartheta \tag{4}$$

where ϑ is an exogenous lump-sum transfer component that captures the progressivity of the tax system.

Individuals incur medical expenses during each period, which are treated as necessary consumption that generates no utility but must be paid. Such expenses amount to out-of-pocket costs and insurance premiums. Following Hubbard et al. (1995) and French and Jones (2011), we model health costs as an exogenous drop in individuals' resources. Empirical evidence in French and Jones (2004) shows that the cost of medical care increases with age and is correlated with individuals' health status. In addition, they find that it exhibits high persistence over time and is very volatile as well. Based on this evidence, we model healthcare costs as:

$$me_t = q(t, hs_t, \eta_t, u_t) \tag{5}$$

where (η_t, u_t) accounts for the idiosyncratic component of the medical expenses uncertainty, in which η_t follows an AR(1) process given by $\eta_t = \varphi_\eta \eta_{t-1} + \nu_t$ with $\nu_t \sim N(0, \sigma_\eta^2)$ and $u_t \sim N(0, \sigma_u^2)$ denotes the transitory component.

Individuals can resort to self-insurance to protect themselves against the uncertainty on labor income and medical expenses. Indeed, besides choosing the amount of time to supply to the labor market, they can trade an asset subject to an exogenous lower bound on asset holdings. We assume that this asset, which is denoted by a_t, takes the form of capital. Thus, savings may be precautionary and allow partial insurance against idiosyncratic shocks. Agents are not allowed to incur debt at any age, so that the amount of assets carried over from age t to $t+1$ is such that $a_{t+1} \geq 0$. Furthermore, given that there is no altruistic bequest motive and death is certain at age $T+1$, agents who survive until age T consume all their available resources, that is, $a_{T+1} = 0$.

We allow individuals who have left the labor force to return to work if they want to do so. Thus, we depart from the standard labor force participation model that treats retirement as an absorbing state. This is consistent with empirical evidence showing that a non-trivial share of retirees, mainly the early ones, end up reentering the labor force following retirement.[15] The importance of departing from the absorbing state assumption lies in the fact that it may lead the model to understate the expected value of retirement, as some retirees would be better off if they were allowed to go back to work.

As already said, individuals aged T_r and over are allowed to apply for social security benefits. Let $b(t_r, x) = q(t_r)b^n(x)$ denote these benefits, where t_r is the age at which the application takes place and x is the average lifetime earnings, which is calculated by taking into account individual earnings up to age T_r. We specify the following law of motion for x:

$$x_{t+1} = \frac{x_t(t-1) + \min\{wl_{w,t}e(z_t, \kappa_t), y_{\max}\}}{t}, \; t = 1, ..., T_r \tag{6}$$

The function $b^n(x)$ is the benefit that agents are entitled to at the normal retirement age. It is a piecewise linear function, which is specified in accordance with the rules of the U.S. social security system:

$$b^n(x) = \begin{cases} \theta_1 x & \text{if} \quad x \leq y_1 \\ \theta_1 y_1 + \theta_2(x - y_1) & \text{if} \quad y_1 < x \leq y_2 \\ \theta_1 y_1 + \theta_2(y_2 - y_1) + \theta_3(x - y_2) & \text{if} \quad y_2 < x \leq y\max \end{cases} \tag{7}$$

where $0 \leq \theta_3 < \theta_2 < \theta_1$ and (y_1, y_2, y_3) are the bend points of the function.

Thus, up to an average earning level of y_1, individuals are entitled to $\theta_1 x$, so that θ_1 corresponds to the retirement replacement rate in this case. If the average past earnings are greater than y_1 but smaller than y_2, they will earn $\theta_1 y_1 + \theta_2(x - y_1)$, and finally if the past earnings are greater than y_2 but below $y\max$, benefits will be given by $\theta_1 y_1 + \theta_2(y_2 - y_1) + \theta_3(x - y_2)$.

The function $q(t_r)$ captures how the retirement benefits are reduced or increased as individuals start receiving them before or after the normal retirement age, T_r^n. In particular, we have that:

$$q(t_r) = \begin{cases} 1 + g_{er}(t_r - T_r^n) \text{ if } t_r \in [T_r, T_r^n] \\ (1 + g_{dc})^{(t_r - T_n)} \text{ if } t_r \in (T_r^n, \bar{T}_r] \end{cases} \tag{8}$$

[15] Ruhm (1990) shows that about 25% of workers reenter the labor force following retirement. Nearly 70% of these movements, which take place mostly before age 65, are into partial retirement, rather than full labor force participation.

Thus, for each year that agents anticipate their benefits, they will face a linear reduction in their entitlements by a rate of g_{er}. In contrast, benefits will be increased by a rate of g_{dc} for each year individuals postpone their receipt of social security benefits after reaching the full retirement age, T_r^n. However, this increase no longer applies when they reach age $\bar{T}_r > T_r^n$, even if they continue delaying retirement.

We allow individuals to apply for social security benefits and continue to work, but those that choose to do so may face the retirement earnings test. Considering that the function of the social security benefits is to partially replace lost earnings, the retirement earnings test aims to prevent workers with relatively high earnings from receiving the benefits. The test withholds one dollar in benefits for each \$2 of annual earnings above an exempt amount for individuals aged $t_r \in [T_r, T_r^n)$ and \$3 for those aged $t_r \in (T_r^n, \bar{T}_r]$. Formally, the earnings test can be written as follows:

$$RET_t = \begin{cases} b(t_r, x) - \frac{\max(y_t - y_{ret,T_r}, 0)}{2} & \text{for } t_r \in [T_r, T_r^n) \\ b(t_r, x) - \frac{\max(y_t - y_{ret,T_n}, 0)}{3} & \text{for } t_r \in (T_r^n, \bar{T}_r] \end{cases} \tag{9}$$

where y_{ret,T_r} and $y_{ret,Tn}$ are the threshold above which the test applies.

Additionally, in our model economy government provides individuals a minimum consumption, $\underline{c}$ after medical expenses are paid. We assume that transfers, tra, are conditional on individuals' available resources. In particular, following Hubbard et al. (1995), we specify:

$$tra_t = max\{\underline{c} + me_t - [1 + r(1 - \tau_k)]a_t - y_t - \epsilon - RET_t d_{ss,t}, 0\} \tag{10}$$

where ϵ is the lump-sum transfers due to accidental bequests and $d_{ss,t} = 1$ if the individual has applied for social security benefits, $d_{ss,t} = 0$ otherwise.

This equation implies that government transfers fill the gap between an individual's "liquid resources" - which may include not only their wealth and labor income, but also other government transfers such as social security benefits - and the consumption floor. Thus, individuals can always consume at least $\underline{c}$, even when their disposable resources fall short of covering their out-of-pocket medical expenses. The equation (10) is intended to be a model counterpart for means-tested programs such as Food Stamp, AFDC, Section 8 housing assistance, Medicaid and SSI.

Given all the considerations above, budget constraint facing an individual in our model economy is:

$$a_{t+1} = [1 + r(1 - \tau_k)]a_t + y_t + \epsilon + tra_t + RET_t d_{ss,t} - me_t - (1 + \tau_c)c_t \tag{11}$$

3.3.2 Recursive formulation of individuals problem

Let $V_{w,t}(s_t)$ denote the value function of an t year old agent, where $s_t = (a_t, \xi, z_t, \eta_t, u_t, x_t, hs_t) \in S$ is the individual state space, and let $V^{t_r}_{ss,t}(s_t)$ for $t = T_r, ..., T$ denote the value function of an individual aged t who has applied for social security benefits at age t_r. In addition, considering that agents die for sure at age T and that there is no altruistic link across generations, we have that $V_{T+1}(s_{T+1}) = 0$. Thus, the choice problem of individuals aged $t = 1, ..., T_r - 2$ can be recursively represented as follows:[16]

$$V_{w,t}(s) = \underset{l_w, l_h, a' \geq 0}{Max} : \left[u(\widetilde{c}, 1 - l_w - l_h) + \beta\psi_{t+1} \sum_{hs'} \pi_t(hs, hs') E V_{w,t+1}(s') \right] \tag{12}$$

subject to (11) and (6), where $s' = (a', \xi, z', \eta', u', x', hs')$.

Whereas the problem of individuals aged $t = T_r - 1, ..., T$ can be written as:

$$V_{w,t}(s) = \underset{l_w, l_h, a' \geq 0}{Max} : \left[u(\widetilde{c}, 1 - l_w - l_h) + \beta\psi_{t+1} \sum_{hs'} \pi_t(hs, hs') E \max\{V_{w,t+1}(s'), V^{t+1}_{ss,t+1}(s')\} \right] \tag{13}$$

where $V^{t_r}_{ss,t}(s)$ is given by:

$$V^{t_r}_{ss,t}(s) = \underset{l_w, l_h, a' \geq 0}{Max} : \left[u(\widetilde{c}, 1 - l_w - l_h) + \beta\psi_{t+1} \sum_{hs'} \pi_t(hs, hs') E V^{t_r}_{ss,t+1}(s') \right] \tag{14}$$

subject to (11), where $s' = (a', \xi, z', \eta', u', x, hs')$.

