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Social Security and Retirement across the OECD

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Abstract

Employment to population ratios differ markedly across Organisation for Economic Cooperation and Development (OECD) countries, especially for people aged over 55 years. In addition, social security features differ markedly across the OECD, particularly with respect to features such as generosity, entitlement ages, and implicit taxes on social security benefits. This study postulates that differences in social security features explain many differences in employment to population ratios at older ages. This conjecture is assessed quantitatively with a life cycle general equilibrium model of retirement. At ages 60–64 years, the correlation between the simulations of this study’s model and observed data is 0.67. Generosity and implicit taxes are key features to explain the cross-country variation, whereas entitlement age is not.

Keywords: Social security, retirement, idiosyncratic labor income risk

JEL Codes: E24, H53, J14, J26

1 Introduction

There are large cross-country differences in employment to population ratios for those aged 20-75 years in the OECD. Turkey had the lowest ratio of 42% in 2006, whereas Norway had a ratio of 66%, the highest in the OECD. These differences are an order of magnitude bigger than differences found over a typical business cycle in OECD countries. These big differences are much larger for people more than 50 years, with the lowest ratio of 13% found in Hungary and the highest of 60% in New Zealand. These differences coexist with big cross-country differences in social security programs. Differences in three features seem particularly relevant. First, the replacement rate, a common measure of how generous social security is, was 38% in Mexico, but 124% in Turkey, in 2006. Second, entitlement age to social security benefits was 55 years in Australia but 67 years in Norway, a 12-year difference. Third, some countries allow individuals to work while collecting social security whereas other countries do not and yet others discourage it to some degree. Among the last group, the US imposes an “earnings test” that penalizes collecting social security while working. This study refers to these three features as generosity, entitlement age, and implicit taxes.

This study seeks to answer two questions. First, can differences in social security features account for large differences in employment to population at older ages? Second, what features of social security are key to accounting for those differences? The answer to these questions is key to assessing current policy debate on social security reform in aging societies. In addition, it is a good exercise to validate whether a standard model of policy evaluation can deliver cross-country differences in employment at older ages as we see in the data.

This study develops a life cycle general equilibrium model of retirement with a discrete labor choice, idiosyncratic labor income risk, and incomplete markets to answer these questions. The model is calibrated to match key statistics of

the US economy and its social security system. The model captures much of the heterogeneity in employment by age found in the data. Therefore, differences in social security account for many differences in employment and simulating counterfactuals allows for an inquiry about the importance of each social security feature considered. Idiosyncratic labor income risk is a mechanism to produce individuals making different retirement decisions, as we see in the data. For example, in the US, 60% of 62-year-old people still work, as do 40% of 65-year-olds, regardless of the discouraging effect of social security.

Differences in social security account for two thirds of the differences in employment to population at ages 60–64 years and 65–69 years. Through variations in only three features of social security, the model is able to match the employment age profile for people aged more than 50 years for many countries in the sample. A useful way to summarize this finding is by using the coefficient of variation of employment to population across OECD countries by age. At ages 60–64 years, differences in social security account for most of the differences in employment to population as the coefficient of variation is 0.32 in the data and 0.38 in the model. Similarly, at ages 65–69 years, the coefficient is 0.49 in the data and 0.56 in the model. Using different assessments, this study consistently documents the crucial importance of the incentives that social security systems provide to people older than 50 years. Furthermore, the model predicts accurately average employment to population of the OECD relative to the US. At 60–64 years, the model predicts the same average employment to population relative to the US as in the data.

Among the three social security features explored, the study finds that variation in generosity and implicit taxes are able to account for most of the differences in employment to population at older ages, whereas differences in entitlement ages are not. This is an important result, as many policymakers believe that increasing retirement age is the way to increase employment to population ratios at older ages. Their intuition is backed up by many reduced form regressions, which find a positive correlation between entitlement ages

and retirement ages; however, they do not take into account that savings decisions change dramatically under different social security systems. Reduced form regressions abstract from the fact that social security reforms in any country trigger changes in savings behavior that results in potentially different retirement behavior. If a government decides to increase entitlement age, people increase savings over their life so they can retire when they plan to and not when they are told to. As a result, people's planned retirement age does not change that much. However, increasing entitlement age is definitely not a bad policy as it would not change retirement age substantially but it would reduce the fiscal burden governments face to finance PAYGO social security systems.

This study shuts down each feature of social security to US levels, one at a time, to explore which social security feature is more important. In addition, it simulates every possible combination of features to explore how they interact. The coefficient of variation of employment to population at ages 60–64 years in the model is 0.12 when there are differences in generosity or implicit taxes only. In contrast, the coefficient of variation is 0.07 when there are differences in the entitlement age only. Either generosity or implicit taxes account for one third of the variability in the model alone but they explain most of the variability when they interact. In addition, the model accurately predicts labor supply profiles for many countries in the sample, capturing both variability and employment to population rates relative to the US.

This study is most related to two streams of literature. The first follows Prescott (2004), who seeks to explain large differences in hours of work per person through differences in the average tax rates for G-7 economies through the lenses of the neoclassical growth model. Rogerson (2007) extends Prescott (2004)'s analysis to study why Scandinavian countries work too much for their level of taxes. He finds that studying how these taxes are spent is key to understanding their effects on hours of work. Ohanian et al. (2008), following Prescott (2004), document trends and cross-country differences in labor supply

in more detail, for a longer time span, and for as many OECD countries for which data is available. Taxes and transfers play a major role in accounting for trend and cross-country differences in hours of work per person. McDaniel (2011) studies the relative importance of differences in taxes and productivity to account for differences in hours of work per person, confirming that taxes remain the major source of variation in hours of work across countries. Similarly, Ragan (2013) studies the role of taxes and transfers, using a household model, to account for time use patterns across countries and time. She finds that public expenditure, in the form of provision of home goods, is key to understanding patterns of time use, in particular, home production time. This major effect of taxes and transfers on the use of time not only circumscribes to a representative household that lives forever. For example, Bicks & Fuchs-Schuendeln (2014) document large cross-country differences in hours of work for married females using a static model of joint family labor decisions. They find that a model of family labor supply that takes into account the full nonlinearity of taxes, in particular second earner taxation, accounts for a substantial fraction of these cross-country differences. It is only a natural extension to study how specific features of social security impact the labor supply of older people.

Two recent studies are close to the present work. Wallenius (2013) analyzes the importance of PAYGO social security systems to understand life cycle labor supply across OECD countries. Her framework is based on previous work by Prescott et al. (2009) and Rogerson & Wallenius (2009), which develop a framework to deal with labor supply in the extensive and intensive margin all together. Wallenius (2013)'s model is extended to include human capital accumulation decisions. She finds that differences in social security programs play a substantial role in accounting for cross-country differences in average retirement ages but they do not seem to play a significant role in accounting for differences in hours of work of prime age individuals. Relative to Wallenius (2013), this study introduces idiosyncratic labor income and mortality risks and is applied to a larger sample of countries. Another important difference is that this study focuses on changing features of social security rather than

imposing one country's social security system on another. A growing body of literature identifies the importance of considering idiosyncratic labor income risks to study the role of taxes and transfers, to account for cross-country labor supply differences¹. Therefore, it seems a good idea to explore the role of social security programs in accounting for retirement behavior in this context.

