# Social Security and Retirement across OECD Countries

Alonso Ortiz, Jorge

Arizona State University, W.P. Carey School of Business

10 November 2009

# Social Security and Retirement across OECD Countries*

[JOB MARKET PAPER]

Jorge Alonso Ortiz

WP Carey School of Business

Arizona State University

November 11, 2009

**Abstract**

There are large differences in the employment to population ratio relative to the US across OECD countries, and these differences are even larger for the old age (55-69 years). There are also large differences in various features of social security, such as the replacement rate, the entitlement age or whether it is allowed to collect social security and working. These observations suggest that they might be an important factor. I assess quantitatively this hypothesis using a life cycle general equilibrium model of retirement. I find that the differences in social security can indeed account for the differences in employment to population ratio at old age in the OECD. I also evaluate which features of social security are most important in this context and find that generosity and whether it allows collecting social security while working are the most important contributors.

**Keywords:** Social security, retirement, idiosyncratic labor income risk
**JEL Codes:** E24, H53, J14, J26

*I am deeply indebted to Richard Rogerson, Berthold Herendorf and Roozbeh Hosseini for their intellectual encouragement. I would also like to thanks Kevin Reffet and Manjira Datta for helpfull insights and the participants of the Department of Economics' Macro seminar and Brown Bag seminar. Special thanks to Galina Verschagina who patiently discussed my manuscript.

# 1 Introduction

There are large differences in employment to population ratio across OECD countries. In 2006 it ranges from 42% in Turkey to 66% in Norway. These differences are even larger for older persons: the employment to population ratio for ages 60-64 ranges from 13% in Hungary to 60% in New Zealand. At the same time there are large differences in the features of social security systems across the OECD. For example, the replacement rate ranges from 38% in Mexico to 124% in Turkey, while entitlement ages varies from 55 in Australia to 67 in Norway. Some countries (such as Denmark) do not allow collecting social security benefits and working while others (such as Canada) do not impose any restrictions. My paper seeks to answer two questions: Can these differences in social security account for the large differences in employment per person at old ages? What features of social security are the most important contributors in accounting for these differences? Understanting these two questions is very important for policy considerations, as demographic projections show that population over 50 will be more than half of the working age population in 2050.

To answer to these questions I develop a life cycle general equilibrium model of retirement with a discrete labor choice, idiosyncratic labor income risk and incomplete markets. The model is calibrated to match key statistics of the US economy and its social security system. A key feature of my model is that I am able to capture the heterogeneity in employment by age that it is found in the data, which is a desirable property if we want to study cross country heterogeneity in retirement. For example, in the US more than 60% of the population is working at age 62, and 40% is still working at age 65. My model is able to capture very well the employment profile of ages 50-80.

To evaluate the effects of differences in social security across countries, I solve for the stationary equilibrium of the model with the same parametrization of the US but with the social security systems of each OECD country. My main findings are as follows. First, it turns out that the differences in social security account for a large part of the differences in retirement behavior. One way of illustrating this finding is to compare the coefficients of variation of employment to population across OECD countries observed in the data with those generated by the model. At ages 60-64 this statistic is .45 in the data and it is .42 in the model. At ages 65-69 it is .8 in the data and .70 in the model. As a matter of fact, the correlation between the data and model predictions is of .73 for ages 60-64 and .75 for ages 65-69. This means that my model captures much of the variability found in the data. Second, when I ask what are the most salient characteristics of social security that account for differences in retirement, it turns out that generosity and restrictions on collecting social security and working are very important, while differences in entitlement age are not. To assess the magnitude of each, I shut down the characteristics of social security to US levels one by one. I find that the coefficient of variation of employment to population at ages 60-64 in the model is .20 when only generosity is active and .22 when only the restriction on collecting social security while working is active. In contrast, it is only .05 when only the entitlement age is active. It follows that generosity and restrictions on collecting social security and working each account for roughly 50% of the variability in the model. I find little evidence that there are significant interactions across these three features.

My paper is most related to two streams of literature. The first one follows Prescott (2004), that sought to explain large differences in hours of work through differences in the average tax rate for G-7 economies, using a stand-in household growth model[1]. Prescott et. al (2007) and Rogerson & Wallenius (2009) developed a life cycle model with an intensive and extensive margin in the labor choice to analyze the effect of a simple tax and transfer system on

[1] Many papers have studied the impact of differences in taxes on hours of work. For example: Ohanian et al. (2007), Rogerson (2007), McDaniel (2009) and Ragan (2005)

hours of work. It turns out that the results are similar to Prescott. Wallenius (2008) extends this framework to include human capital accumulation and studies differences in hours per capita of Belgium, France and Germany that are generated through differences in social security. She finds that social security has large effects on hours of work, mostly through the extensive margin.

Relative to Wallenius my paper has two important characteristics. First, my model incorporates heterogeneity and it is able to match the distribution of retirement that it is found in the data whereas in her model everybody retires at the same age. Second, I compute outcomes for a much larger set of countries. While I also find large effects of social security, heterogeneity reduces the impact on employment to population. These smaller effects can be due to a smaller response of individuals to social security when there is labor income risk or to composition effects; as when there is mortality risk the weight of older individuals on the total population is smaller. To investigate the role of heterogeneity I cut the variance of the income risk by a half and recalibrate the model to match the US economy. I find that a country with a social security system two times more generous that the US, and everything else equal, will have an employment to population ratio 3% below of the US in a world with half the labor income risk, whereas the employment to population ratio will be 6% below of the US in a world with all the idiosincratic labor income risk. Note that twice the variance implies twice the effect on employment. Furthermore, the employment to population ratio at ages 60-64 will be 9% below of the US in the former case, whereas it will be 25% below of the US in world with the amount of idiosyncratic labor income risk found in the data. This points out to mortality risk and the implied age structure of the population in my model as the main contributor to this discrepancy[2]. An aditional advantage of this model is that it can be used to study how social security impacts the ability of indviduals to insure against risk and it can be

[2]More experimentation is needed to check for the importance of heterogeneity in each OECD country.

used for welfare comparissons. These applications are left for future extensions.

A second stream of literature studies different aspects of social security. I will not attempt to survey it here as it is very extense[3]. The most related reference from this literature is French (2005,2007). He develops a model with labor income, health risk and incomplete markets to study the role of social security in accounting for retirement behavior in the US. He finds the market incompleteness plus social security are key to understand retirement behavior. This provides some support to the importance of the assumptions in my model. I depart from his work in that I include general equilibrium. This is an important extension if we want to study cross country differences in retirement.

The rest of the paper is organized as follows. In the next section I document the differences in retirement, employment and social security across the OECD. Section 3 presents the model. Section 4 describes the calibration procedure. Section 5 describes the counterfactual experiments and their results. Finally, section 6 concludes and outlines directions for future research.

# 2 Employment and social security in OECD

This section presents empirical evidence for OECD countries in 2006. I use labor force statistics by age and sex from OECD on-line database[4] and social security data from "Pensions at Glance 2009" and the "Total Economy Database[5]" There are large differences in employment to population ratio[6].