Solving the dynamic programs in (12), (13) and (14), we obtain decision rules for the time spent in the labor market and the time spent in home production $d_{l_w,t}$, $d_{l_h,t} : S \to [0, 1]$, asset holdings $d_{a,t} : S \to R_+$, consumption $d_{c,t} : S \to R_{++}$, and for the decision of applying for Social Security retirement benefits, $d_{ss,t} : S \to \{0, 1\}$. Note, however, that individuals may only apply for benefits at age $t \geq T_r$. Additionally, once they apply, they are not allowed to forsake the benefits, which means that if $d_{ss,t-1} = 1$, then $d_{ss,t} = 1$.

[16] To simplify the notation, we have suppressed the subscript for age from both the state and control variables.

3.4 Government

In our economy, the government manages a social security system, wherein the pension benefits to pensioners are financed through an exogenous tax τ_{ss}. The amount of benefit received by each retired agent depends on his or her individual average lifetime earnings through a concave, piecewise linear function, which was presented above. Additionally, the government levies proportional taxes on consumption, τ_c, labor income, τ_w, and capital income, τ_k, to finance an exogenous stream of expenditures, G, government transfer and the servicing and repayment of its debt, D. We allow τ_c to adjust to ensure that government budget constraint is satisfied at equilibrium. Finally, we assume that the government collects the accidental bequests and transfers it to all agents in the economy on a lump-sum basis.

3.5 Technology

The technology in this economy is given by a Cobb-Douglas production function with constant returns to scale, which is specified by $Y = K^{\alpha}N^{1-\alpha}$ where $\alpha \in (0, 1)$ is the output share of capital income, and Y, K and N denote aggregate output, capital and labor respectively. This technology is managed by a representative firm, which behaves competitively in the sense that it picks capital and labor to maximize its profit, taking prices as given. Thus, the problem of the representative firm can be written as follows:

$$\Pi = \underset{K,N}{Max} : K^{\alpha}N^{1-\alpha} - wN - (r + \delta)K \tag{15}$$

where δ is the depreciation rate of capital.

Thus, the first-order conditions of the firm's maximization problem are:

$$r = \alpha \left(\frac{K}{N}\right)^{\alpha-1} - \delta \tag{16}$$

$$w = (1 - \alpha)\left(\frac{K}{N}\right)^{\alpha} \tag{17}$$

3.6 Equilibrium

At each point of time, agents are heterogeneous in regard to age t and to state $s \in S$. The agents' distribution at age t among the states s is described by a measure of probability λ_t

defined on subsets of the state space S. Let $(S, \Omega(S), \lambda_t)$ be a space of probability, where $\Omega(S)$ is the Borel $\sigma-$algebra on S. Thus, for each $\omega \subset \Omega(S)$, $\lambda_t(\omega)$ denotes the fraction of agents aged t that are in ω. The transition from age t to age $t+1$ is governed by the transition function $Q_t(s, \omega)$, which depends on the decision rules and on the exogenous stochastic process for (z, η, u, hs). The function $Q_t(s, \omega)$ gives the probability of an agent at age t and state s to transit to the set ω at age $t+1$.

Definition 1 *Given the policy parameters, a recursive competitive equilibrium for this economy is a collection of value functions* $\{V_{w,t}(s), V_{ss,t}^{t_r}(s)\}$, *policy functions for individual asset holdings* $d_{a,t}(s)$, *for consumption* $d_{c,t}(s)$ *for labor supply at the market* $d_{l_w,t}(s)$ *and at home* $d_{l_h,t}(s)$, *Social Security benefit claiming decisions* $d_{ss,t}(s)$, *prices* $\{w, r\}$, *age dependent but time-invariant measures of agents* $\lambda_t(s)$, *transfers* ϵ *and a tax on consumption* τ_c *such that:*

1) $\{d_{a,t}(s), d_{l_w,t}(s), d_{l_h,t}(s), d_{c,t}(s), d_{ss,t}(s)\}$ *solve the dynamic problems in* (12), (13) *and* (14);

2) *The individual and aggregate behaviors are consistent, that is:*

$$\begin{aligned} K &= \sum_{t=1}^{T} \mu_t \int_S d_{a,t}(s) d\lambda_t - D \\ N &= \sum_{t=1}^{T} \mu_t \int_S d_{l_w,t}(s) e(z_t, \kappa_t) d\lambda_t \end{aligned}$$

3) $\{w, r\}$ *are such that they satisfy the optimum conditions* (16) *and* (17);

4) *The final good market clears:*

$$\sum_{t=1}^{T} \mu_t \int_S \{d_{c,t}(s) + [d_{a,t}(s) - (1-\delta) d_{a,t-1}(s)]\} d\lambda_t = K^\alpha N^{1-\alpha}$$

5) *Given the decision rules,* $\lambda_t(\omega)$ *satisfies the following law of motion:*

$$\lambda_{t+1}(\omega) = \pi_t(hs_t, hs_{t+1}) \int_S Q_t(s, \omega) d\lambda_t \quad \forall \omega \subset \Omega(S)$$

6) *The distribution of accidental bequests is given by:*

$$\epsilon = \sum_{t=1}^{T} \mu_t \int_S (1 - \psi_{t+1}) d_{a,t}(s) d\lambda_t$$

7) τ_c *is such that it balances the government's budget:*

$$\tau_c = \frac{G + SSB + \sum_{t=1}^{T} \mu_t \int_S tra_t(s) d\lambda_t + rD - \tau_k rK - \tau_w wN}{C}$$

where SSB *is the social security balance and* C *denotes the aggregate consumption.*

4 Data and calibration

In this section we describe the data used to calculate the model and the calibration procedures[17]. Initially, the model is calibrated by taking into account 2000 data, which is set as a benchmark. Afterwards, we introduce into the model the changes observed in the economic environment between 1950 and 2000 and investigate whether our model can replicate some stylized facts regarding retirement behavior. Finally, we isolate the effect of Social Security, of the aging population, of Medicare and of the individuals' productivity profile and investigate the relative importance of each of these factors to the changes in retirement behavior during the period.

4.1 Demography

The population age profile $\{\mu_t\}_{t=1}^{T}$ depends on the population growth rate g_n, the survival probabilities ψ_t and the maximum age T that an agent can live. In this economy, a period corresponds to one year and an agent can live 81 years, so $T = 81$. Additionally, we assumed that an individual is born at age 20, so that the real maximum age is 100 years.

Given the survival probabilities, the population growth rate in 1950 and 2000 is chosen so that the age distribution in the model replicates the dependency ratio observed in the data. Thus, we set $g_n = 0.0125$ for 1950 and $g_n = 0.0105$ for 2000. These values generate

[17] The standard calibration procedure of overlapping generations models can be found in Auerbach and Kotlikoff (1987), which we follow here.

dependency ratios of 12.13% and 17.27%, respectively. By modeling the age-population distribution in such a way that it replicates the dependency ratio in data, we can capture the large increase in the number of individuals eligible for social security retirement benefits over the period under study.[18]

Data on survival probability by age and by health status were extracted from Bell and Miller (2005) and French (2005). As Panel A of Figure 3 suggests, life expectancy has increased from 1950 to 2000, as the survival probability profile shifted up and to the right during this period. For example, conditional on being alive at age 20, the expected life span was 69 years in 1950 for an individual in good health condition, whereas this same agent was expected to live until nearly 75 years of age in 2000. Likewise, the longevity of a healthy individual aged 50 rose from 72 to approximately 78 years during the same period.

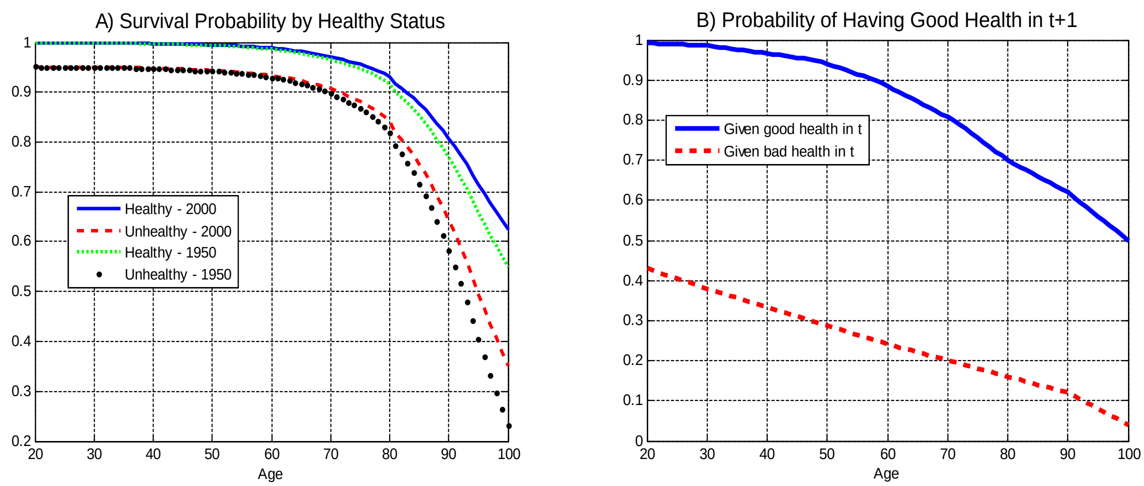

Figure 3: Survival and Good Health Probabilities

The transition probability matrices $\Pi_t = [\pi_t(hs_t, hs_{t+1})]$ were constructed using estimates from French (2005) for the probability of having good health in $t+1$ conditional on the health status in t. Panel B of Figure 3 shows such probabilities for both cases: poor and good health in period t. As one should expect, the probability of being healthy tomorrow decreases with

[18]The number of individuals eligible for social security benefits has also increased because of amendments to the social security regulations. For example, in 1954 agricultural workers, farm and domestic workers were added. For simplicity, in this paper we focus on the changes in the age-population distribution.

age and is far higher for healthy agents than it is for individuals with poor health today, which suggests high persistence of health shocks over the lifecycle.