The closest reference to this work is Erosa et al. (2012). They analyze the role of social security programs in combination with disability insurance to account for the employment to population of older people across the OECD. They find that social security plays a central role in accounting for labor market behavior of older people but disability insurance does not seem to play a role for most of the countries in their sample. By comparison, this study focuses on a much larger sample of countries and investigates which features of social security are most important to account for cross-country variations in employment to population at older ages. In the framework of Erosa et al. (2012), radical reforms are analyzed, as in Wallenius (2013), such as introducing the French system into the US. By comparison, the framework of this study allows us to evaluate the effects of gradual changes in social security rules, such as generosity, entitlement ages, and implicit taxes. In terms of matching cross-country differences in labor supply of older people, we reach quantitatively similar conclusions.

The second stream of literature uses reduced form econometric models, microsimulation, and structural models. This literature is not surveyed here because it is vast². These studies analyze both positive and normative aspects of social security. Relative to the reduced form literature, the model of this study allows us to investigate how people change their behavior when social security rules change and, relative to the microsimulation studies, this study

¹For example, Pijoan-Mas (2006) and Guvenen et al. (2014).

²For example, Gustman & Steinmeier (1986), Stock & Wise (1990), Phelan & Rust (1998), Hugget & Ventura (1999), Gruber & Wise (2004, 2007), French (2005), Coile & Gruber (2007), Nishiyama & Smetters (2007), and French & Jones (2011), to mention just a few important contributions to the study of social security.

introduces preferences that are identical across countries and features general equilibrium. French (2005) and French & Jones (2011) develop a model with idiosyncratic labor income and health risk to study the role of social security in accounting for retirement behavior in the US. This study finds similar results in a general equilibrium environment and it is applied to a large sample of countries. The results show that the interaction of risk, market incompleteness, and social security matter in order to understand retirement decisions.

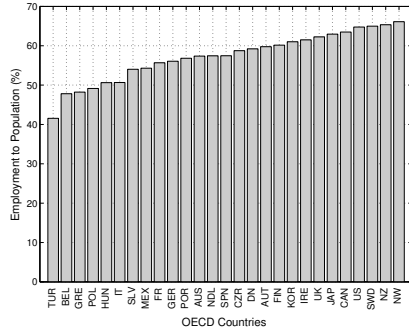
2 Employment and Social Security in the OECD

This section presents empirical evidence for OECD countries in 2006 using labor force statistics by age and sex from the OECD online database; social security data from “Pensions at Glance 2009”; and productivity data from the “Total Economy Database³.” Data were collected from the OECD on employment to population at ages 20–75, 50–54, 55–59, 60–64, 65–69, and 70–74 years to study the role of social security in accounting for cross-country differences in employment to population at older ages. Employment to population at 20–75 years, chosen to match the definition of total employment in this model, is not the main objective of this study. However, it is useful as a benchmark to understand the magnitude of cross-national differences in employment at older ages.

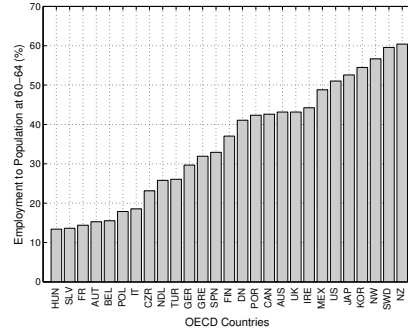
Figure 1 pictures employment to population at ages 60–64 years (b) compared to the total employment to population (a). Employment to population at 20–75 years in Turkey was 42%, the lowest across the OECD in 2006, and Norway had the highest, at 66%. Differences became even larger for older individuals. Employment to population at ages 60–64 years was 13% in Hungary and 60% in New Zealand. The US was at the upper end of the distribution of employment, with employment to population at 20–75 years of 65% and employment to population at 60–64 years of 55%.

The main hypothesis of this study is that differences in key features of social security account for cross-country differences in employment to population of

³The Conference Board and Groningen Growth and Development Center.



(a) 20-75



(b) 60-64

FIGURE 1. Employment at 20-75 vs. 60-64

older people, but any social security program is made up of a complex set of allocation rules, from individual characteristics (e.g., age; sex; marital, employment, and health statuses; and earnings histories) to payment. Tracking every single aspect that may matter for retirement decisions would be unfeasible in a general equilibrium model, thus, I choose three main statistics that are easily available to all: generosity, measured by replacement rates; entitlement ages; and implicit taxes on earnings if individuals work and collect social security at the same time. Other features of social security and tax and transfer programs may be important for retirement. The most relevant features and programs are differences in pension entitlements due to marital status, disability insurance, and unemployment insurance. In fact, unemployment insurance is probably important as a bridge to retirement in European countries, even more for European Mediterranean countries. There are many countries whose pension entitlements differ, depending on marital status, for example, spouses that are entitled to half of 401k in the US or part of social security benefits. In addition, there are specific pension schemes for professions considered dangerous or filthy and specific social security rules that apply to public employees in many countries. Taking these features into account would greatly complicate the modeling of retirement decisions; thus, this study abstracts from them. Disability insurance is potentially an important feature to understand retirement decisions as our health and abilities to perform tasks

deteriorate with age. Introducing disability insurance schemes make sense as they can be used as a bridge to retirement, as can unemployment insurance. I am not aware of any study that examines the interactions of social security and unemployment insurance in a similar framework, although Erosa et al. (2012) incorporate features of disability insurance and find that, even though there are large cross-country differences in the rules governing disability insurance, they do not seem to account for any relevant fraction of the large cross-country differences in employment to population at older ages.

The three main social security features that this study explores are generosity, entitlement ages, and implicit taxes. This is at odds with the empirical literature, which uses accrual rates computed through actuarial techniques to measure the disincentive created by a social security system on employment at older ages. Using accrual rates would probably be better to capture the marginal effects of social security but it would miss the main driving features. The definition of generosity that this study uses is net replacement rate, the ratio of net social security benefits to average life cycle earnings. The OECD provides different measures of generosity but given that the model of this study abstracts from other taxes, such as taxes on social security benefits, it makes sense to use net replacement rates as a benchmark because they are the closest measure of what an average individual gets out of his lifetime earnings to spend on consumption after retirement. In addition, the definition is compatible with the structure of the model used in this study⁴.

The entitlement age is defined by the social security law of each country. The entitlement ages sometimes depend on sex and occupation. This study chooses the first age at which a male is entitled to claim social security benefits. More information can be found in the appendix. To simplify the computations, it is assumed that implicit taxes for each country are a 0–1 variable. Two sources are relied on to determine whether a country allows a person to collect social security and work and to what extent. The first source of information comes

⁴Other definitions of replacement rate are used in the computations, with similar results.

from Duval (2003), who computes a measure of “taxes on continuing to work,” based on social security rules on a subsample of OECD countries. To complement this source, this study uses “Social Security around the World,” a compilation of the rules governing social security systems for every country that has one. Usually, this source provides information on whether social security allows for the collection of benefits and work at the same time. In this study’s model, a country allows the collection of social security alongside work if it is stated in “Social Security around the World.” Otherwise, the implicit taxes computed by Duval are used and are assigned a 0 if his measure of implicit tax is more than 50%. For a sensitivity analysis, Duval’s numbers are again used and very similar results are obtained.