[3]For example, Gustman and Steinmeier (1986), Stock and Wise (1990), Gruber and Wise (2004, 2007), Coile and Gruber (2007), Phelan & Rust (1998), French (2005,2007), Hugget & Ventura (1999) and Nishiyama % Smetters (2007) to mention a few important contributions to the study of social security

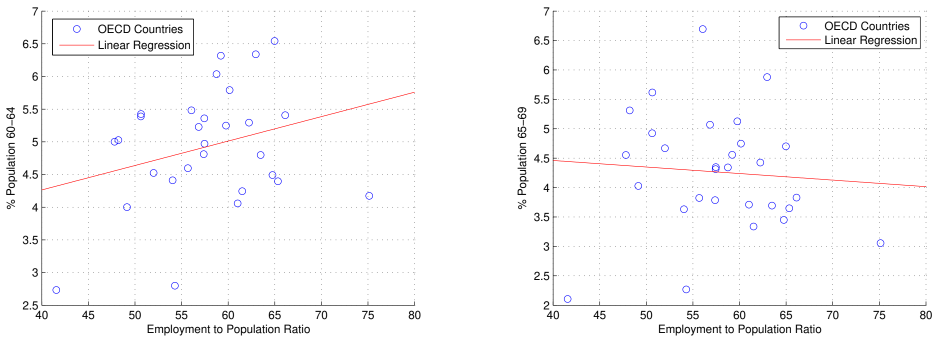
[4]http://stats.oecd.org/Index.aspx

[5]The Conference Board and Groningen Growth and Development Center

[6]I define employment to population ratio as the ratio of employees age 20-75 to individuals 20-75. My model economy will have an initial age of 20 and few individuals work past age

Turkey has the lowest employment rate at 42% of the US whereas Norway is at 66%. These differences are even larger for older individuals. If we look at ages 60-64 the difference are even larger, ranging from 13% in Hungary to 60% in New Zealand (see Figure 1) The US has an employment to population ratio of 65% and it is 51% for ages 60-64, therefore employment to population ratio ranges from .6 to 1.02 of the US and employment to population ratio at 60-64 ranges from .2 to 1.2 of the US.

Figure 1: Employment differences in OECD



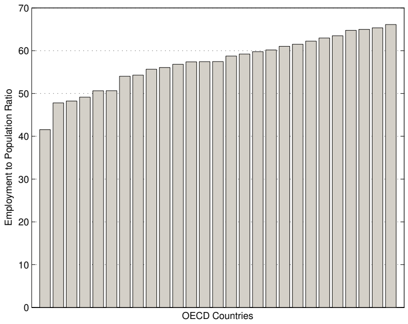

(a) 20-75 (b) 60-64

These differences are not driven by productivity, as there are countries with low employment to population ratio like Belgium (48%), Italy (50%), France (57%) or Germany (56%) that has relatively high labor productivity relative to the US[7] (in the same order 101%, 87%, 98% and 95% respectively) We could think that these differences are driven by differences in demographic structure. Figure 2 shows that the correlation between the ratio of population 60-64 and 65-69 to total population and employment to population is close to zero when both groups are considered together and it is positive for ages 60-64.

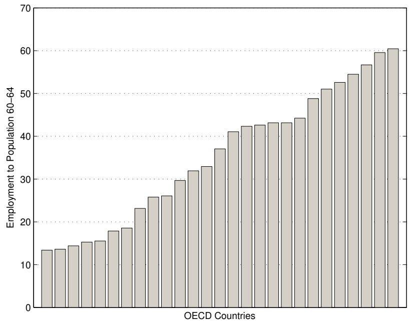
75. Also OECD has data limitations beyond age 70-74.

[7]The coeffient of correlation for the sample is .4. Alonso & Rogerson (2009) show that labor productivity may be high in countries with high taxes, via selection effects on employment

Figure 2: Demographic Composition and Employment




(a) 60-64




(b) 65-69

There are large differences in social security across the OECD. I choose three key features of social security to explore. The first key feature is generosity, defined as pre-retirement net earnings to pension entitlement at retirement age for an average earner[8]. The OECD computes this statistic for single individuals that entered the labor market at age 20 and had a continuous earnings history[9].

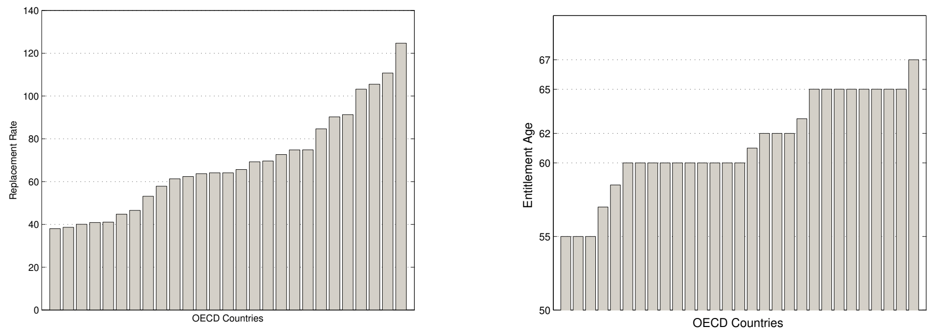
The second key feature is entitlement age. The OECD countries usually have two different entitlement ages: early entitlement age and normal entitlement age. They may depend on sex and occupation. I focus on early entitlement age of males and abstract from differences in entitlement age by occupation. Figure 4 summarizes the large differences in generosity and entitlement age across the OECD.

Finally, countries across the OECD impose different restrictions on collecting social security and working. For example, Denmark gives social security only to those individuals that are not employed, while other countries like

[8]This is known as replacement rate

[9]More details on how OECD computes this statistic can be found in the Appendix

Figure 3: Generosity and Entitlement Age



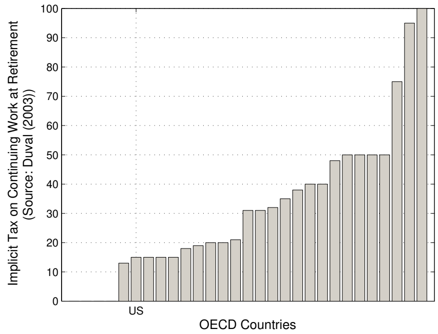

(a) Generosity (b) Entitlement Age

Canada do not impose any restriction at all. A third group of countries have social security that is mean tested in the sense that social security is taxed away if labor earnings are above some threshold. If a country allows for some sort of compensation that is actuarially fair, there should not be major effects from the tax on social security. The US after 2000 is in this case. I summarize these restriction by a single parameter and I call it implicit tax on continuing to work. Duval (2003) computes this tax for some OECD countries at different ages (55, 60 and 65) Figure 5 shows the value of the tax at entitlement age for each country[10].

OECD countries cluster on three different ranges: one third have implicit tax rates below 20%, one third have taxes between 20% and 50% and the last third have taxes over 50%. I assume that this last third will have an implicit tax rate on continuing to work of 100%. I further check if there is any explicit restriction described in the summmary "Social Security around the World" provided by the US Social Security Administration.