4.2 Preferences and technology

Values of the preference parameters $(\beta, \gamma, \bar{\xi}, \sigma_\xi^2, \varkappa)$ are summarized in Table 2. The intertemporal discount rate, β, was set to 1.On a yearly basis, this value is consistent with a capital–output ratio of 3.09. The parameters of the stochastic process of shocks on the preference for leisure $(\bar{\xi}, \sigma_\xi^2)$ are from Kaplan (2011) and we set $\gamma = 3$. For Cobb-Douglas preferences, the coefficient of relative risk aversion is given by $1 - \rho + \rho\gamma$ and the Frisch elasticity for leisure is given by $\frac{1-\rho+\rho\gamma}{\gamma}$. For an individual with $\xi = \bar{\xi}$, the values reported in Table 2 entail a value of 1.77 for the coefficient of relative risk aversion and of 0.59 for the Frisch Elasticity for leisure. These values are consistent with the empirical evidence in Auerbach and Kotlikoff (1987), Rust and Phelan (1997) and Domeij and Flodén (2006).

The parameter $\varkappa$ is calibrated so that the model replicates the difference in the pattern of hours worked between healthy and unhealthy individuals over the lifecycle. French (2005) shows that at any point in the life cycle, the effect of health on working hours is sizeable, ranging from 10% to 20%. With a value for $\varkappa$ of 0.20, the model yields that individuals with poor health work, on average, 13% than do those with good health. Figure 4 shows the average hours worked among healthy and unhealthy agents for the benchmark case.

Table 2: Preferences and Technological Parameters

β	γ	$\bar{\xi}$	σ_ξ^2	$\varkappa$	α	δ	$\underline{c}$	ς	ϕ
1.0	3.0	1.60	0.25	0.20	0.36	0.054	0.056	0.7	0.55

In representative agent models, given the capital income share and the depreciation rate, there is a one-to-one relationship between the parameter ρ and the fraction of time that individuals spend working in the stationary state. In overlapping generation models with heterogeneous agents, however, this relationship is more complicated. In this case, the usual procedure used to choose ρ is such that the average fraction of time that individuals spend working is consistent with the empirical evidence, which suggests a value of approximately 30%.[19] In our model economy, because $\rho = \frac{1}{1+\xi-\varkappa hs}$, average hours worked is governed by $\bar{\xi}$

[19] See, for instance, Juster and Stafford (1991).

and, given a value of 1.60 for $\bar{\xi}$, individuals devote 28.5% of their time to the labor market under the baseline calibration.

The parameter ϕ, which governs the elasticity of substitution between market goods and time spent in home production, is set to 0.55. This value is consistent with the estimates in Aguiar and Hurst (2007) who report a range of 0.50-0.60 for ϕ. Given $\phi = 0.55$, the parameter ς is then calibrated so that the average time spent in home production in the model economy matches its counterpart in the data, which is nearly 10% of the time endowment according to the American Time Use Survey (ATUS).

The consumption floor, $\underline{c}$, which is the model counterpart for means-tested programs such as Food Stamp, AFDC, Section 8 housing assistance, Medicaid and SSI, is set to 17% of the average income of the benchmark economy. This value corresponds to nearly \$6220 (in 2000 dollars) and is within the range of values found in the literature. Indeed, Hubbard et al. (1995) estimate a value of \$7000 for $\underline{c}$, which, in 2000 dollars, corresponded to nearly 19% of the average income in the US economy. Using a similar procedure, French and Jones (2011) find a value of \$4380, which is nearly 12% of the average income in 2000.

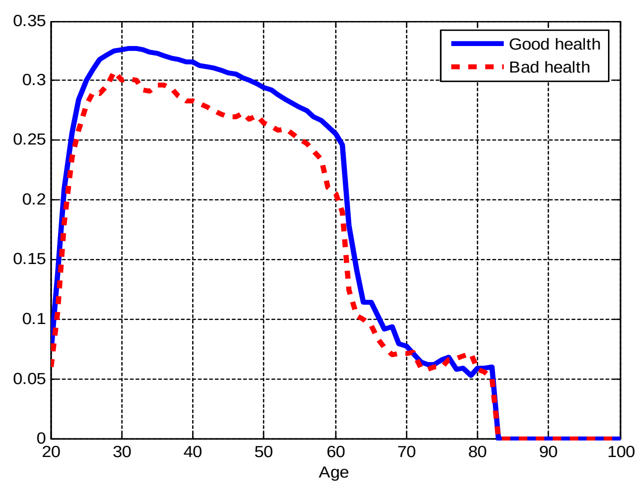

Figure 4: Average hours worked by health status - Model 2000

The values of technological parameters (α, δ) are also summarized in Table 2. We chose a value for α based on U.S. time series data from the National Income and Product Accounts (NIPA). The depreciation rate, in turn, is obtained by $\delta = \frac{I/Y}{K/Y} - g$. We set the investment-product ratio I/Y equal to 0.25 and the capital-product ratio K/Y equal to 3.09. The economic growth rate, g, is constant and consistent with the average growth rate of GDP over the second half of the last century. Based on data from Penn-World Table, we set g equal to 2.7%, which yields a depreciation rate of 5.4%.

4.3 Individual labor productivity

Each agent in this economy is endowed with an individual productivity level $e(z_t, \kappa_t)$. Following Huggett and Ventura (1999), we specify $e(z_t, \kappa_t) = \exp(z_t + \kappa_t)$, where κ_t denotes the age-efficiency profile and z_t denotes the persistent shocks on earnings, with the underline stochastic process being characterized by the parameters $(\varphi_z, \sigma_\varepsilon^2)$. Several authors have estimated similar stochastic processes for labor productivity.[20] Controlling for the presence of measurement errors and/or effects of some observable characteristics such as education and age, the literature provides a range of $[0.88, 0.96]$ for φ_z and of $[0.10, 0.25]$ for σ_ε. In this article, we follow the estimates of Floden and Lindé (2001) and set φ_z and σ_ε^2 to be equal to 0.91 and 0.016, respectively.

The values for κ_t are constructed similarly to Huggett (1996) and MacGrattan and Rogerson (2007). We use annual earnings and annual hours worked for the age groups 15-24, 25-34,..., 75-84 from IPUMS (U.S. Department of Commerce, Bureau of the Census 1950-2005). First, we construct hourly wages by dividing annual earnings by annual hours for each age group. Afterwards, we use a second order polynomial to interpolate the points to obtain the age-efficiency profile by exact age. We then truncate the polynomial to zero when it goes below zero which occurs at age 91 for 2000 and age 92 for 1950. Figure 5 shows the profiles for 1950 and 2000 that are used in the calculations. The profiles shown in the figure are consistent with the empirical evidence provided by Heckman et. al. (2003) that shows that the efficiency indexes for older workers are smaller in 1990 than in 1950.[21]

[20] A revision of this literature can be found in Atkinson et. al. (1992).

[21] See also Ferreira and Pessoa (2007). We have not used the age-efficiency profiles estimated by Heckman et. al. (2003) because they do not provide estimates for 2000.

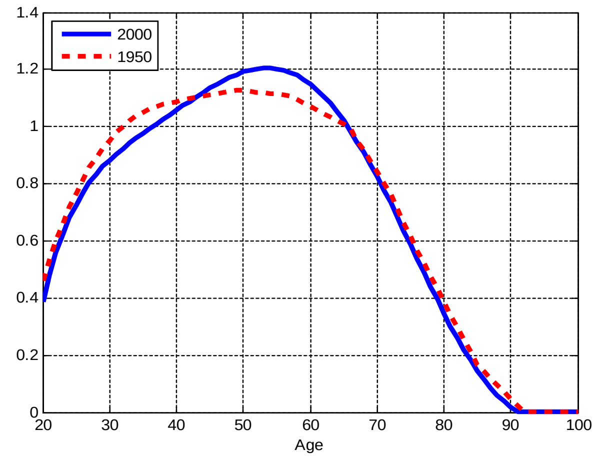

Figure 5: Age-efficiency profile

This fall in the relative productivity of older workers can be explained by technological progress. As shown in Sala-i-Martin (1996), changes in the technology of production have lowered the productivity of older workers thereby leading employers to replace them. Similarly, Graebner(1980) maintains that technological change leads to retirement because elderly individuals learn slower, making them obsolete in periods of faster innovation. [22]

4.4 Medical expenses and Medicare

The out of pocket medical expenses function, $q(t, hs_t, \eta_t, u_t)$, is parameterized as follows:

$$q(t, hs_t, \eta_t, u_t) = \chi(t, hs_t) \exp(\eta_t + u_t) \tag{18}$$

where the function $\chi(t, hs_t)$ captures the effect of age and health on healthcare costs.