These three features are sufficient to capture differences in social security programs around the world and it will be shown that they account for a substantial amount of cross-country differences in employment to population at older ages. A country that requires more years of employment to achieve full benefits will have a smaller generosity. Figure 2(a) shows how large differences in generosity across the OECD are, with net replacement rates ranging from 38% in Mexico to 124% in Turkey. There are also large differences in entitlement

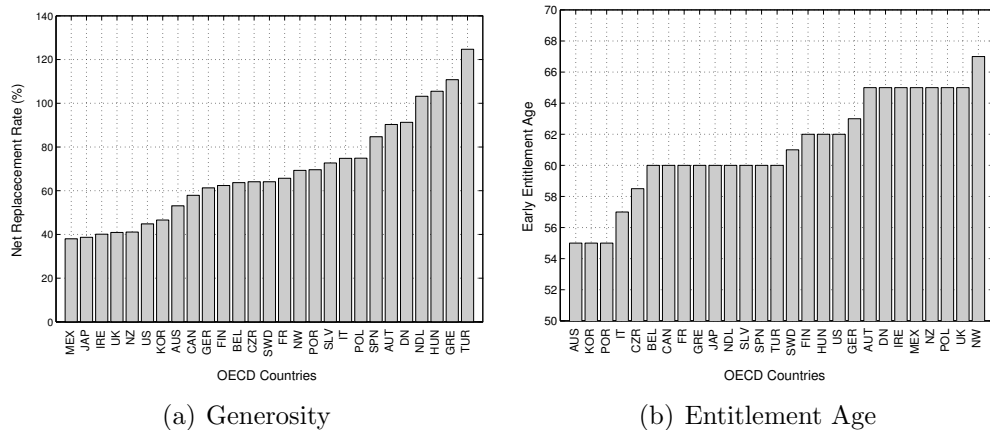


FIGURE 2. Social Security Generosity and Entitlement Age

ages, as Figure 2(b) shows, which vary from 55 years in Australia to 67 years

Country	Implicit Tax on Continuing to Work (at Retirement)
AUS	0.95
CAN	0.00
CHE	0.00
CZE	0.00
DEU	0.00
DNK	0.00
ESP	0.00
FIN	0.00
FRA	0.00
GBR	0.00
GRE	0.00
HUN	0.00
IRL	0.00
ISL	0.00
ITA	0.00
JPN	0.00
KOR	0.00
MEX	0.00
NZL	0.00
NOR	0.00
POL	0.00
PRT	0.00
SLO	0.00
SVK	0.00
SWE	0.00
TUR	0.00

variability in implicit taxes.

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

There is a stationary distribution of the population, N , which grows at a constant rate n . People live a maximum number of A periods. In every period, each individual faces an idiosyncratic probability of dying $1 - s_a$, which depends only on age. These assumptions induce a stationary population structure, in which each age group is a constant fraction, μ_a , of a measure of the population⁶.

⁶This number is obtained with the following recursion: $\mu_{a+1} = \frac{s_{a+1}}{1+n} \mu_a$ with $\sum_a \mu_a = 1$

3.2 Preferences and Endowments

Preferences over sequences of consumption $\{c_a\}$ and leisure $\{1 - h_a\}$ are identical across countries. Consumption must be positive and hours of work are restricted to be either zero or \bar{h} , as the objective of this study is the extensive margin. The utility function to value uncertain streams of consumption and leisure is standard and is written as

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

3.3 Individual Productivity

People, indexed by i , are born identical to the economy but as they age, their productivity ($z_{i,a}$) changes. Productivity is determined through the interaction of two different components and can be written as

$$z_{i,a} = z_a^d z_{i,a}^w$$

where z_a^d is a deterministic component identical to every individual of the same age and $z_{i,a}^w$ is a stochastic component that follows a AR(1) that is written as

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

where $\epsilon_{i,a} \rightarrow N(0, \sigma_\epsilon^2)$ is iid across individuals.

3.4 Technology

There is a representative firm that operates a constant returns to scale technology to produce an homogeneous good, Y , using aggregate capital, K , and aggregate efficiency units of labor, L . Aggregate capital depreciates at a constant rate δ .

3.5 Markets

There are markets for capital, labor, and product for every period but no markets for insurance, borrowing, or lending (as in Aiyagary, 1994). Therefore, individuals accumulate precautionary savings on top of life cycle savings.

3.6 Social Security

Social security is defined by two elements. The first is a payroll tax, τ , which is levied on every worker. The second component is a function, $\phi(\bar{e}_a, h_a, a)$, which characterizes benefit payments and entitlement conditions. It is a function of average life cycle earnings as the benefit amount replaces different average earnings at a different rate. Progressive replacement rates are held at US levels but average replacement rates are scaled up or down to each country. Furthermore, the benefit function depends on labor choices because social security rules in some countries may restrict the possibility of receiving benefits while working. Furthermore, the function depends on age because individuals are not entitled to receive social security until they reach an entitlement age, \hat{a} . Further details about social security are given in the calibration section.

3.7 Accidental Bequests

People have an idiosyncratic probability of dying every period and they may leave some assets unused. This study assumes that the government collects all these assets and distributes them as a lump sum transfer among living people, B .

3.8 Individual Decision

Individual decisions are written recursively. This study focuses on comparing steady states, and thus, abstracts from the time subscript.

Individuals decide how much to consume, c ; how much capital to save, k' ; and whether they work or not, h . In a steady state, taking interest rates, r ,

wages, w , payroll tax, τ , the social security benefit function, ϕ , and accidental bequests, B , as given, each individual solves the following Bellman equation:

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

3.9 Aggregate State Variables

The aggregate state variables of the economy are a list of measures over individual states $\{\Psi_a(k, z^w, \bar{e})\}$. In a steady state, it is a function of the individual state variables.

3.10 Steady State Recursive Competitive Equilibrium

The individual state variables, other than age, are collected in a vector $x = (k, z^w, \bar{e})$ to save some notation. 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 , τ , K , L , and B , such that:

1. $c_a(x)$, $k'_a(x)$, $h_a(x)$, and $V_a(x)$ solve Equation (3) for every $a = 1, \dots, A$.
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) $\sum_a \mu_a \int_X [c_a(x) + k'_a(x)] d\Psi_a = F(K, L) + (1 - \delta)K$,
 - (b) $\sum_a \mu_a \int_X k'_a(x) d\Psi_a = (1 + n)K$, and
 - (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 bequests are distributed evenly among living individuals.

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

4 Calibration

I calibrate the model to key features of the US economy. Some parameters are chosen independently, relying on various data sources and previous research, whereas other parameters are chosen within the model. Demographics, productivity, fraction of time worked, labor share, and social security system are calibrated independently. However, the depreciation rate, discount rate, intertemporal elasticity of substitution, and weight of leisure in the utility function are chosen by solving the steady state equilibrium to match some key statistics of the US economy.

4.1 Parameters Calibrated Independently

This study is required to choose the growth rate of the population, n ; the age when individuals enter the economy; the length of life, A ; the probability of survival, s_a ; the individual productivity process, $z_{i,a}$; the labor share, α ; the fraction of time working, \bar{h} ; and the social security system.