[10]I choose the implicit tax from Duval (2003) that is closer to the entitlement age.

Figure 4: Implicit Taxes on Continuing to Work




# 3 Model Economy

This section describes assumptions about demographics, preferences and endowments, technology, policy and market structure.

## 3.1 Demographics

Demographic structure is stable, but the size of the population ($N$) grows at a constant rate $n$. Any given person of age $a$ survives to the next period with probability $s_a$. Individuals have a maximum life length of $A$ years. A given the population growth and the survival probabilities, each age group represents a constant fraction of the population $\mu_a$[11].

## 3.2 Preferences and endowments

Every individual has identical preferences over sequences of consumption $\{c_a\}$ and leisure $\{h_a\}$. Consumption must be non negative and I assume that hours of work can take two values: zero or $\bar{h}$. Every individual is endowed with one

[11]This number is obtained with the following recursion: $\mu_{a+1} = \frac{s_{a+1}}{1+n}\mu_a$ and I normalize the weights to 1, so $\sum_a \mu_a = 1$.

unit of time each period and have preferences given by[12]:

$$E_0 \left[ \sum_{a=1}^{A} \beta^a \left( \prod_{j=1}^{a} s_j \right) u\left(c_a, 1 - h_a\right) \right] \tag{1}$$

## 3.3 Individual productivity

Individuals in my economy are endowed each period with different productivities ($z_{i,a}$), where $i$ index each individual. These differences come from two different sources: a deterministic component that depends on age and it is hump-shaped ($z_a^d$) and an idiosyncratic component independent for each individual ($z_{i,a}^w$), characterized by an $AR(1)$

$$\log(z_{i,a}) = \log(z_a^d) + \log(z_{i,a}^w) \tag{2}$$

## 3.4 Technology

There is a representative firm that operates a constant returns to scale technology that transforms aggregate capital ($K$) and aggregate efficiency units of labor ($L$) into a homogeneous and perfectly divisible product ($Y$). Aggregate capital and labor are obtained by aggregating through individuals. Capital depreciates at a rate $\delta$. Output can be used for either consumption or investment.

## 3.5 Markets

There are capital, labor and product markets that open at each date and operate in perfect competition. There are no insurance markets. As in Aiyagari (1994) and individuals can not borrow and accumulate precautionary savings.

[12]Note that this preferences imply that individuals are not altruistic towards future generations

I will characterize the stationary equilibrium of these markets.

## 3.6 Social Security

Social security is defined by two elements. First, a payroll tax ($\tau$) that is levied on every worker. Second a function $\phi(\bar{e}_a, h_a, a)$ that characterizes the relation between the average of individual's earnings histories ($\bar{e}$) and social security benefit. Note that it is a function of age as individuals do not get social security until entitlement age ($\hat{a}$) and it is also a function of the labor choice, to capture restrictions on collecting social security and working.

## 3.7 Accidental Bequests

As individuals may die with positive probability every period they may leave some capital. I assume that government collects this capital and distribute it lump sum among those individuals alive ($B$).

## 3.8 Recursive Stationary Representation of the Individual Decision

I represent the individual decision problem recursively. I abstract from the time dimension to save notation as I will use a stationary characterization of the equilibrium. The individual state variables of the economy are: wealth ($k$), the idiosyncratic component of productivity ($z^w$), average earnings ($\bar{e}$) and age ($a$). Each period, individuals decide how much to consume ($c$), how much capital to hold ($k'$) and employment ($h$) for every combination of the individual state variables.

Taking interest rates ($r$), wages ($w$), payroll tax ($\tau$), social security ($\phi(\bar{e}_a, h_a, a)$)

and accidental bequests ($B$) as given, each individual solves the following Bellman equation:

$$V_a(k, z^w, \bar{e}) = \max_{c,k',h} u(c, 1-h) + \beta s_{a+1} E_{z^w} \left[V_{a+1}(k, z'^w, \bar{e}')\right] \\ \text{s.t. } c + k' = (1+r)k + (1-\tau)wz_a h + \phi(\bar{e}, h_a, a) + B \tag{3}$$

## 3.9 Aggregate State Variable

The aggregate state variable of the economy is a list of measures over the individual state variables $\{\Psi_a(k, z^w, \bar{e})\}$ that can be easily obtained iterating forward using the optimal decisions of the individuals and the idiosyncratic labor income process; assuming that they enter the economy with zero wealth, zero average earnings, and with a draw from the stationary distribution of the idiosyncratic productivity shock. The aggregate state is used to aggregate individual choices to get prices in the stationary equilibrium.

## 3.10 Stationary Recursive Competitive Equilibrium

To save notation I collect individual state variables but age in a vector $x = (k, z^w, \bar{e})$ and age, $a$.

A stationary recursive competitive equilibrium is a list of functions and scalars: ($c_a(x)$,$k'_a(x)$,$h_a(x)$,$V_a(x)$,$\phi(\bar{e}, h_a, a)$,$\Psi_a(x)$,$w$,$r$,$\tau$,$K$,$L$,$B$) such that:

1. $c_a(x)$,$k'_a(x)$,$h_a(x)$ and $V_a(x)$ solve equation (4) for every $a = 1, ..., A-1$
2. $K$ and $L$ solve the representative firm profit maximization problem, so input prices are given by the first order conditions: $r = F_K(K, L) - \delta$ and $w = F_L(K, L)$
3. Markets clear
   (a) $\sum_a \mu_a \int_X \left[c_a(x) + k'_a(x)\right] d\Psi_a = F(K, L) + (1-\delta)K$

(b) $\sum_a \mu_a \int_X k'_a(x) d\Psi_a = (1+n)K$

(c) $\sum_a \mu_a \int_X z_a h_a(x) d\Psi_a = L$

4. The aggregate state is consistent with individual behavior

5. Social security is balanced

$$\tau L = \sum_{a \geq \hat{a}} \mu_a \int_X \phi(\bar{e}, h_a(x), a) d\Psi_a$$

6. Accidental bequest are distributed evenly among individuals alive

$$\sum_a \mu_a (1 - s_{a+1}) \int_X (1+r) k'_a(x) d\Psi_a = B(1+n)$$

# 4 Calibration

I calibrate the model to key features of the US economy. Some parameters are pinned down individually from sources exogenous to the model, like demographics, the individual productivity process, the fraction of time working and social security, whereas technology is pinned down individually from solving the stationary equilibrium of the model to match a single statistic. Finally, preferences are jointly pinned down to match some key statistics.