The parameters $(\varphi_\eta, \sigma_\eta^2, \sigma_u^2)$ that characterize the idiosyncratic component of medical expenses uncertainty are taken from French and Jones (2004). Table 3 reports the values of these parameters. As shown in the Table, the estimates from French and Jones reveal that not only are the shocks on medical expenses very persistent, but they are also quite volatile, with nearly 50% of the cross-sectional variance in spending being generated by transitory shocks.

[22] Blondal and Scarpetta (1999) also argue that the labor market for the elderly has worsened because of technology changes.

Table 3: Parameters

φ_η	σ^2_η	σ^2_u
0.922	0.05	0.50

We construct the age-health medical expenditures profile, $\chi(t, hs_t)$, for the benchmark economy using the per person healthcare cost estimates by age reported in Meara et al. (2004). Based on data from five national household surveys they estimate per person spending for 2000 and for the following age groups: 5-14,15-24, 25-34,...,75+.[23] We use a second order polynomial equation to interpolate these points to obtain the age profile by exact age. The interpolated profile is displayed in Figure 6. Finally, we normalize the profile by dividing it by the average annual wage, which, according to the Social Security Bulletin (2001), was $36,564.

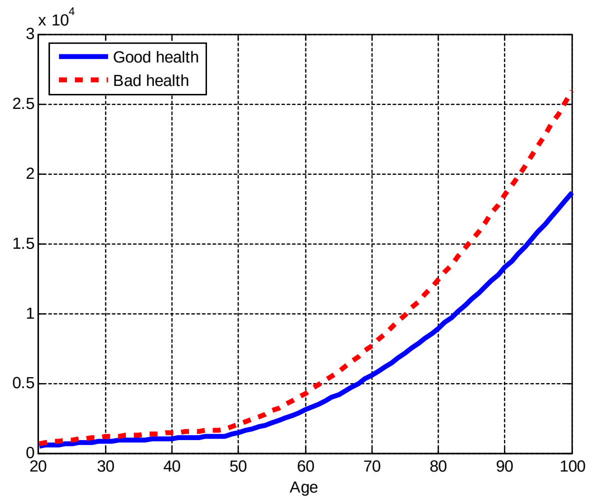

Figure 6: Medical expenses by age (US$) - 2000

We model the effect of Medicare on retirement by investigating how it has changed the out of pocket medical spending function (18). Finkelstein and McKnight (2008) identify the effect of Medicare on healthcare expenditures by comparing changes in spending for individuals over age 65 to changes in spending for individuals under age 65 between 1963 and 1970. To increase the plausibility of the identifying assumption that, absent Medicare,

[23] The 1963 and 1970 Surveys of Health Services Utilization and Expenditures; National Medical Care Utilization and Expenditure Survey; the National Medical Expenditure Survey; and the Medical Expenditure Panel Survey.

changes in various types of spending for individuals above and below age 65 would have been the same, they focus primarily on changes in spending for the "young elderly" (ages 65 to 74) relative to spending for the "near elderly" (ages 55 to 64). The authors find that the introduction of Medicare is associated with a decline of 25% in the mean and of 16% in the standard deviation of out-of-pocket medical spending. In our context, these findings mean that, without Medicare, the out-of-pocket spending function (18) is shifted up for individuals aged 65 and over according to $\widetilde{me}_t = f_1 me_t + f_2$, where the parameters f_1 and f_2 are calibrated in such a way that the new mean and variance of the distribution of healthcare costs capture the removal of Medicare.

4.5 Social Security and Taxation

The social security system in our economy is modeled so that it takes into consideration the main characteristics of the U.S. Social Security System. In 1950, the earliest age at which a person could receive Social Security retirement benefits was 65 so we set $T_r = 46$. After 1961, however, age 62 was adopted as an early retirement age, with reduced benefits. In our context, this point implies that $T_r = 43$ for 2000. The normal retirement age is the age at which a person may first become entitled to unreduced retirement benefits. This age was 65 in 1950 and in 2000, so we have that $T_r^n = 46$ for both years.[24]

In the United States the old-age benefit payable to the worker upon retirement at full retirement age is called the primary insurance amount (PIA). The PIA is derived from the worker's annual taxable earnings, averaged over a period that encompasses most of the worker's adult years. Until the late 1970s, the average monthly wage (AMW) was the earnings measure generally used. For workers first eligible for benefits after 1978, average indexed monthly earnings (AIME) have replaced the AMW as the usually applicable earnings measure. In our context, both AMW and AIME are given by (6).

The complete parameterization of the benefits function requires the specification of values for the parameters $\{\theta_1, \theta_2, \theta_3, y_1, y_2, y\max\}$. The values used for each one of those parameters are presented in Table 4. The parameters (y_1, y_2) correspond to the bend points applied in the formula of calculation of the PIA, whereas $(\theta_1, \theta_2, \theta_3)$ determine the replacement rate applied in each one of the intervals defined by the bend points. For 1950, we use the bend

[24] The normal retirement age will increase gradually to 67 for persons reaching that age in 2027 or later, beginning with an increase to 65 years and two months for persons reaching age 65 in 2003.

points applied to calculate the PIA from creditable earnings after 1936 according to the Social Security Bulletin (2001). In this case, the PIA corresponds to 40% of the first \$50 of AMW plus 10% of the next \$200 of AMW. We multiply these values by 12, adapting to the annual base of the model and then normalize the result dividing it by the average annual wage.

Table 4: Benefit Function Parameters

	y_1	y_2	$y_{\max}$	θ_1	θ_2	θ_3
1950	0.23	-	1.13	0.40	-	0.10
2000	0.19	1.17	2.34	0.90	0.32	0.15

We follow a similar procedure for 2000. The values in this case correspond to those applied in the calculation of the PIA for workers who were first eligible in 1979 or later according to Social Security Bulletin (2001). In 2000, the PIA equaled 90% of first \$531 of AIME, 32% of next \$2671 and 15% of AIME over \$3202. We again divide these values by the average annual wage.[25]

If individuals retire between 62 and 65 years old, their benefits are reduced by a formula that takes into account the remaining time to reach the normal retirement age. Thus, according to the Social Security Supplement (2001), if individuals retire at age 62, 63 or 64 they will receive 80%, 86.7% and 93.3% of the full retirement benefit, respectively. Thus, we set $g_{er} = 0.067$. Conversely, social security benefits are increased by a given percentage if individuals delay their retirement beyond the normal retirement age. This delayed retirement credit was instituted in 1972 to provide a bonus to compensate for each year past age 65 that a person delays receiving benefits, until age 70. Hence, g_{dc} is equal to zero in our economy in 1950. For 2000, we set g_d equal to 0.04, which is the delayed retirement credit for those born in 1929-1930.

Figure 7 plots the benefit function obtained for 1950 and 2000. The horizontal axis corresponds to the average past earnings, x, and the vertical axis corresponds to the benefit. Note that we have normalized the average past earnings to the average labor income, y_m. Thus, for example, if an individual has x equal to y_m, his benefit would be equal to 17% of the corresponding y_m in 1950, whereas in 2000 it would be 42% of that value. It is immediately

[25] According to the Social Security Bulletin (2001), the average annual wage was \$36,564 in 2000 and was \$2,654 in 1950.

apparent from Figure 7 that benefits have become much more generous between 1950 and 2000.

Remember that $y_{\max}$ corresponds to the level of earnings above which earnings in Social Security covered employment is neither taxable nor creditable for benefit computation purposes. In 1950, the maximum taxable annual earning was \$3000, whereas in 2000 it was \$76200. We, then, divided these values by the average annual wage for both years to obtain $y_{max} = \{1.13, 2.34\}$, respectively.

Remember also that the parameter τ_{ss} denotes the contribution from workers to the Social Security system. In 1950, American workers covered by the social security system contributed 3.0% of their wages to Old-Age and Survivors Insurance (OASI), which pays monthly cash benefits to retired worker (old-age) beneficiaries, whereas in 2000 that contribution was 10.6%. Thus, we set $\tau_{ss} = 0.03$ for 1950 and $\tau_{ss} = 0.106$ for 2000.[26]

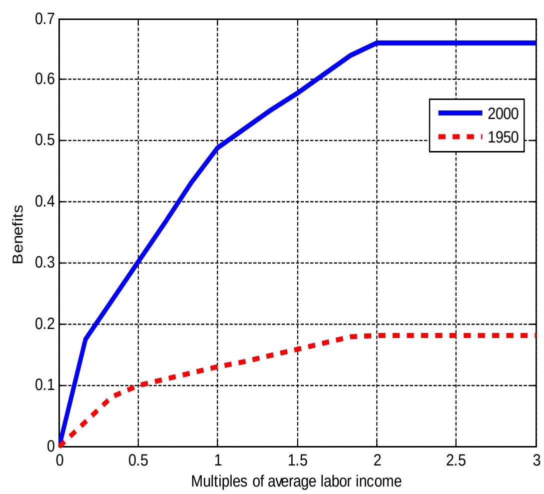

Figure 7: Benefits by multiples of average labor income

The amount exempted of the retirement earnings test for individuals aged 62-64 was \$10,080 in 2000, whereas it was \$17,000 for individuals aged 65-70. These values correspond, respectively, to 27% and 46% of the average wages in 2000. Thus, we set y_{ret,T_r} and $y_{ret,Tn}$ to be $0.27y_m$ and $0.46y_m$, respectively. We assume that there is no retirement earnings test for the 1950 economy.[27]

[26]These values come from the Social Security Bulletin (2001) and are the combined employee-employer tax for Old Age Social Security tax (OASI).