4.1.1 Demographics

The growth rate of the population is set to be equal to the US historical average of 1.2%, over the period 1960–2006. This number is taken from the US Census Bureau Statistical Abstract of 2009. Individuals are born to the economy aged 20 years and die with a probability of 1 when they are 94 years.

Therefore, the life span is $A = 75$. The probability of survival is taken from actuarial tables, for males, provided by the US Social Security Administration, in 2004, and it is used to derive stationary weights for the population in the model. These two elements are displayed in Figure 4.

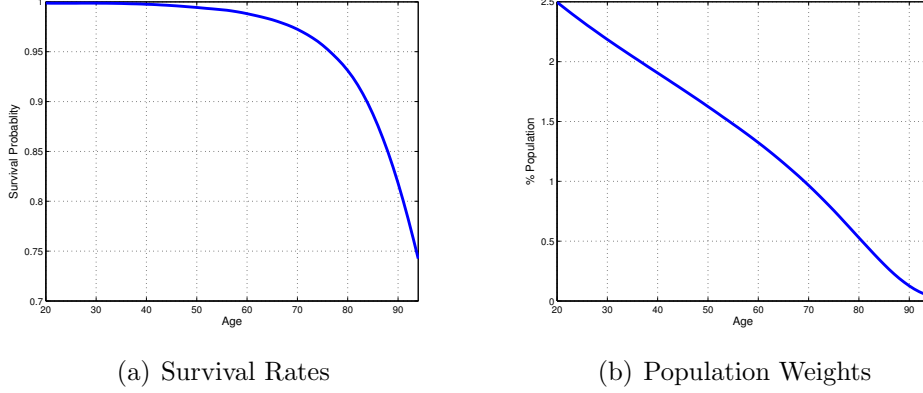


FIGURE 4. Survival Rates and Population Weights

4.1.2 Individual productivity process

Individual productivity, $z_{i,a}$, is characterized by two components: a deterministic component of age, z_a^d , and a stochastic component, $z_{i,a}^w$.

To characterize the deterministic component, this study uses annual earnings and annual hours worked for a sample of white non-disabled males with at least a high school education from IPUMS-CPS⁷ over the period 1992–2006. The sample selection is driven by the objective of isolating the incentive effects of social security systems on retirement, and not by life-cycle labor supply decisions that are driven by race, gender, or education. The study drops females because some of their choices are related to fertility, which are harder to model⁸. High school dropouts are also left out of the sample because they have remarkably different employment behavior and earnings dynamics that

⁷<http://cps.ipums.org>.

⁸It is worth noting that the deterministic component of productivity for males and females looks alike.

would not map that well under the OECD assumption that individuals have full careers beginning at age 20 years. It is a reasonable first step to start without it as the model abstracts from permanent heterogeneity. Finally, it abstracts from disabled individuals because they face a rather different set of employment incentives because of disability insurance. Despite excluding disability insurance, Erosa et al. (2012) show that disability insurance is relatively unimportant.

The empirical literature usually decomposes annual earnings into age, time, and cohort components. A well-known problem in this literature is that time and cohort components cannot be identified separately, without very strong assumptions. Hugget et al. (2011) decompose earnings under three different hypotheses. They assume that either time effect or cohort effect is absent, or that time effect and cohort effect are orthogonal. They find that none of the assumptions significantly affects the estimation of the age component of earnings. In the steady state, the time effect should be proportional to the time variable, so this study assumes that earnings grow at a 2% rate due to productivity gains⁹. Hourly wages are constructed by dividing annual earnings and annual hours. Then, the ratio of mean hourly wage by age is computed to mean hourly wage. This produces a hump-shaped profile that is used to fit a quadratic polynomial over ages 20–65 years, as self selection sets in much more strongly after entitlement ages. The polynomial is truncated to zero at age 80 years when it becomes negative¹⁰. The stochastic component of individual productivity is characterized by an AR(1) stochastic process

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

⁹Hugget et al. (2011) document a growth of wage per hour in the PSID of 1.5% for the period 1969–1992.

¹⁰Note that this does not deliver very different results than assuming that the deterministic component of the productivity is given by the average earnings by age relative to average earnings, as is frequently done in the literature.

with $\epsilon_{i,a+1} \xrightarrow{iid} N(0, \sigma_\epsilon^2)$. The parameters ρ and σ_ϵ^2 are taken from French & Jones (2011) and equal 0.977 and 0.0141, respectively.

The fraction of time spent working, \bar{h} , is set to 0.45 of available time in a year. To calculate the available time, it is assumed that individuals can use 12 hours a day at work, delivering 4,380 hours in a year and 1,971 hours spent at work.

4.1.3 Social security

The social security program is calibrated to the US. In my benchmark calibration, individuals start collecting benefits at age 62 years, the early entitlement age in the US, but entitlement ages vary across countries in the simulations. Many countries have an early entitlement age on top of a regular entitlement age. This study abstracts from normal entitlement age to save computation time. In the simulations, it is shown that differences in entitlement age cannot account for much of the differences in employment to population at older ages. In all probability, the inclusion of normal retirement ages would not change the results by much.

This study assumes that the US has a zero implicit tax. If we use the implicit tax on continuing to work obtained by Duval (2003) as a proxy for this restriction, it is one of the smallest across the OECD at 12%. In the US, one strong penalty for collecting social security while working was the “earnings test,” a tax on social security benefits for individuals who claimed entitlement before age 67 years, while still working. The test established two income thresholds. After the first threshold, \$1 of social security benefits were taxed away for every \$2 of labor earnings above the first threshold; and after the second threshold, \$1 of social security benefits were taxed away for every \$3 of labor earnings above the second threshold. On top of this arrangement, the US system included an actuarial compensation factor that allowed individuals to compensate for some of the benefit loss later on. The “earnings test” was reformed in 2000. Before the reform, the test applied to people who continued

to work and were younger than 67 years and the actuarial compensation of those between the ages of 65 and 67 years was not actuarially fair. Since the reform, the test is applied only to individuals younger than 65 years and the compensation is actuarially fair. Therefore, as a first approximation, it seems reasonable to abstract from it and to assume that the US has no restrictions on collecting social security while working.