## 4.1 Parameters calibrated individually

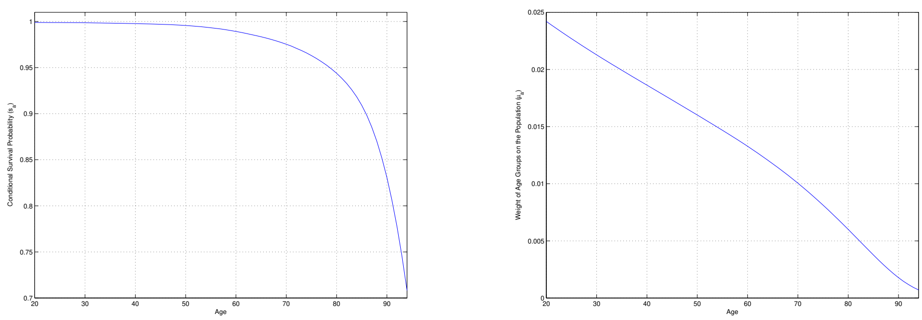
I need to choose growth rate of population ($n$), the age individuals enter the economy, life length ($A$), survival rates ($s_a$), productivity process ($z_a$), fraction of time working ($\bar{h}$) and social security.

### 4.1.1 Demographics

I choose population growth rate to equal the US 1960-2006 average of 1.2%. This number is taken from the US Census Bureau Statistical abstract 2009.

Individuals enter the economy with 20 years and they die with probability 1 when they are 94, therefore $A = 75$. Survival rates are taken from the actuarial tables for males provided by the US Social Security Administration in 2004. Figure 5 shows survival rates for the selected life span and the implied stationary population weights.

Figure 5: Survival and Stationary Weights




(a) Probability of Survival

(b) Weight of the Population

#### 4.1.2 Individual productivity process

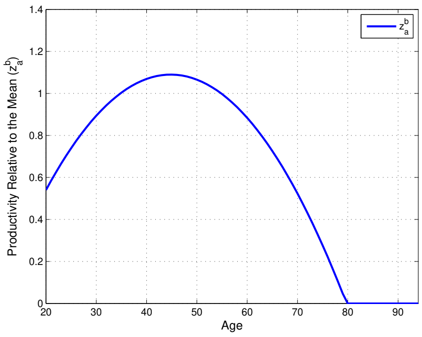
Individual productivity $z_{i,a}$ is characterized by two components: a hump-shaped deterministic function of age ($z_a^d$) and a stochastic component that hits each individual every period of her life ($z_{i,a}^w$).

To characterize the deterministic component, I use annual earnings from IPUMS-CPS over the period 1992-2006 and annual hours worked. I express annual earnings in $US1982 and assume that they grow at a 2% rate due to productivity gains[13]. I construct hourly wages dividing annual earnings and annual hours. I compute the ratio of mean hourly wage by age to mean hourly wage. This looks like a hump shaped profile. I adjust a quadratic polynomial to eliminate sample variability and truncate the polinomial to zero when it

[13]Therefore I assume there are time effects

goes below zero (80 years) This is not an important assumption as very few individuals are working that old. Figure 6 shows the result. Cohorts from 35 to 55 years are more productive than the average and between cohort productivity peaks at age 45.

Figure 6: Between Cohort Productivity ($z_a^d$)




The stochastic component of individual productivity is characterized by an AR(1)

$$\log(z_{a+1}^w) = \rho \log(z_a^w) + \epsilon_{a+1}$$

with $\epsilon_{a+1} \stackrel{iid}{\rightarrow} N(0, \sigma_\epsilon^2)$ The parameters $\rho$ and $\sigma_\epsilon^2$ are taken from French (2005) and equal .977 and .0141 respectively.

Finally, the fraction of time spent working is set to 45% of available time in a year, assuming 12 hours for commuting, eating and sleeping and a year of 360 days ($\bar{h} = .45$)

#### 4.1.3 Technology

I assume the technology is Cobb-Douglas, $Y = K^\alpha L^{1-\alpha}$. I choose $\alpha$ to match a labor share value from NIPA of .64. The depreciation rate is set such that the ratio of investment to output equals .2.

### 4.1.4 Social security

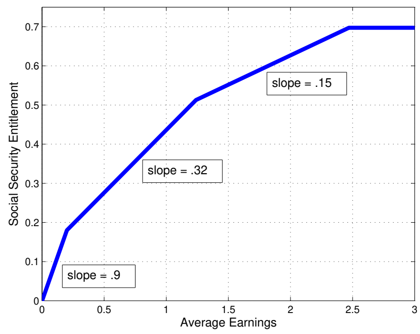
Social security ($\phi(a, h_a, \bar{e})$) is a a function of three elements. First, it depends on age ($a$) through an entitlement age ($\hat{a}$). I assume that individuals may get the pension when they reach the early entitlement age in the OECD. In the US it is 62 years. I abstract from the normal entitlement age and the decision to claim for benefits to keep the decision problem and the state space as small as possible, and because it is of second order importance to study cross country retirement behavior. Generically, individuals can not borrow against social security, poor individuals would like to get benefits as they become available and if I set entitlement to the normal entitlement age, these would affect their employment choices. Rich individuals would not be affected by these in any case.

Social security is a function of employment choices through the restrictions on collecting social security and working. I assume that if a country has such restriction, social security will be zero if employment is positive and a function of individual average earnings otherwise, whereas it will be a function of individual average earnings if the country does not have such restriction. To determine if a country restricts social security and working I use the implicit tax on continuing to work provided by Duval (2003) and details on social security systems around the world provided by the US Social Security Administration.

Social security is a piece-wise linear function of average individual earnings ($\bar{e}$) as in Hugget & Ventura (1999), French (2005) or Nishiyama & Smetters (2007) The bend-points are multiples of the economy-wide average earnings so it can be directly taken to the model economy. US social security replace 90% of the first monthly \$761, 32% from \$761 and through \$4,586, and 15% above \$4,586. This is equivalent to .2,1.24 and 2.47 in multiples of annualized average earnings. Therefore social security can be writen as

$$\phi(\bar{e}_a, h_a, a) = \begin{cases} 0 & \text{if } a < \hat{a} \text{ or } h_a = \bar{h} \\ \varphi(\bar{e}_a) & \text{otherwise} \end{cases}$$

Figure 7: $\varphi(\bar{e})$




Finally, I made some additional simplifications. Social security takes into account the 35 years of highest earnings while I just take the simple average, capped for individual earnings higher than 247% of average earnings. I also assume that there are not limit for taxation while in the US earnings above roughly \$100,000 are exempt My objective is to focus on three key elements common to every country on the OECD rather than introducing details that may be important is some conuntries but totally absent in others.

## 4.2 Parameters calibrated jointly

### 4.2.1 Preferences

I assume that utility is separable in consumption and leisure and take the following form

$$u(c, 1-h) = \frac{c^{1-\sigma}}{1-\sigma} + \lambda \cdot (1-h) \tag{4}$$

this function is characterized by the relative risk aversion ($\sigma$) and the weight of leisure, ($\lambda$) Individuals discount the future at the rate $\beta$.

### 4.2.2 Calibration Objective

I assume a model period of 1 year and choose $(\sigma, \lambda, \beta)$ jointly to match the following key statistics of the US economy: a capital-output ratio of 3.0, an investment-output ratio of .2, a labor share of .64 and the employment to population ratio from ages 50 to 80. I get employment to population ratio from the same sample of the CPS that I used to get hourly wages. As I have more moments than parameters I choose the vector of parameters to calibrate to minimize the square deviation of the moments from the data and the simulated moments. I use the Nelder-Meade algorithm to find the minimum.