[27]This assumption is for simplicity. In fact, in 1950, the RET was applied in a monthly basis, which makes

Finally, we specify the others parameters related to government activity. First, we set government consumption, G, to 18% of the output of the economy under the baseline calibration, whereas the ratio of federal debt held by the public to GDP is set at 40%. We assume a labor income tax rate of 14% and a capital income tax rate of 27%. The consumption tax is determined in such a way that the government budget balances in equilibrium, which implies a tax rate equal to 12% in the benchmark economy. These values are consistent with others retirement papers that also take into account a more general tax system (see, for example, Fuster el at., 2007). To calibrate the size of the lump sum transfer, ϑ, we target the ratio of the Gini coefficient of after-tax earnings to the Gini coefficient of pre-tax earnings in the U.S.. According to Heathcote el at. (2010), this ratio was nearly 0.92, which yields a value of 0.045 for ϑ.

5 Results

5.1 Benchmark Economy

The retirement rate by age in the model is given by the measure of agents at age t, λ_t, who are out of the labor force. Panel A of Figure 8 presents the retirement rate generated by the model for the benchmark case and the retirement profile observed in the U.S. economy in 2000. The model is able to reproduce very closely the retirement profile by age in 2000. In particular, it captures the jump in retirement at ages 62 and 65 and the relatively large number of individuals leaving the labor force before they reach the minimum eligible age for early benefits. Note that, in both the data and the simulation, almost 15% of the 55-year-old individuals were out of the labor force in 2000.

it difficult to model in our context as we set one period as one year. This assumption is likely to have small impact on our results because fewer than 5% of beneficiaries were affected by the test, according to the SSA's Annual Statistical Supplement, 2000.

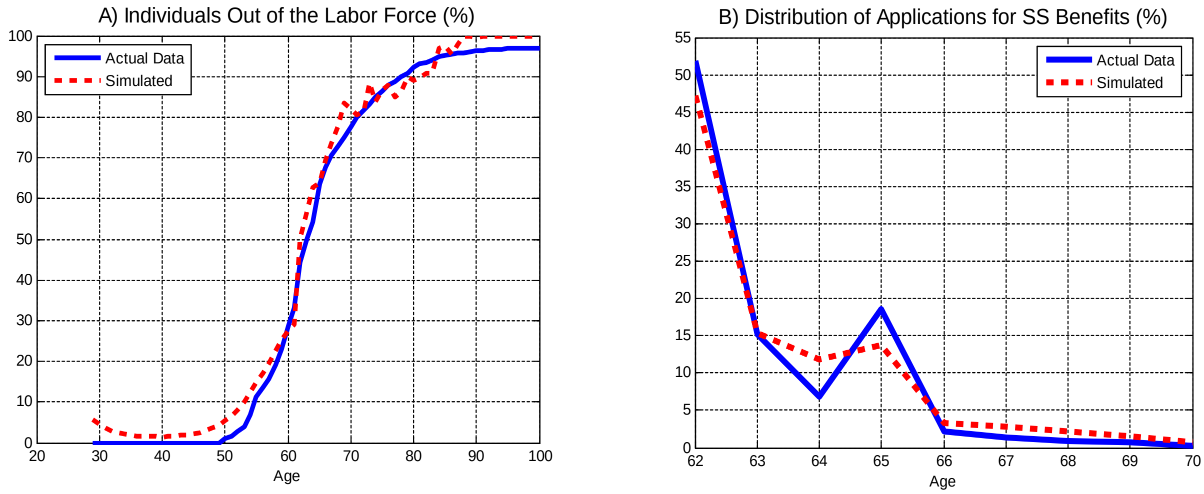

Figure 8: Model-data comparison for the benchmark economy - 2000

Our model is also able to reproduce very closely the pattern of applications for Social Security benefits. From Panel B of Figure 8 one can see that almost 48% of the total applications in the model economy occur at age 62, while the corresponding figure in the data is 52%. Market incompleteness and the role of insurance played by Social Security benefits are very important to explain the high rate of claims at age 62. The peak in applications that takes place at age 65, in turn, is associated with the eligibility for full retirement benefits. In this case, the model yields a rate of 13.9%, while the actual value is 18%.

Figure 9 presents the retirement profile for the bottom and top 2.2% of the hourly earnings distribution, Panel A, and the retirement profile by health status, Panel B. The main message is that low earners and unhealthy individuals are much more likely to retire earlier than are their counterparts. As a matter of fact, for every age group, the retirement rate for individuals with low earnings is above that of the individuals with high earnings, as Panel A shows, which is consistent with the evidence in Table 1. According to the simulations, at age 62, nearly 90% of the individuals in the bottom of the distribution are out of the labor force, whereas 11% of the top 2.2% earners at the same age left the labor force.[28]

[28] Note that hourly earnings in our model are given by $we(z_t, \kappa_t)$. Thus, the distribution of hourly earnings at a given age is determined by the conditional distribution of the persistent productivity shock z_t.

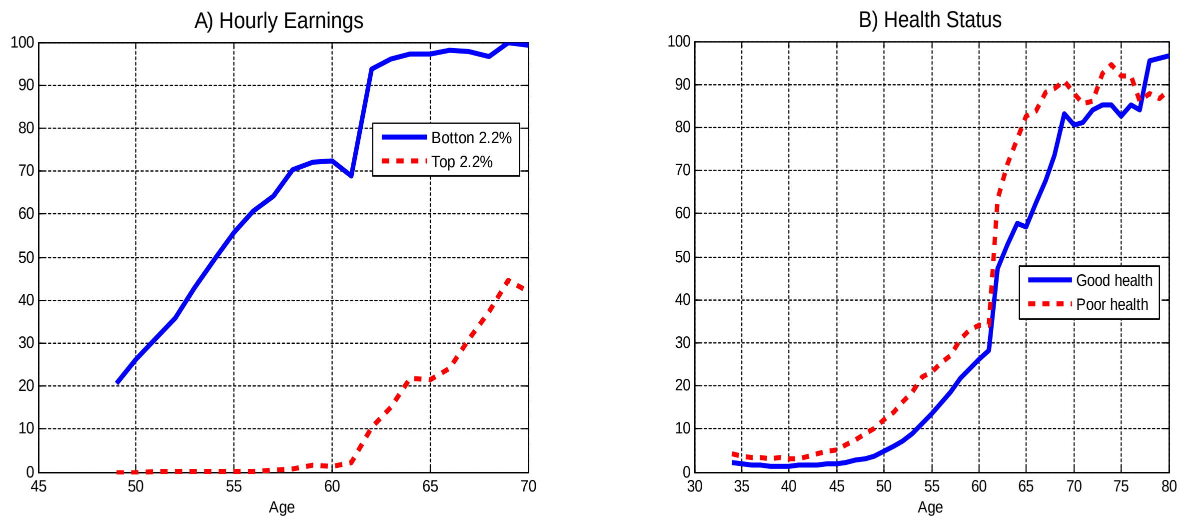

Figure 9: Retirement by Hourly Earnings and by Health Status (%) - Model 2000

Likewise, up until the age of 75, the retirement profile of the unhealthy is always above that of the healthy individuals. Note also the steep jump in the retirement of the unhealthy at age 62, which is the minimum age for receiving Social Security benefits. These results are consistent with the empirical evidence in Section 2 and in Rust and Phelan (1997), which shows that individuals in poor health are roughly twice as likely to start collecting benefits at 62 rather than at age 65. This difference exists because Social Security benefits provide a type of insurance against idiosyncratic shocks. Thus, in the presence of market incompleteness, which limits individuals' ability to protect themselves against those shocks, lower income and unhealthy agents have a high incentive to apply for benefits as soon as they become eligible to secure a stream of income when it is needed. Additionally, given that the retirement replacement rate is decreasing with respect to the average past earnings, low income agents may find attractive to claim benefits earlier than the normal age even after considering the penalty for early applications.

Figure 10 displays the average profiles of consumption and market expenditures generated by the model for the benchmark case. According to evidence from Hurd (1990), among many, there is a drop in consumption expenditures at the time of retirement. Our model, due mostly to the hypothesis of death risk (e.g., Davies, 1981) and intratemporally non-separable utility (Attanasio and Weber, 1993), is able to replicate this fact. However, the consumption profile that also includes home goods is much smoother, reproducing evidence in Aguiar and Hurst (2005). From Panel B we see why. At the same time that the average hours in the market fall because individuals are leaving the labor force, average non-market hours increase. This phenomenon occurs because, as noted in Section 2, as the relative price of their time falls, individuals will substitute away from market expenditures and use more of their time to produce consumption goods at home.