The social security benefit formula is taken from the US Social Security Administration. It is a piecewise linear function of average individual life cycle earnings, \bar{e} , as in Hugget & Ventura (1999), French (2005), and Nishiyama & Smetters (2007). The bend points are multiples of AW so they can be taken directly to the model economy. The US social security replaces 90% of the first \$761 a month, 32% from \$761 to \$4,586, and 15% above \$4,586. This is equivalent to 0.2, 1.24, and 2.47 in multiples of AW. Therefore, it is written as

$$\phi(\bar{e}_a, h_a, a) = \begin{cases} 0 & \text{if } a < 62 \\ \varphi(\bar{e}) & \text{otherwise} \end{cases}$$

and it is characterized in Figure 5. Note that, as this study assumes that

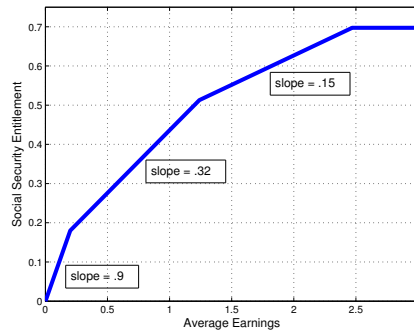


FIGURE 5. Social Security Benefits by Average Earnings

the implicit US tax is zero and h_a does not play any role. Other simplifications worth mentioning are that US social security takes into account the 35 best years of earnings, while this study takes only a simple average over life-time, capped for individual earnings higher than 247% of AW. It characterizes

individual average earnings by

$$\bar{e}' = \begin{cases} \frac{\bar{e} \cdot (a-1) + \min(wz_{i,a}h, 2.47 \cdot AW)}{a} & \text{if } a < \hat{a} \\ \bar{e} & \text{otherwise} \end{cases}$$

This study abstracts from the fact that US social security requires individuals to be employed for at least 10 years. This is not an issue in the model because everybody works more than 10 years in any event. In addition, it assumes that there are no earnings limits on the payroll tax, while in the US earnings above \$100,000 are exempt, roughly $3AW$. This seems a harmless assumption, as the mass of individuals that earn more than $3AW$ is relatively small. Although it is harder to tell how many people have life cycle average earnings above $3AW$, there are reasons to believe that they are not above 10%¹¹.

4.1.4 Labor Share

The production technology is Cobb-Douglas, $Y = K^\alpha L^{1-\alpha}$. Labor share, $1-\alpha$, is set to be 0.64 of the value of production, as it is found using NIPA, as is standard in the macroeconomic literature.

4.2 Parameters Calibrated Together

Preference parameters and the depreciation rate match some key moments of the US economy. The utility function is separable in consumption and leisure and can be written as

$$u(c, 1-h) = \frac{c^{1-\sigma}}{1-\sigma} + \lambda \cdot (1-h) \quad (2)$$

This function is characterized by relative risk aversion, σ , and the weight of leisure, λ .

¹¹According to the CPS March Supplement 2006, only 4.6% of the population earned more than $3AW$.

Objective. $(\sigma, \lambda, \beta, \delta)$ is chosen to match the following key statistics in the US: a capital–output ratio of 3, an investment–output ratio of 0.2, a labor share of 0.64, and an employment to population ratio age profile from the ages of 50 to 80 years. Employment is computed to population ratios from the same sample of the CPS that was used to compute hourly wages. There are 33 moments and 4 parameters, thus, the parameters are chosen to minimize the square deviation of the moments from the data and their simulated equivalent. Even though every parameter may impact any moment, the discount factor, β , is mostly related to the capital–output ratio. Once the algorithm finds a value of the discount factor that makes the capital–output equal to 3, the value of α chosen to be 0.36 delivers a labor share of 0.64, and a value of δ of 0.066 delivers an investment–output ratio of 0.2. The deterministic component of productivity, z_a^d , the weight of leisure in the utility, λ , and the relative risk aversion, σ , interact to deliver an employment age profile. It is not obvious why relative risk aversion plays a role in determining the shape of the employment profile and this deserves a brief comment. For a high value of σ , which implies a low elasticity of substitution, the drop in employment when individuals receive social security benefits will be smaller than if σ were smaller. The employment age profile will be steeper for smaller values of the relative risk aversion coefficient.

4.3 Calibration results

Table 1 shows the results of the calibration. Relative risk aversion, σ , is within the range of values found in the literature, which varies from one to eight; β is in the low range for life cycle models but the results nonetheless produce a hump-shaped consumption profile, as shown in Figure 6. The model matches

TABLE 1

Parameters from the Calibration								
A	n	σ	λ	β	α	δ	ρ	σ_ϵ^2
75	.012	2.50	2.50	.97	.36	.066	.977	.0141

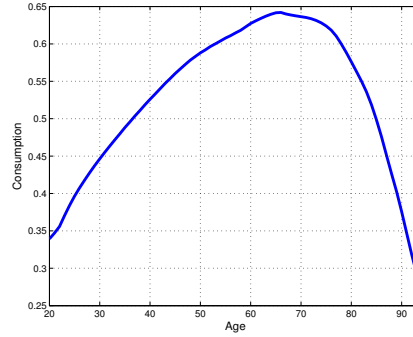


FIGURE 6. Consumption Age Profile

the ratios of capital and investment to output and labor share perfectly, but these are not shown in this paper. In addition, the model is successful at matching the employment to population ratio by age. Figure 7 shows the match of employment to population for ages 50–80 years. After 80 years, very few people work and, in this study’s model, nobody works. As the model de-

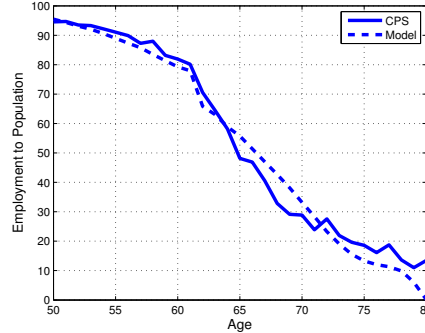


FIGURE 7. Employment Age Profile: Data vs. Model

livers an employment to population age profile similar to the US, it is fair to express all variables relative to the US to compare both data and simulations, and it is a key feature for undertaking comparative statistics.

Furthermore, the model matches unintended moments, which is always encouraging for the results. It is well known that there is a lot of selection about employment occurring at older ages. Therefore, the estimates of the wage per

hour profile could be biased. To address the importance of selection, Figure 8(a) compares the polynomial fit to life cycle wage per hour in CPS, which is used in the calibration, to simulated life cycle earnings, shown in Figure 8(b). Despite possible biases in the estimates of the polynomial coefficients, the model produces an earnings age profile consistent with the data. Another

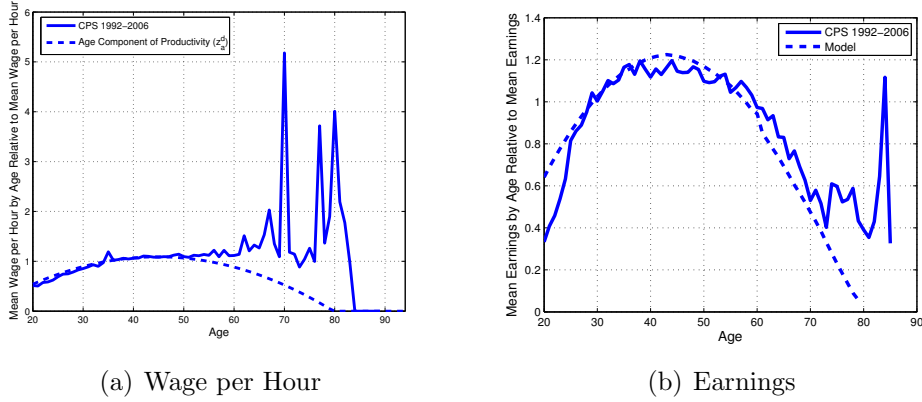


FIGURE 8. Wage per Hour and Earnings: Data vs. Model

important feature that the model matches very well is the replacement rate: the model is 40% compared to 45% in the data. The equilibrium payroll tax in the model is 10.38%, which is similar to the US payroll tax of 12.5%. When contributions made to Medicaid are discounted in the data, the payroll tax becomes 9.5%, even closer to the model payroll tax.