## 4.3 Calibration results

Table 1 shows the results of the calibration. Relative risk aversion ($\sigma$) is within the range of the values found in the literature which vary from 1 to 8, $\beta$ is in the low range for life cycle models but I still get a hump-shaped consumption profile.

Table 1: Parameters

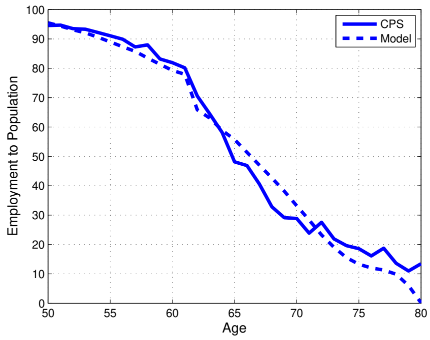
| $A$ | $n$ | $\sigma$ | $\lambda$ | $\beta$ | $\alpha$ | $\delta$ | $\rho$ | $\sigma_\epsilon^2$ |
|---|---|---|---|---|---|---|---|---|
| 75 | .012 | 2.50 | 2.50 | .97 | .36 | .066 | .977 | .0141 |

The model matches the ratios of capital and investment to output and the labor share perfectly. It is also successful matching the employment to population ratio by age. Figure 8 shows the match of employment rates for ages 50-80[14].

This is a key feature of my model as I need an accurate representation of the employment to population to do cross country comparisons. French (2005) also match the employment profile but he seems to over-estimate employment by age above age 62 more than I do. That he attempts to match the wealth distribution at the same time is the most likely reason of his results. To match the accumulation of wealth in the top wealth quintile you need a high $\beta$ but

[14]After 80 almost nobody is working and in my model nobody is working.

Figure 8: Employment rate fit




this would also induce individuals to retire early. In French (2007) he partially solves this issue introducing heterogeneous preferences.

# 5 Policy experiments

In this section I describe the experiments that allow me to do cross country comparisons of employment to population at older ages and what are the features of social security that affect employment the most.

## 5.1 Description of the Experiments

Section 2 documented large differences in employment to population and retirement to population at older ages across OECD countries. It also documented large differences in social security. As I get a very good fit of the model to the US, I use the US as a benchmark and express all the employment statistics relative to it. I also express the generosity of the social security relative to the US.

To account for differences in employment through differences in social security I solve the stationary equilibrium of the model for different parameterizations of social security to mimic the differences in generosity, entitlement age and restrictions on collecting social security and working. The I compare the results of the simulations to the OECD employment data for 2006.

I begin with the employment to population 60-64 because it is the most common age of retirement. Still, there are some countries that have entitlement ages below 60 or above 64, so I group these countries by entitlement age and compute the employment to population around entitlement age. This means that if a country like Italy which has entitlement age of 57 is to be compared to the US, I use the employment to population for ages 55-59. Finally I pin down the features of social security that are key to generate the large differences in employment to population found in the data by shutting down to US levels some features of social security while leaving others active.

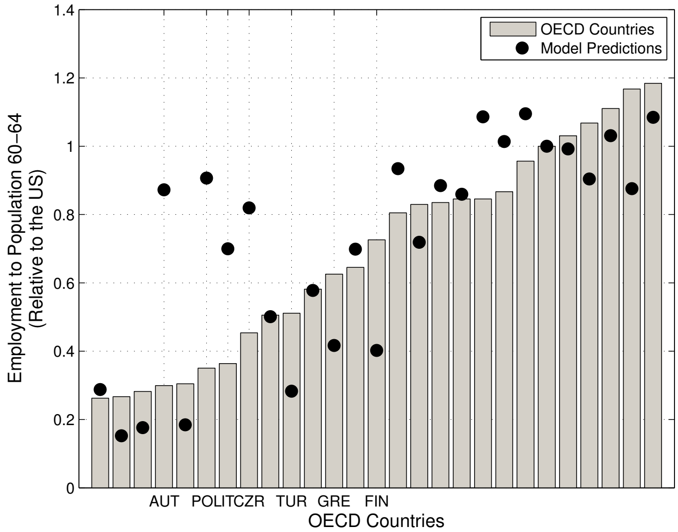
## 5.2 Results

### 5.2.1 Retirement relative to the US

First, the differences in social security account for the large differences in retirement behavior. This is a surprising result as my model allows for differences along three key dimensions of social security only. Figure 9 illustrates the ability of the model to match the retirement behavior, measured as the employment to population ratio relative to the US. The bars are OECD countries' data and the dots are model simulations for OECD countries. Countries are sorted from low to high employment to population 60-64 relative to the US.

The model does a very good job matching the size of the differences and the pattern that is observed in the data and it is also able to make accurate predictions for many OECD countries. Austria, Poland, Italy and Czech Republic stand out as outliers. My model accounts for two thirds of employment variability of Turkey, Greece and Finland and over-predicts employment of UK, Ireland and Mexico. Korea and Sweden are under-predicted but the model captures almost all the variability. Assuming that there are not measurement

Figure 9: Employment to population 60-64

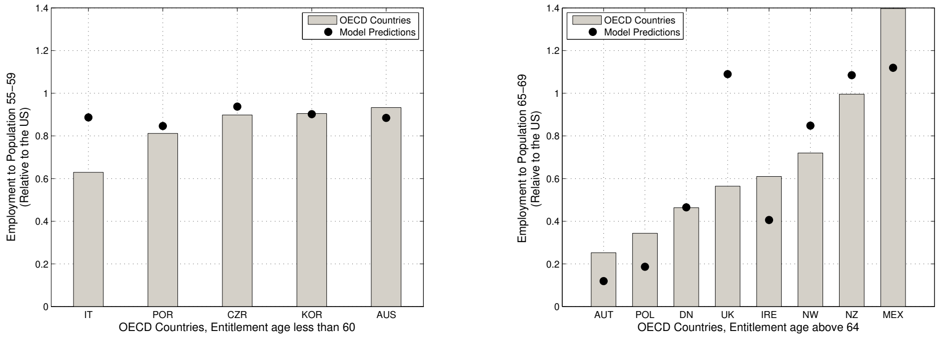



issues in the OECD data, there are a few potential reasons for these discrepancies. First, there are some countries that have retirement ages that do not fall within the ages 60-64 and my model may capture behavior at entitlement age better. All the countries mentioned above but Turkey, Greece and Finland (with entitlement ages 60,60 and 62 respectively) have entitlement ages below 60 (Italy, Czech Republic and Korea) or above 64 (Austria, Poland, UK, Ireland and Mexico)

I address this issue computing employment to population for countries grouped by retirement age. Figure 10 shows the fit of employment for countries with entitlement ages less than 60 (Figure 10 (a)) and entitlement ages greater than 64 (Figure 10 (b)).