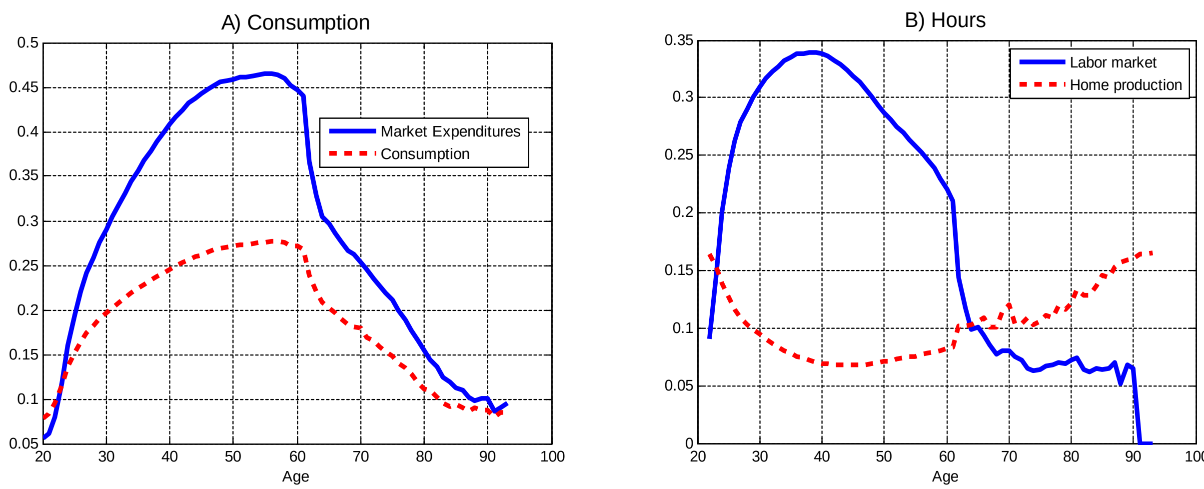

Figure 10: Average consumption and the allocation of time over the life-cycle - Model 2000. In Panel A), "Consumption" corresponds to $\widetilde{c}_t$, which includes time spent in home production, while we call "Market Expenditures" the variable c_t.

Finally, the second column of Table 5 shows some descriptive statistics for the benchmark economy. The table also shows values around which these statistics are found in the related literature. In terms of the distribution of labor earnings, wealth and consumption, the model economy is successful in approximating recent estimates for the U.S.. Burkhausera el at. (2004) report that the earnings Gini coefficient for all earners in 2000 was nearly 0.43, while the model economy generates a value of 0.405. Moreover, the model yields a substantially higher concentration of wealth than of earnings, as is the case in the actual data. Wolff (1994) reports wealth Gini coefficients of approximately 0.80, which is close to the simulated value under the baseline calibration. Finally, estimates in Garner (1993) suggest an actual consumption Gini coefficient near to 0.31, while this measure in the model is close to 0.34[29]. Overall, the model does a good job in reproducing the relevant statistics,

[29] The high level of wealth concentration generated by the model economy is largely due to the assumptions of minimum level of consumption and health shocks. As is noted by Quadrini and Rios-Rull (1997), minimum consumption entails that low income agents have no incentive to accumulate assets because it implies that

and the "retirement facts" presented in Section 2.

Table 5: Descriptive Statistics

	Benchmark Economy	Literature
Capital-Output Ratio	3.09	3.00
Gross Interest Rate	6.15%	6%
Average Hours worked	0.28	0.31
Consumption tax	12%	8%
Gini Index - Earnings	0.41	0.43
Gini Index - Wealth	0.84	0.80
Gini Index - Consumption	0.34	0.31

5.2 Counterfactual Exercises

5.2.1 1950

To investigate how well the model explains the changes in retirement between 1950 and 2000, we introduced into the model the 1950 parameters, as described in the last section. Figure 11 presents the retirement profile generated by the model and the retirement profile observed in the data. The model is also able to replicate the pattern of retirement in 1950 quite well. Remember that the differences between the 1950 and 2000 economies are the changes in the experience profile, changes in the demographic composition of population, modifications in the parameters relative to the social security system and the introduction of Medicare. As there is little left to be explained according to Figure 15, simulation results suggest that the changes in these variables account for almost all the observed change in retirement behavior over the period. Note also that, as it was the case in the 2000 simulation, labor force participation starts to decline after age 50 and the model is able to reproduce this fact, although its prediction slightly overstates this movement. In any case, the match after age 60 is very good.

Note also that the sharp decline in labor force participation at age 62 observed in 2000 is not present in the current simulation, which matches the data. Hence, this model simulation

for poor people, the effective tax rate on savings can be above 100 percent. Health shocks, in turn, as they affect the conditional survival probability, generates heterogeneity in the intertemporal discount rate, which is a powerful way to increase wealth dispersion.

shows that institutional changes related to social security are in fact effective at influencing retirement behavior. In this case, the introduction of early benefits between 1950 and 2000 created a peak in the distribution of social security applications in the latter year that was not present in the former.

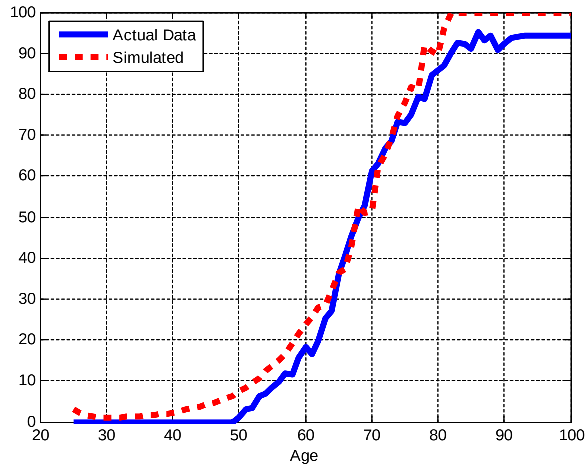

Figure 11: Individuals out of the labor force (%) - 1950

5.2.2 Accounting for the changes in retirement

In this subsection, we investigate the importance of each factor in determining the changes in retirement. In Panel A of Figure 12, we modify the benchmark case by changing the rules of Social Security to those of 1950, while keeping everything else constant. In Panel B, Medicare was eliminated (again, keeping all other parameters as in the benchmark case); in Panel C we feed the model with the 1950 demographic profile and in Panel D the age-efficiency profile of the benchmark economy is substituted with that of 1950.

The impact of Social Security and Medicare on retirement is sizable. For instance, the retirement rate of 65-year-old individuals is close to 65% in the baseline economy. This rate declines to 45% once social security parameters are changed, and to 50% if Medicare insurance were not to exist. For 70-year-old individuals, the decline is from 82% to 60% and 58%, respectively. In the latter case, for instance, without the incentive of public health insurance at 65, individuals tend to stay longer in the work force. Among other reasons, they need the income (and savings) to pay for medical expenses.