5 Policy Experiments

This section evaluates the importance of three key features of social security to explain cross-national differences in employment to population at older ages. It also investigates which of the features of social security considered are most important. All the comparisons are done from a steady state to a steady state.

Before the experiments are described, a reasonable question to ask is whether the model delivers a similar relationship between features of social security,

such as generosity, and employment to population at older ages. This is important to support the results of the model, as the relationship between all features of social security and employment to population at older ages could be due to plain luck. If the model did not deliver similar correlations between generosity and employment to population at older ages, it could point to some fundamental weakness. To address this issue, Figure 9 shows the correlation between employment to population at ages 60–64 years (a) and ages 65–69 years (b).

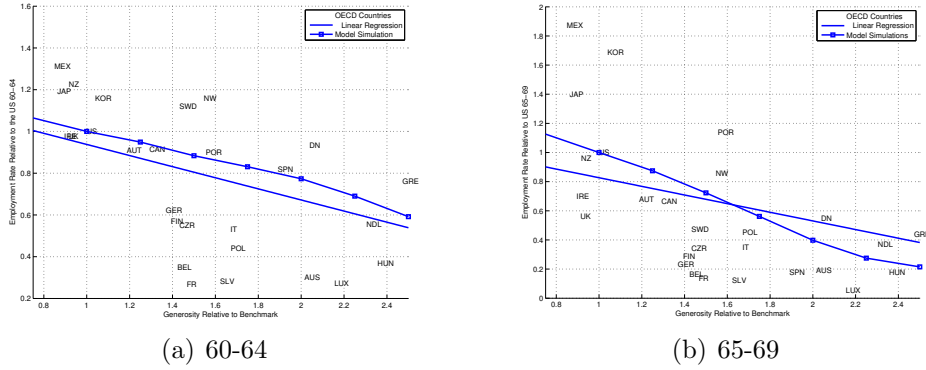


FIGURE 9. Generosity and Employment at Older Age: Data vs. Model

The model produces a similar fit of the data, if not better, than a linear regression which is what this study aimed for.

5.1 Description of the Experiments

Section 2 documents large differences in employment to population rates at older ages across the OECD. It also documents large differences in three key features of social security: generosity, entitlement ages, and implicit taxes. In all the experiments, employment to population at older ages and features of social security are compared relative to the US. Levels are not compared directly because a subsample of the US population is isolated for the calibration using micro-data, which is many times not available for other countries. While the fit of simulations to employment to population age profile is also not perfect

and such errors could be transmitted to levels, they are not transmitted to employment to population relative to the US. As a robustness experiment, the model is recalibrated to include females and the results do not change much.

To account for differences in employment through differences in social security, the stationary equilibrium of the model is solved for with different parameters for social security to mimic differences in generosity, entitlement age, and implicit taxes. The results of simulations are compared with OECD employment data in 2006. To address which feature or combination is more important, the model is simulated shutting down features of social security one by one to US levels. In addition, every possible combination of social security features is explored.

5.2 Results

5.2.1 Retirement relative to the US

The main idea of this study is that cross-country differences in social security account for large cross-country differences in employment to population at older ages. Model simulations show that differences in the features of social security selected account for a substantial fraction of the differences in employment of older people. This is surprising because there are many things occurring as people age. On the one hand, people's health gets worse with age, so differences in health systems across the OECD may matter. Different countries present very different combinations of PAYGO public systems and defined contribution private systems, in particular, Australia and New Zealand, which have some version of a defined contribution system. In addition, many European countries are experiencing a rise in defined contribution systems.

Figure 10(b) shows how male employment to population at 60–64 years compares in the model and the data. Of course, there are some outliers, such as Austria or Italy, but given the wide cross-country variation in institutional

features, it is not surprising. The match would greatly improve if those countries were dropped and the matching of employment to population at older ages would remain for a substantial proportion of OECD countries. Some dif-

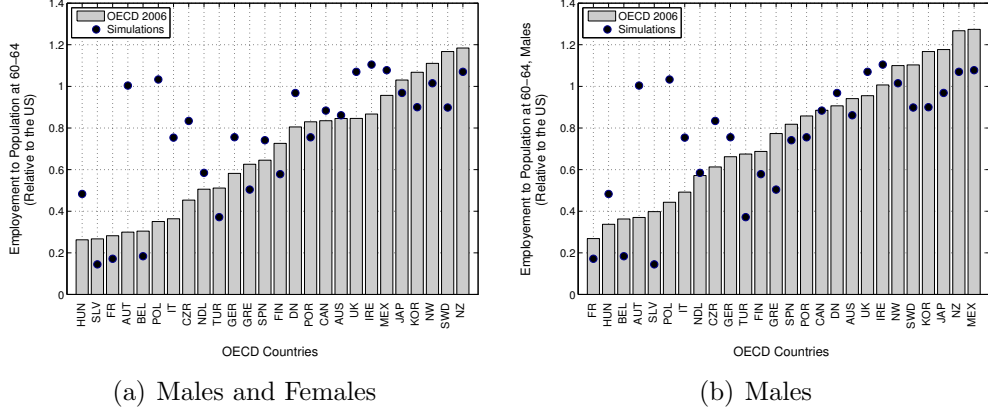


FIGURE 10. Employment Rate 60-64: Data vs. Simulations

ferences in institutional features may show up as differences in employment to population at older ages by sex. As a robustness exercise, the model is recalibrated to males and females and the same cross-country simulations are performed, with the result that the effect on employment to population of older males and females, relative to the US, is very similar.

In addition, the results may depend on our chosen definition of generosity. Table 4 in Appendix C shows correlations between model simulations and data when different definitions of generosity are used, in particular, gross replacement rates, public replacement rates, and net social security wealth. These different definitions of generosity are fed into the model and the results do not change much. The worst fit, with a correlation of 0.48, is found when gross replacement rates are used, but it remains a big number. Another important assumption is Duval (2004)'s definition of implicit taxes. To address the importance of this issue, his numbers rather than the 0–1 classification are fed into the model. The results are shown in Table 5 in Appendix C. The correlations between the model simulations and data remain high. They are 0.59 at ages 60–64 years and 0.64 at ages 65–69 years. These high correlations persist

regardless of the definition of generosity.