The model fit is better at entitlement age as it is illustrated when I group countries by entitlement age. But why does the model miss some variability in post-entitlement employment of countries with entitlement age smaller than 60 and pre-entitlement employment in countries with entitlement age bigger than

Figure 10: Employment to population at entitlement age




(a) Entitlement age $< 60$

(b) Entitlement age $> 64$

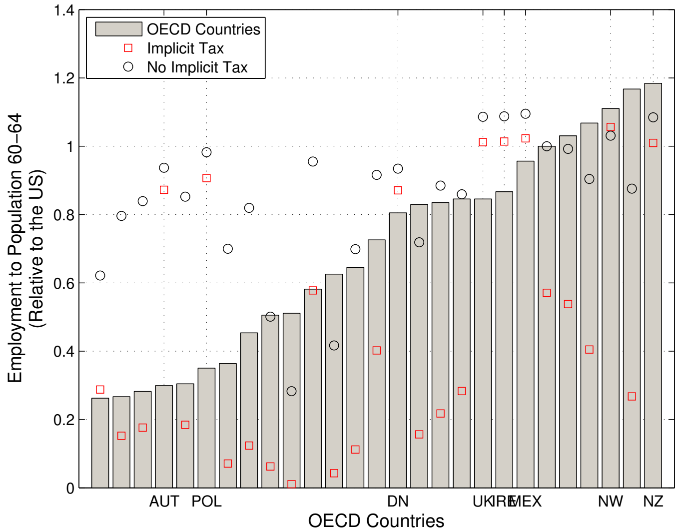
64. One potential weakness in my modeling choices could be the assumption about restrictions on collecting social security and working. For countries in which collecting social security and working is not totally forbidden, assuming so it is a judgment call. In the real world these incentives on continuing work are not constant after early retirement and they would require a detailed modeling of normal retirement age and the entitlement choice, or an age dependent tax on social security that captured the incentives with some accuracy. I leave this as a future extension as I am already performing relatively well and it would increase computational burden without clear advantages. Figure 11 shows the model simulations under two different assumptions: all countries restrict collecting social security and working, and all countries do not.

The message that we get from these experiments is that these three key features of social security are able to explain a substantial amount of retirement behavior.

### 5.2.2 Employment Relative to the US

The differences in social security also account for a substantial amount of the differences in employment. These differences are accounted through retirement

Figure 11: Sensitivity to Implicit Tax




behavior. Figure 12 shows the fit of employment to population relative to the US. There are many factors that may affect employment behavior during a life so it is remarkable that social security is able to account for such a big amount.

It is also worth noting the role of restrictions on collecting social security and working. Figure 12 is analogous to Figure 11 and show how sensitive is the employment to population ratio to assuming that every country restricts collecting social security and working and that no country does.

My model still misses for non-European countries like Turkey and Mexico, Eastern European countries like Poland, Hungary and Slovak Republic and Belgium, Italy, France and Germany. An extension that included differences in income taxation independent of social security would fill part of what is missing on Continental European countries. Turkey, Mexico, Greece and Italy have female populations that are not as integrated into the labor force and when I look at the employment to population of males relative to the US I

Figure 12: Employment to population

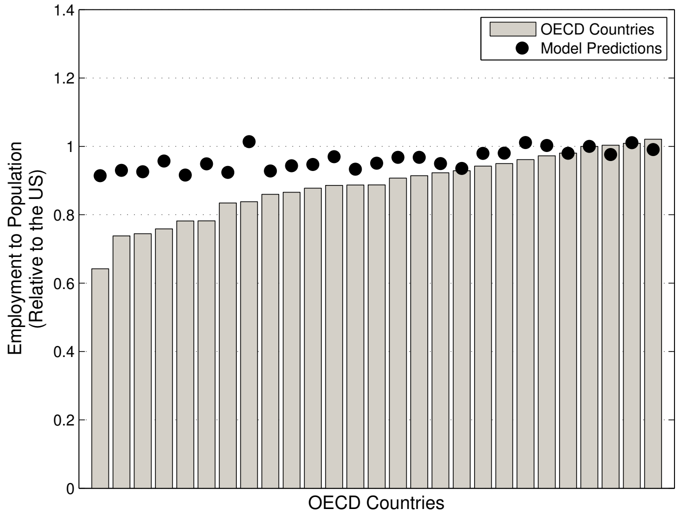
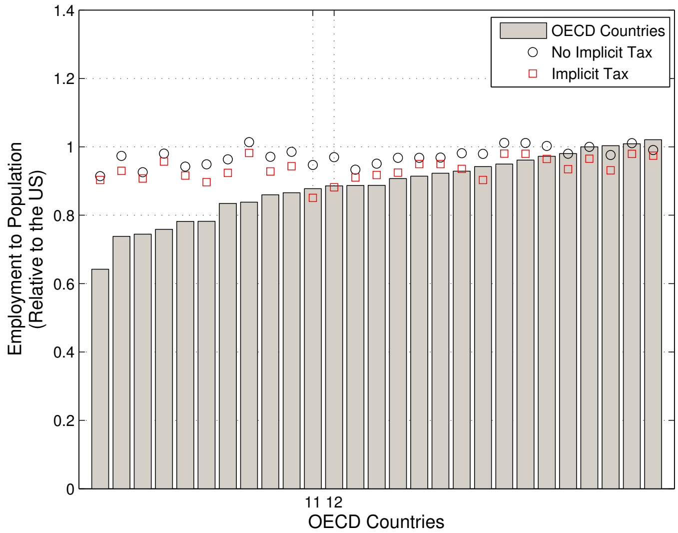
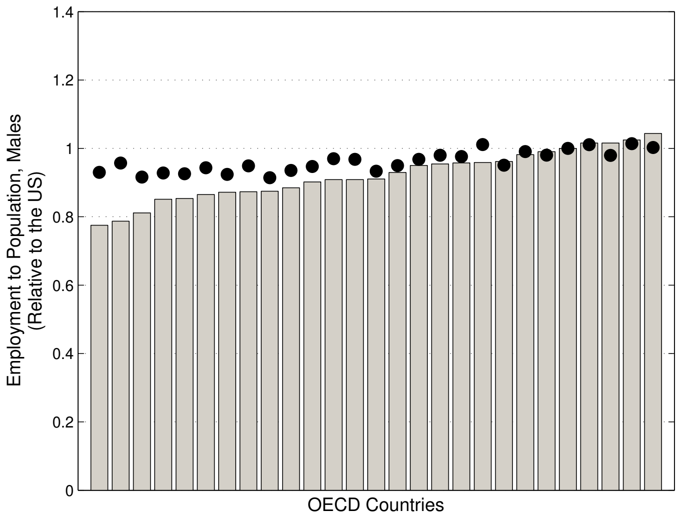



Figure 13: Sensitivity of Employment to Implicit Tax




get a different picture. Figure 14 shows the fit of the model when I restrict to males. Note that the picture for retirement will not change that much as retirement decisions are usually coordinated. Still retirement decisions of couples is an interesting topic by itself and how different treatment of social security of spouses may matter for individual and joint retirement choices.