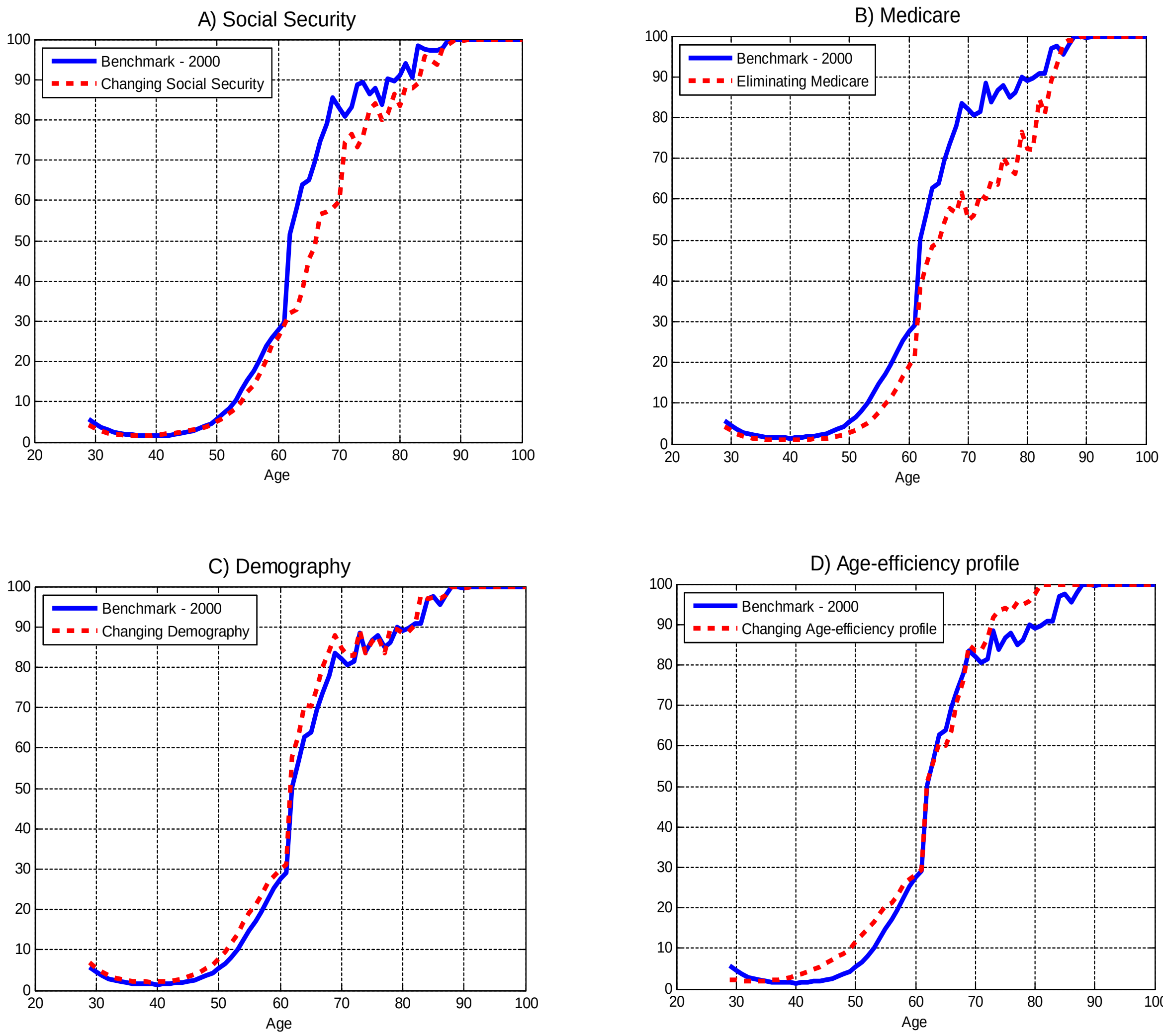

Figure 12: Individuals Out of the Labor Force (%) - Model Simulations

From Panel C it can be observed that the lower life expectancy of 1950 would cause the older workers in 2000 to leave the labor force earlier. In other words, longer life expectancy causes a postponement of retirement in the model. This phenomenon happens because once the survival probabilities are shifted up, there is also an increase in the intertemporal discount rate, leading agents to save more and work harder. Thus, the finding of Kalemli-Ozcan and Weil (2006) that the reduction of mortality risk decreases labor force participation because individuals can better plan their retirement does not hold true in our richer environment in which Social Security provides insurance against lifespan uncertainty. Hence, the observed increase in longevity in the second half of the previous century does not help to explain the increase in retirement. Much the opposite, it has negative impact that, apparently, was compensated for by the changes in Medicare and Social Security. In fact, our simulation partly favors Bloom et al. (2007) as they show that, depending on social security provisions, improvement in life expectancy may increase working life.

In the simulation presented in Panel D the age-efficiency profile in the benchmark economy is substituted with that of 1950. The impact in this case is not too large. For ages below 63, labor force participation falls, which is due to the fact that the age-efficiency profile in 2000 surpasses that in 1950 for ages 42-63. After that age, the impact is positive but small. This findings contrasts with Ferreira and Pessôa (2007), who found that this channel was a key force for the increase in retirement. Possible explanations for the different results are the fact that we use Census data and their calibration is based on CPS data and the introduction of Social Security and Medicare in our model.

Table 6 presents some of the numbers of the simulations of retirement rates for ages 62 to 68 in a different form. The second column presents the 2000 simulation ("Benchmark") and the last column presents the 1950 simulation, where all factors were changed at the same time. The remaining columns display the isolated impact (i.e., keeping all other factors constant at their 2000 values) of Social Security, Demography, Age-Efficiency and Medicare, respectively, on retirement rate. The farther the number in one of these columns is from the 2000 value, the stronger the effect of the corresponding factor.

For all ages, changes in Social Security have the strongest impact on retirement. For instance, the estimated retirement rate at age 62 when changing only the rules of Social Security is 31.9%, very close to the value of the full 1950 simulation[30] (27.7%) and smaller than that of all the other three cases. The isolated impact of Medicare is the second strongest. At age 65, for instance, the elimination of Medicare from the benchmark economy would

[30] Another way to see this result is as follows: if in 2000 the rules of Social Security were the same as in 1950, the retirement rate at age 62 would be almost the same as that in 1950.

cause a reduction in the retirement rate of almost twelve percentage points.

Table 6: Decomposition of the Changes in Retirement Rates

Age	Variable Changed					
	Benchmark	Social Security	Demography	Age-Efficiency	Medicare	All (1950)
62	50.6[1]	31.9	58.9	53.4	41.2	27.7
63	56.9	32.9	63.9	57.4	46.4	28.5
64	61.8	36.7	70.7	60.0	50.2	31.0
65	65.2	46.5	71.3	62.2	53.7	36.6
66	69.5	48.5	75.5	64.1	57.9	38.6
67	74.8	55.2	80.1	72.1	61.1	45.0
68	78.1	57.1	84.7	76.9	62.0	50.2

[1]Share of individuals out of the labor force (%).

As previously noted, changes in the age-efficiency profile between the two years had only a limited impact. As a matter of fact, for ages 62 and 63 its effect goes in the opposite direction, and for all the remaining ages retirement rates are smaller than in the benchmark case. Finally, changes in the demographic profile imply that retirement rates in 2000 would be higher than the benchmark rates, for every age group, with the corresponding 1950 parameters.

5.2.3 Retirement Earnings Test and Delayed Retirement Credit

In this section we present two exercises to further illustrate the importance of Social Security legislation to the labor decision of the elderly. Under the Retirement Earnings Test (RET), Social Security benefits are reduced if earnings exceed specified amounts. However, the Senior Citizens Freedom to Work Act of 2000 abolished the Social Security earnings test for those between the full retirement age and 70 years of age. The removal of the RET allows older workers to remain in the labor force beyond their full retirement age without having part of their retirement benefits withheld. We use our model economy to investigate the effect of this policy change on retirement. In particular, we run a counter-factual experiment in which the retirement earnings test for individuals age 65-70 is eliminated, keeping everything else as in the benchmark calibration. Given that the elimination of RET is likely to have higher impact on higher earners than on lower ones, we show in Table 7 the change in the share of retirees aged 62-69 for the first and fifth quintile of the average past earnings distribution. As one can see in the Table, retirement decreases for individuals aged 65-69 in both cases but the fall is much larger for high earners. Indeed, the share of retirees aged 65, 66 and 67 in the fifth quintile is, without RET, 14.75%, 15.52% and 19.32% lower in comparison to the benchmark case, respectively, against 1.08%, 2.31% and 3.22% obtained among those in the first quintile.

Table 7: Change in retirement by past earnings (%)

Age	First Quintile without RET	Fifth Quintile without RET
62	0.14	3.05
63	1.28	2.03
64	0.15	1.37
65	-1.08	-14.75
66	-2.31	-15.52
67	-3.22	-19.32
68	-4.21	-15.54
69	-3.85	-12.59

Finally, we also investigate the isolated impact of Social Security's Delayed Retirement Credit (DRC) on the retirement of older men. The credit constitutes an incentive built into the program to promote work at older ages. It raises lifetime Social Security benefit payments for recipients who delay receiving benefits beyond age 65. We use our model to investigate the impact of the DRC on retirement behavior and on claiming behavior. In particular, we run a counterfactual experiment in which we set $g_{dc} = 0$. Table 8 shows the percentage change in retirement and in the applications for Social Security benefits by age. The model predicts a small effect of the DRC on retirement. This result should be expected because in our model economy retirement behavior is independent from the claiming behavior, which is more likely to be affected by changes in the DRC. In fact, the third column of Table 8 shows a sizeable impact of DRC on the distribution of applications for social security. Benefits are now claimed much earlier, mainly at age 65: with $g_{dc} = 0$, applications at age 65 increases by 33.2%. In contrast, they fall for ages 66, 67 and 68. Hence, our model suggests that DRC is in fact able to delay applications for benefits and thus ease the pressure on the Social

Security system.

Table 8: Change in retirement and benefit claims (%)

Age	Change in Retirement	Change in Applications
62	-2.93	4.37
63	-2.85	3.26
64	-3.61	7.71
65	-1.57	33.20
66	-1.29	-57.18
67	-1.00	-63.80
68	-1.37	-68.14

6 Conclusions

In this paper, we have studied a lifecycle economy in which individuals optimally pick the time to leave the labor force. The model mimics relevant features of the American economy and takes special care in the calibration of the Social Security system. Simulations were able to match very closely the retirement profile of American men as well as the changes in retirement from 1950 to 2000. The model was able to reproduce the differences in the retirement profiles between low and high productivity individuals and between the healthy and unhealthy. The match of the peak of the distribution of social security applications at age 62 was particularly good.

The model suggests that the changes in Social Security over the second part of the last century and the introduction of Medicare account for most of the changes in the retirement profile by age observed in the period. In contrast, we found that the isolated effect of demography would be to postpone the date that workers leave the labor force. Hence, the increase in longevity observed in the last century cannot explain the reduction in the labor force participation of the elderly. The impact of technology factors represented in the change in the age-efficiency profile was mixed and small. The contrast with Ferreira and Pessôa (2007) may be because the current model includes many other factors affecting retirement.

In addition, we found that the elimination of the Delayed Retirement Credit has a small impact on retirement but would drastically increase Social Security applications at the age of 65. Hence, the incentive of the DRC has played an important role in inducing workers to postpone claiming benefits beyond the normal retirement age and thus ease the pressure on the Social Security system.

References

[1] Aguiar, M., and Hurst, E., 2005. Consumption and Expenditure. Journal of Political Economy, 113, pp. 919-948.

[2] ______________________, 2007. Life Cycle Prices and Consumption. American Economic Review, 97, pp. 1533-1559.

[3] ______________________, 2008. Deconstructing Lifecycle Expenditure, NBER Working Paper 13893.