Furthermore, differences in social security are able to account for the employment profiles, from ages 50–54 years to ages 70–74 years, of many countries. Figure 11 shows the fit of model simulations to data in four different countries, of the many the model can fit: Australia, France, Japan, and Finland, countries that are markedly different to the US¹². It is remarkable how many

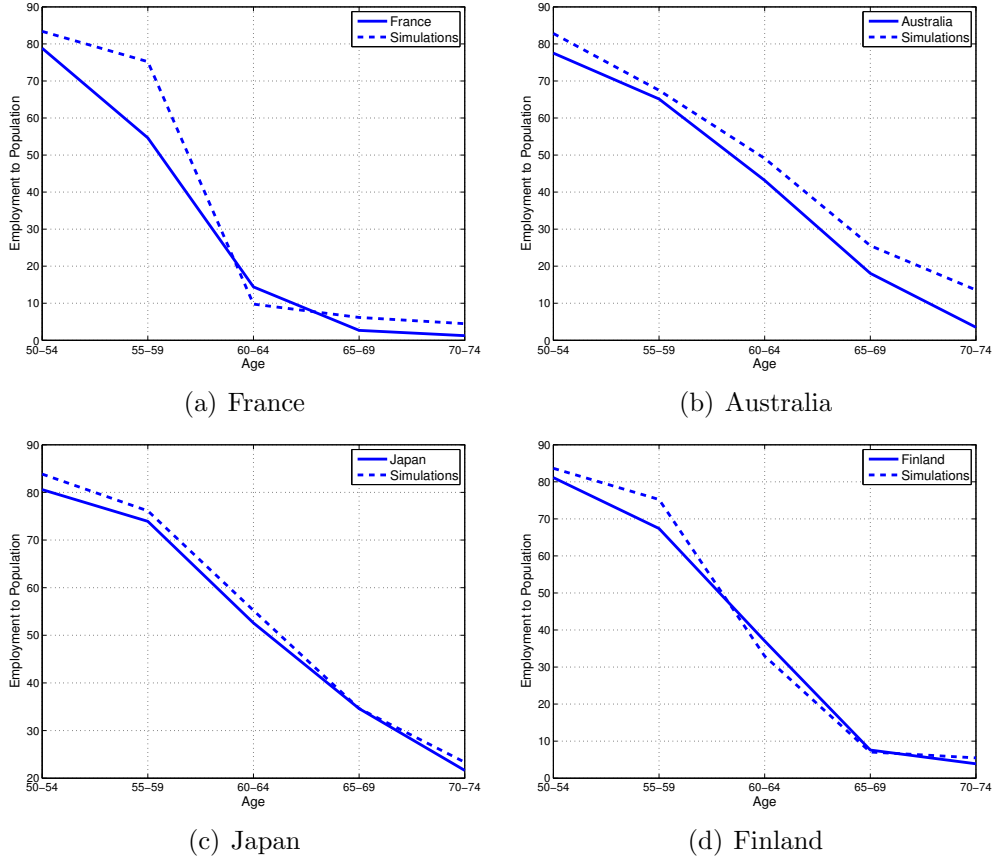


FIGURE 11. Employment at Older Age: Selected Countries

of the employment profiles at older ages are accounted for by differences in three features of social security only. However, the next question to address is which features of social security, or their combination, are most important.

¹²Figures for every country are available upon request.

5.3 Which Features of Social Security are Most Important?

To account for which features of social security are most important, counterfactual simulations are run. Shutting down social security features to US levels one by one, and with every possible combination, enables quantification of the importance of each feature. Figure 12 summarizes the results of the counterfactual simulations. From panel (a) we learn that the important

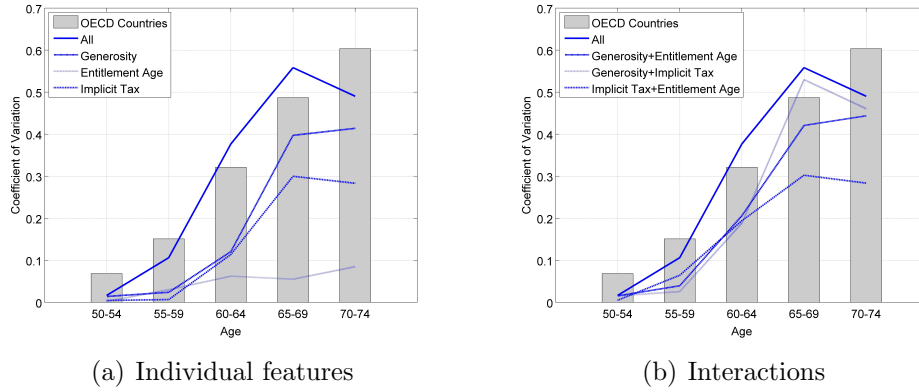


FIGURE 12. Employment Variation by Age and Social Security Features

features to account for differences in employment to population at older ages are generosity and implicit taxes but entitlement age is not. Generosity and implicit taxes each account for a third of the variability in employment at older ages but they actually overpredict variability when they interact. When simulations are run allowing for all interactions between each feature of social security, it is found that differences in entitlement age cannot account for differences in employment to population at older ages.

Three different features of social security account for much of the cross-country variability in employment to population at older ages, but they are also able to account for average differences in employment relative to the US. This exercise should be understood as how the average country in the OECD compares with the US. Figure 13 shows the same decomposition depicted in Figure 12. Social

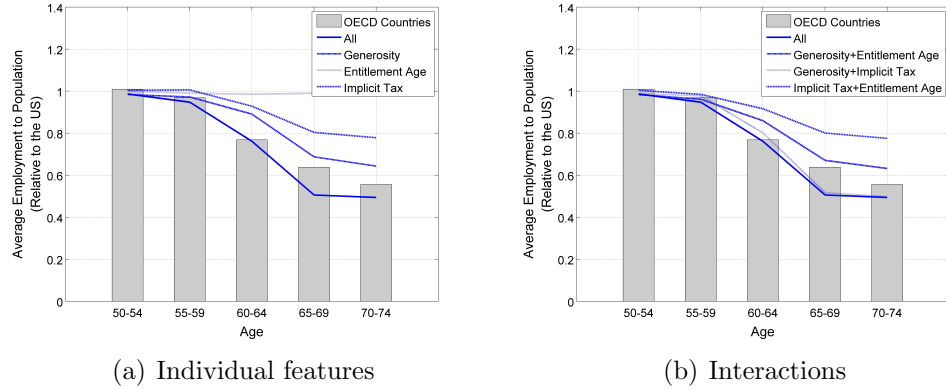


FIGURE 13. Employment Variation by Age and Social Security Features

security features account for a large fraction of the differences in employment to population at older ages of the average OECD country relative to the US. In particular, generosity, implicit taxes, and their interaction account for most of the differences in the average employment to population at older ages relative to the US. On the other hand, the entitlement age cannot account for much of the differences, nor its interaction with other social security features.

Many policymakers argue about strategies to encourage their citizens to work later in life. One of the most popular policy reforms is increasing entitlement age. However, according to the model of this study, this would barely affect retirement age. People would change their saving behavior and retire at the age they planned to in the steady state, and not when they are told to. This result does not mean that increasing retirement age is a bad policy. In the steady state, social security would be cheaper, easing the tension that aging societies place on public finances.

6 Concluding Remarks

There are large cross-country differences in employment to population and these differences are even bigger at older ages. Many factors may affect this measure of retirement behavior, but social security seems a natural candidate.

Social security is a tax and transfer program present in almost every country. It accounts for a large fraction of countries' gross domestic product and it accounts for an even bigger fraction of their tax proceeds. In addition, there are large cross-country differences in social security features. An interesting question to answer is how much of these differences in employment to population at older ages social security can account for, in particular, through three different features only: generosity, implicit taxes, and entitlement ages. Furthermore, it is interesting, in particular from the policy debate perspective, to investigate which features of social security are most important.