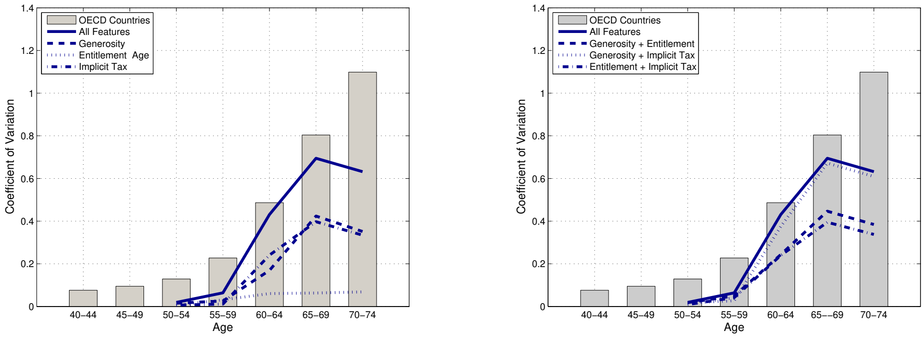
Figure 14: Employment to population, males




### 5.2.3 What features of social security are most important?

Using an eyeball measure it is possible to tell that implicit taxes on continuing to work is an important feature of social security to generate retirement and employment variability. I can use some counter-factual simulations to pin down the most relevant features of social security. First I will focus on the individual role of each key feature of social security: generosity, entitlement age and implicit tax on continuing to work. I let one feature active at a time and set the other features to the US levels. My measure of variability is the coefficient of variation of the data and the model. I compute the standard deviation of employment relative to the US for different ages and the mean. The ratio of the standard deviation to the mean gives a unit-less measure of variability. I do the same for my model simulations of OECD countries.

Figure 15: Features that account for variability




(a) Individual features

(b) Interactions

Figure 15 (a) shows that the most important features are the implicit tax on continuing to work and generosity, while the entitlement age is not important. As there are potentially important interactions I allow two features active at the same time. I find that generosity and implicit tax on continuing to work account for almost all the variability after age 60 but I need the three features to generate variability as in the data for ages 55-59 (Figure 15 (b))

# 6 Conclusion and Future Research

I have built a life cycle general equilibrium model of retirement behavior to account for the differences in retirement and employment across OECD countries relative to the US. My results point out to the importance of differences in three key features of social security: generosity, entitlement age and implicit tax on continuing to work. With just these three, I account for a substantial amount of the large differences in retirement and employment found in the data.

My model opens up some interesting research possibilities. Even if just three features of social security account for retirement and employment there is another feature of social security that may be interesting to explore, which is redistribution. How do we define redistribution? Assume that a good measure of redistribution is the social security entitlement over mean earnings at the age of retirement of an individual that earns two times the mean earnings of the country minus this same statistic for an individual that earns just half of the mean earnings of the country. If we accept that measure of redistribution, there are also large differences in redistribution across OECD countries. It is likely that different redistribution provide different incentives over the life cycle and it may play an important complementary role with generosity. It turns out that it is not easy to separate which part is generosity as any change in generosity ex ante change redistribution ex post and vice-versa. My model offers the possibility to account for both generosity and redistribution if social security was calibrated to match generosity and redistribution in the data (which are ex-post measures) In addition, other details of social security may matter for cross country differences in retirement and employment. Many countries have a minimum universal component of social security that is not linked to the earnings history of an individual and modeling this may help to understand the quantitative importance of social security to account for different labor supplies.

Why do some countries have higher employment to population relative to the US but still lower hours of work per person. Pijoan-Mas (2006) as it was pointed out in the introduction, shows that the competitive equilibrium of an economy with idiosyncratic labor income risk and incomplete markets has inefficiently high hours of work. An exercise worth doing would be to introduce an intensive margin as in French (2005) and inquire about the role of social security to account for differences in hours of work and employment. Also the framework proposed by Prescott, Rogerson & Wallenius (2007) and Wallenius (2009) could be extended to include within cohort heterogeneity. A similar exercise is done by Krebs (2004) to study the welfare gains of stabilizing business cycle fluctuations in a model with human capital formation but no labor choice, finding big welfare gains from reducing fluctuations. Potentially we would be able to understand the effect of social security through human capital formation and using hours or the length of working careers to self insure income risk.

A third interesting extension would be to model single and couple behavior at the same time. It is a well known fact that couples tend to retire about the same time. In addition, almost all OECD countries have a differential treatment of female spouses in social security. What is the role of social security rules by sex in shaping retirement decisions of males and females?

Finally, all the space in this paper has been devoted to social security, which is the biggest tax and transfer program across the OECD. Health insurance programs are of the same order of magnitude in the GDP and they may also play an important role into shaping employment over the life cycle. Understanding how different health insurance programs affect employment across the OECD will require introducing health explicitly and will throw an interesting insight on the current policy debate about health, ongoing in the US.

# 7 References

Benitez-Silva, H. (2000) "A Dynamic Model of Labor Supply, Consumption/Saving, and Annuity Decisions Under Uncertainty." SUNY-Stony Brook

Benitez-Silva, H. (2002) "Job Search Behavior at the End of the Life Cycle." Center for Retirement Research Working Papers (Boston College)

Benitez-Silva, H. & Heiland, F. (2006) "The Social Security Earning Test Revisited: Information, Distortions, and Costs." SUNY-Stony Brook & Florida State University

Blau, D.M. (2008) "Retirement and Consumption in a Life Cycle Model."

Journal of Labor Economics, 26 (1), (35-71)

Boskin, M. (1987) “Too Many Promises: The Uncertain Future of Social Security.” Dow Jones-Irwin.

Bullard, J. & Feigenbum, J. (2007) “A leisurely reading of the life-cycle consumption data.” Journal of Monetary Economics 54 (2305-2320).

Chang, Y. & Kim, S. (2006) “From Individual to Aggregate Labor Supply: A Quantitative Analysis based on a Heterogeneous-Agent Macroeconomy,” International Economic Review, 47 (1), (pp. 1-27)

De Nardi, M.C., Imrohoroglu, S. & Sargent, T.J. (2001) “Saving and Pension Reform in General Equilibrium Models.” Oxford Review of Economic Policy, vol. 17 (1)

French, E. (2005) “The Effects of Health, Wealth, and Wages on Labour Supply and Retirement Behavior.” Review of Economic Studies, 72 (395-427)

French, E. (2007) “The Effects of Health Insurance and Self-Insurance on Retirement Behavior” Federal Reserve of Chicago.

Gruber, J. & Wise, T. (2004) “Social Security and Retirement around the World.” NBER

Gruber, J. & Wise, T. (2007) “Social security programs and retirement around the world: Fiscal implications of reform.” NBER

Gustman, A. & Steinmeier, T. (1986) “A Structural Retirement Model” Econometrica, Vol. 54, No. 3, pages 555-584.