[4] Attanasio, O. and Weber, G., 1993. Consumption Growth, the Interest Rate and Aggregation. Review of Economic Studies, 60(3), pp. 631-649.

[5] Auerbach, A. and Kotlikoff, L., 1987. Dynamic Fiscal Policy, Cambridge University Press.

[6] Banks, J., Blundell, R., and Tanner, S., (1998). Is There a Retirement-Savings Puzzle?. American Economic Review, Vol. 88 (4), pp. 769-788.

[7] Becker, G., 1965. A Theory of the Allocation of Time. The Economic Journal, 75, pp. 493-517.

[8] Bell, F. and Miller, M., 2005. Life Tables for The United States Social Security Area 1900-2100. Social Security Administration: Actuarial Study No. 120.

[9] Benítez-Silva, H. and Heiland, F., 2008. Early claiming of social security benefits and labour supply behavior of older Americans. Applied Economics, Vol. 40 (23), pp. 2969 – 2985.

[10] Blondal, S. and Scarpetta, S., 1998. The Retirement Decision in OECD Countries. OECD Economics Department WP 202.

[11] Bloom, D.,Canning, D., Mansfield R. and Moore, M., 2007, "Demographic Change, Social Security Systems, and Savings," Journal of Monetary Economics 54: 92–114.

[12] Burkhauser, R. V., Couch, K. A., and Phillips, J., 1996. Who Takes Early Social Security Benefits? The Economic and Health Characteristics of Early Beneficiaries. The Gerontologist, Vol. 36 (6), pp. 789-799.

[13] Burkhauser, R. V., Butlerb, J. S., Fengc, S. and Houtenville, A. J., 2004. Long term trends in earnings inequality: what the CPS can tell us. Economics Letters, Vol. 82 (2), pp. 295-299.

[14] Burtless, G., 1986. Social Security, Unanticipated Benefit Increases and the Timing of Retirement. Review of Economic Studies, 53(5), pp. 781-805.

[15] Conde-Ruiz, J. and V. Galasso, 2003, Early Retirement, Review of Economic Dynamics, 6(1), pp. 12-36.

[16] Davies, J., 1981. Uncertain Lifetime, Consumption and Dissaving in Retirement. Journal of Political Economy, 89(31), pp. 561-77.

[17] Diaz-Gimenez, J. and J. Diaz-Savavedra, 2009, Delaying Retirement in Spain, Review of Economic Dynamics, 12(1), pp. 147-167.

[18] Dwyer and O. Mitchell, 1999, "Health problems as determinants of retirement: are self-rated measures endogenous? Journal of Health Economics. pp. 173-93.

[19] Domeij, D. and Flodén, 2006, The labor-supply elasticity and borrowing constraints: Why estimates are biased, Review of Economic Dynamics, vol. 9(2), pp. 242-262.

[20] Eisensee, T., 2006, Fiscal Policy and Retirement in the Twentieth Century, manuscript, Institute for International Economic Studies, Stockholm University.

[21] Feldstein, M., 1974. Social Security, Induced Retirement, and Aggregate Capital Accumulation. Journal of Political Economy, 82(5), pp. 905-26.

[22] Ferreira, P. C. and Pessôa, S. A., 2007. The Effects of Longevity and Distortions on Education and Retirement. Review of Economic Dynamic, 10(3), pp. 472-493.

[23] Finkelstein, A. and McKnight, R., 2008. What did Medicare do? The initial impact of Medicare on mortality and out of pocket medical spending. Journal of Public Economics, vol. 92(7), pages 1644-1668.

[24] Floden, M. and Lindé, J., 2001. Idiosyncratic Risk in the United States and Sweden: Is There a Role for Government Insure?. Review of Economic Dynamics, 4(2), pp. 406-437.

[25] French, E., 2005, "The Effects of Health, Wealth, and Wages on Labour Supply and Retirement Behavior," Review of Economics Studies (2005) 72, pp. 395-427.

[26] French, E., and Jones, J.B., 2004. On the Distribution and Dynamics of Health Care Costs. Journal of Applied Econometrics, 19(4), 705-721.

[27] French, E., and Jones, J.B., 2011. The Effects of Health Insurance and Self-Insurance on Retirement Behavior. Econometrica, vol. 79 (3), pp. 693-732.

[28] Fuster, L., Imrohoroglu, A., and Imrohoroglu, S., 2007. Elimination of Social Security in a Dynastic Framework. Review of Economic Studies, 74, pp. 113–145.

[29] Garner, T. I., 1993. Consumer Expenditures and Inequality: An Analysis Based on Decomposition of the Gini Coefficient. The Review of Economics and Statistics, Vol. 75 (1), pp. 134-38.

[30] Graebner, W., 1980. A History of Retirement: The Meaning and Function of an American Institution. 1885-1978, New Haven, CO: Yale University Press.

[31] Gruber, J. and Wise, D., 1999. Social Security Programs and Retirement around the World. The University of Chicago, Chicago.

[32] Gruber, J. and Orszag, P., 2003. Does the Social Security Earnings Test Affect Labor Supply and Benefits Receipt?. National Tax Journal, 56(4), pp. 755-773.

[33] Gustman, T. and Steinmeier, T. L., 1986. A Structural Retirement Model. Econometrica, 54(3), 555-584.

[34] Heathcote, J., Perri, F., and Violante, G., 2010. Unequal We Stand: An Empirical Analysis of Economic Inequality in the United States, 1967–2006. Review of Economic Dynamics, 13(1), pp. 15-51.

[35] Heckman, J., Lochner, L. and Todd, P., 2003. Fifty Years of Mincer Earnings Regressions. NBER Working Papers 9732.

[36] Hubbard, R., J. Skinner, and S. Zeldes., 1995. Precautionary Saving and Social Insurance. Journal of Political Economy, 103(2), pp. 360-399.

[37] Huggett, M., 1996. Wealth Distribution in Life-Cycle Economies. Journal of Monetary Economics, 38(3), pp. 469-494.

[38] Huggett, M. and Ventura, G., 1999. On the Distributional Effects of Social Security Reform. Review of Economic Dynamics, 2(3), 498-531.

[39] Hurd, M., 1990. Research on the Elderly: Economic Status, Retirement, and Consumption and Saving. Journal of Economic Literature, 28(2), pp. 565-637.

[40] Imrohoroglu, A., Imrohoroglu, S. and Jones, D., 1995. A Life Cycle Analysis of Social Security. Economic Theory, 6(1), pp. 83-114.

[41] Juster, F. T. and Stafford, F. P., 1991. The Allocation of Time: Empirical Findings, Behavioral Models and Problems of Measurement. Journal of Economic Literature, 29(2), pp. 471-522.

[42] Kalemli-Ozcan, S. and Weil, D. N., 2010. Mortality Change, the Uncertainty Effect and Retirement. Journal of Economic Growth, Vol. 15 (1), pp. 65-91.

[43] Kopecky, K . A., 2011. The Trend in Retirement. International Economic Review, vol. 52 (2), pp. 287-316.

[44] Kaplan, G., (2011). Inequality and the Lifecycle. PIER Working Paper series, number 11-014.

[45] Krueger, A. and Pischke, J., 1992. The Effect of Social Security on Labor Supply: A Cohort Analysis of the Notch Generation. Journal of Labor Economics, 10(4), pp. 412-437.

[46] McGarry, K., 2004. Health and Retirement: do Changes in Health Affect Retirement expectations? Journal of Human Resources, 39(3). pp. 624-648

[47] McGrattan, E. R. and Rogerson, R., 1998. Changes in Hours Worked Since 1950. Federal Reserve Bank of Minneapolis Quarterly Review, 22(1): 2-19.

[48] Meara, E., White, C. and Cutler, D. M., 2004. Trends In Medical Spending By Age, 1963-2000. Health Affairs, 23 (4), pp. 176-183.

[49] Nishiyama, N. and Smetters, K., 2007. "Does Social Security Privatization Produce Efficiency Gains?," The Quarterly Journal of Economics, 122(4), pp. 1677-1719, November.

[50] Quadrini, V., and Rios-Rull, J. V., 1997. Understanding the U.S. Distribution of Wealth. Federal Reserve Bank of Minneapolis Quarterly Review, Vol. 21 (2), pp. 22-36.

[51] Rojas, J. and C. Urrutia, 2008, Social Security Reform with Uninsurable Income Risk and Endogenous Borrowing Constraints. Review of Economic Dynamics, 11, pp. 83-103.

[52] Ruhm, C. J., 1990. Bridge Jobs and Partial Retirement. Journal of Labor Economics, 8(4), 482-501.

[53] Rust, J. and Phelan, C., 1997. How Social Security and Medicare Affect Retirement Behavior in a World of Incomplete Markets. Econometrica, 65(4), pp. 781-831.

[54] Sala-i-Martin, X., 1998. A Positive Theory of Social Security. Journal of Economic Growth, 1(2), pp. 277-304.

[55] Stock, J. and Wise, D., 1990. Pensions, the Option Value of Work, and Retirement. Econometrica, 58(5), pp. 1151-1180.

[56] Wolff, E., 1994. Trends in household wealth in the United States: 1962-1983 and 1983-1989. Review of Income and Wealth, Vol. 4 (2), pp. 143-174.