To answer these questions, this study used a general equilibrium model of life cycle labor supply decisions, which features idiosyncratic labor income risk and differences in social security features. After calibrating the model to the US, the combination of the three features of social security was simulated. It was found that these features account for a significant amount of the variation in employment to population at older ages. In addition, social security features account for differences in average employment across the OECD relative to the US. Most importantly, differences in social security are able to accurately fit employment to population age profiles at older ages for many of the OECD countries.

Among generosity, implicit taxes, and entitlement ages, the first two stand out as the most important features of social security. Each accounts for one third of the variability and their interaction slightly over-predicts it. In addition, they account for most of the differences in average employment to population age profile relative to the US. Cross-country differences in entitlement ages can account for neither the variability in employment to population at older ages, nor differences in the averages relative to the US. The policy message that can be read is that even though this policy may not encourage people to work longer, it would reduce public spending in social security in the steady state.

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7 Appendices

7.1 Appendix A: OECD Social Security Data

TABLE 2

OECD Social Security Relative to the US

Country	Replacement			Wealth			Eligibility	
	Gross	Net	Public	Gross	Net	Weighted	ERA	WSS
AUS	1.07	1.19	0.38	1.25	1.22	1.22	55	0
AUT	2.07	2.02	2.07	2.11	1.60	1.60	65	1
BEL	1.09	1.42	1.09	1.16	1.04	1.04	60	1
CAN	1.15	1.29	1.15	1.24	1.22	1.22	60	0
CZR	1.28	1.43	1.28	1.38	1.38	1.38	58.5	0
DN	2.07	2.04	0.59	2.11	1.42	1.42	65	0
FIN	1.45	1.39	1.45	1.60	1.20	1.20	62	1
FR	1.38	1.47	1.38	1.69	1.49	1.49	60	1
DEU	1.11	1.37	1.11	1.31	1.05	1.05	63	1
GRE	2.47	2.47	2.47	2.60	2.24	2.24	60	0
HUN	1.98	2.36	1.31	2.25	2.00	2.00	62	1
IRE	0.88	0.90	0.88	1.11	1.11	1.11	65	1
IT	1.75	1.67	1.75	1.82	1.38	1.38	57	0
JAP	0.87	0.86	2.28	1.02	0.95	0.95	60	0
KOR	1.09	1.04	0.88	1.02	1.05	1.05	55	0
MEX	0.93	0.85	0.12	0.87	0.87	0.87	65	0
NDL	2.28	2.30	0.78	2.96	2.20	2.20	60	0
NZ	1.00	0.92	1.00	1.31	1.07	1.07	65	0
NW	1.53	1.55	1.34	1.85	1.53	1.53	67	0
POL	1.58	1.67	0.80	1.53	1.27	1.27	65	1
POR	1.39	1.55	1.39	1.47	1.47	1.47	55	0
SLV	1.46	1.62	0.62	2.60	1.60	1.60	60	1
SPN	2.10	1.89	2.10	2.22	1.84	1.84	60	0
SWD	1.59	1.43	0.98	1.80	1.29	1.29	61	0
TUR	2.24	2.78	2.25	2.00	2.00	2.00	60	0
UK	0.79	0.91	0.80	0.75	0.73	0.73	65	0
US	1.00	1.00	1.00	1.00	1.00	1.00	62	0

Source: "Pensions at Glance", OECD (2009) and Duval (2004)

ERA: Early Retirement Age

WSS: Working and Collecting Social Security

7.2 Appendix B: Alternative Calibration

In the benchmark calibration of the model, this study uses data for white males from the CPS and then runs simulations under different configurations of social security. However, the simulations are compared to data from the OECD, which abstracts from the selection chosen. The model is recalibrated to US employment to population at ages 50–54, 55–59, 60–64, 65–69, and 70–74 years. It finds that the parameters that match the aggregate moments and the employment distribution are roughly similar but with a higher value of leisure in the utility function (λ) to compensate for an employment distribution that is shifted down when women and other ethnic groups are included. The same relative wages by age are kept, as there are no big differences by sex.

TABLE 3

Calibrated Parameters								
A	n	σ	λ	β	α	δ	ρ	σ_ϵ^2
75	.012	2.85	6.00	.958	.36	.066	.977	.0141

7.3 Appendix C: 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 (τ_0).
2. These values are solved by 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, the policy functions $c(x, a), k'(x, a)$, and $h(x, a)$ are obtained for every $a = 1, \dots, A$.
3. The distributions over the individual's state space ($\Psi_a(a)$) are computed using Monte Carlo simulations. First, it is assumed 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. K_0, L_0, B_0 , and τ_0 are updated aggregating over the simulated distributions to K_1, L_1, B_1 , and τ_1 .
5. If aggregate variables in the previous point are close enough and product markets clear, iterations are stopped. Otherwise, they are continued until convergence.

90 points for the individual capital are chosen, 30 points for the idiosyncratic shock, and 4 points for average earnings. Care has to be taken in the computations: the problem is nonstandard as there is nonconvexity on labor choice. This is probably not a problem in theory, as this study integrates the value function over a continuous distribution with no mass points. Nevertheless, in the numerical computations, the data is on a grid, and this can be a problem. As this study does not attempt to prove that the objective function is concave and differentiable, it uses golden section search at each point of the individual state for each employment status (0 or \bar{h}) and then chooses the maximum

between these two numbers. Note that golden section search simply requires that the objective is single peaked on an interval of choice and no derivative is used at all. A tradeoff between reliability and computational efficiency makes this type of problem time consuming. For example, solving for the stationary equilibrium of the model may take between 30 minutes to 3 hours. Calibration may take from a few days to weeks.

7.4 Appendix D: Sensitivity analysis

TABLE 4

Correlation between data and simulations (full sample)
Benchmark simulations

Age	Net Replacement		Gross Replacement		Public Replacement		Net Wealth	
	All	Males	All	Males	All	Males	All	Males
20–75	0.64	0.76	0.41	0.44	0.60	0.69	0.55	0.70
50–54	0.35	0.25	0.25	0.13	0.36	0.14	0.21	-0.01
55–59	0.19	0.18	0.20	0.21	0.31	0.30	0.13	0.08
60–64	0.67	0.71	0.48	0.51	0.62	0.67	0.64	0.69
65–69	0.65	0.64	0.31	0.31	0.66	0.65	0.64	0.63
70–74	0.65	0.64	0.37	0.35	0.45	0.51	0.60	0.58

Full sample includes all OECD countries

Benchmark simulations are under the assumption of a 0–1 earnings test

TABLE 5

Correlation between data and simulations (full sample)
Using Duval (2004)’s definition of implicit taxes

Age	Net Replacement		Gross Replacement		Public Replacement		Net Wealth	
	All	Males	All	Males	All	Males	All	Males
20–75	0.64	0.64	0.58	0.57	0.62	0.59	0.59	0.58
50–54	0.31	0.28	0.14	0.01	0.31	0.13	0.12	-0.03
55–59	0.20	0.22	0.18	0.19	0.26	0.28	0.15	0.16
60–64	0.59	0.60	0.56	0.57	0.54	0.55	0.56	0.56
65–69	0.64	0.63	0.58	0.56	0.64	0.63	0.61	0.60
70–74	0.62	0.60	0.56	0.54	0.42	0.48	0.56	0.55

Full sample includes all the OECD