Hansen, G. (1993) “The Cyclical and Secular Behaviour of the Labour Input: Comparing Efficiency Units and Hours Worked,” Journal of Applied Econometrics, vol. 8 (1), (pp. 71-80)

Hotchkiss, J.L. (1991) “The definition of Part-Time Employment: A Switching Regression Model with Unknown Sample Selection.” International Economic Review, 32 (4) (pp. 899-917)

Hugget, M & Ventura, G. (1999) “On the Distributional Effects of Social Security Reform.” Review of Economic Dynamics 2 (498-531).

Imrohoroglu, A., Imrohoroglu, S. & Joines D. H. (1995) “A life cycle analysis of social security.” Economic Theory 6 (83-114)

Kotlicoff, L. & Auerbach, A. (1987) "Dynamic Fiscal Policy." Cambridge University Press.

Krussel, P. & Smith, A. (1998) "Income and Wealth Heterogeneity in the Macroeconomy." Journal of Political Economy, 106 (5)

McDaniel, C. (2009) "Hours worked in the OECD 1960-2003: Driving forces and propagation mechanisms" Kenyon College

Manoli, D. & Wagner, M. (2007) "Pension Benefits & Retirement Decisions: Income vs. Price Effects." (Job Market Paper) Berkeley University.

Munnell, A.H. & Sass S.A. (2007) "The Labor Supply of Older Americans." Center for Retirement Research Working Papers (Boston College)

Nishiyama, S. & Smetters, K. (2007) " Does Social Security Privatization Produce Efficiency Gains?" The Quarterly Journal of Economics, November (1677-1719)

Ohanian, L., Raffo, A. & Rogerson, R. (2008) "Long-term changes in labor supply and taxes: Evidence from OECD countries, 1956-2004", Journal of Monetary Economics, Elsevier, vol. 55(8), pages 1353-1362, November.

Prescott (2004) "Why do Americans Work so much Longer than Europeans?" Quarterly Review, Federal Reserve Bank of Minneapolis, issue Jul, pages 2-13.

Prescott, Rogerson & Wallenius (2009) "Lifetime Aggregate Labor Supply with Endogenous Workweek Length", Review of Economic Dynamics, Elsevier for the Society for Economic Dynamics, vol. 12(1), pages 23-36, January.

Ragan, K (2005) "Taxes, Transfers and Time use: Fiscal Policy in a Household Production Model," November 2005.

Rogerson (2007) "Taxation and Market Work: Is Scandinavia an Outlier?" Economic Theory, Springer, vol. 32(1), pages 59-85, July.

Rogerson & Wallenius (2007) "Micro and Macro Elasticities in a Life Cycle Model With Taxes" NBER Working Paper No. 13017, April.

Wallenius (2009) "Social Security and Cross-Country Hours: A General Equilibrium Analysis". Job Market Paper.

Stock & Wise (1990) "The Option Value of Work and Retirement." Econometrica, Vol. 58, No. 5, pages 1151-1180.

Rust, J & Pheland, C. (1997) “How Social Security and Medicare Affect Retirement Behavior In a World of Incomplete Markets.” Econometrica, Vol. 65, No. 4. (781-831)

Rust, J. (1999) “Strategies for Incorporating Risk, Uncertainty, and Private Insurance Mechanisms in Models of Social Security.” Yale University.

Skirbekk, V. (2004) “Age and Individual Productivity: A Literature Survey” Vienna Yearbook of Population Research, Vienna : Austrian Academy of Sciences Press: 133-153.

Storesletten, K., Telmer, C.I., Yaaron, A. (1999) “The risk-sharing implications of alternative social security arrangements.” Carnegie-Rochester Conference Series on Public Policy. Volume 50 (June) (213-259)

# 8 Appendix A: OECD Social Security Data

Table 2: OECD Social security

| Country | Gross Generosity | Net Generosity | Entitlement | Implicit Tax |
|---|---|---|---|---|
| AUS | 1.07 | 1.19 | 55 | 0.00 |
| AUT | 2.07 | 2.02 | 65 | 1.00 |
| BEL | 1.09 | 1.42 | 60 | 1.00 |
| CAN | 1.15 | 1.29 | 60 | 0.00 |
| CZR | 1.28 | 1.43 | 58.5 | 0.00 |
| DN | 2.07 | 2.04 | 65 | 0.00 |
| FIN | 1.45 | 1.39 | 62 | 1.00 |
| FR | 1.38 | 1.47 | 60 | 1.00 |
| DEU | 1.11 | 1.37 | 63 | 1.00 |
| GRE | 2.47 | 2.47 | 60 | 0.00 |
| HUN | 1.98 | 2.36 | 62 | 1.00 |
| IRE | 0.88 | 0.90 | 65 | 1.00 |
| IT | 1.75 | 1.67 | 57 | 0.00 |
| JAP | 0.87 | 0.86 | 60 | 0.00 |
| KOR | 1.09 | 1.04 | 55 | 0.00 |
| MEX | 0.93 | 0.85 | 65 | 0.00 |
| NDL | 2.28 | 2.30 | 60 | 0.00 |
| NZ | 1.00 | 0.92 | 65 | 0.00 |
| NW | 1.53 | 1.55 | 67 | 0.00 |
| POL | 1.58 | 1.67 | 65 | 1.00 |
| POR | 1.39 | 1.55 | 55 | 0.00 |
| SLV | 1.46 | 1.62 | 60 | 1.00 |
| SPN | 2.10 | 1.89 | 60 | 0.00 |
| SWD | 1.59 | 1.43 | 61 | 0.00 |
| TUR | 2.24 | 2.78 | 60 | 0.00 |
| UK | 0.79 | 0.91 | 65 | 0.00 |
| US | 1.00 | 1.00 | 62 | 0.00 |

# 9 Appendix B: Numerical Methods

The algorithm used to compute the equilibrium of the model is similar to Hugget & Ventura (1999) The following steps describe the salient features of the computation:

1. Choose an initial value of aggregate capital ($K_0$), aggregate labor in efficiency units ($L_0$), accidental bequests ($B_0$) and payroll tax ($\tau_0$)

2. For these values I solve iterating backwards, starting from $V(x, A) = 0$, the Bellman's equation of the individual at each point of the individual state space $(k, z^w, \bar{e})$. As a result I get the policy functions $c(x, a)$,$k'(x, a)$,$h(x, a)$ for every $a = 1, \ldots, A$

3. I compute the distributions over the individual's state space $(\Psi_a(a))$ using Montecarlo's simulations. I start assuming that individuals start with a capital equal to accidental bequests, average earnings of zero and an initial draw of productivity belonging to the stationary distribution of $z^w$

4. I update $K_0$,$L_0$,$B_0$ and $\tau_0$ aggregating over the simulated distributions to $K_1$,$L_1$,$B_1$ and $\tau_1$

5. If aggregate variables in the previous point are close enough and product markets clear, I stop iterations. Otherwise I continue until convergence.

I choose 100 points for the individual capital, 30 points for the idiosyncratic shock and 4 points for average earnings. I use golden section search at each point of the individual state for each employment status (0 or $\bar{h}$) and then choose the maximum between these two numbers. I use 40,000 observations for each age group for the Montecarlo step.