A Theory of Labor Supply Late in the Life Cycle: Social Security and Disability Insurance*

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Abstract

This paper studies the role of social security, disability insurance, and taxation for understanding differences in labor supply late in the life cycle across European countries and the United States. First, we use the newly released Survey of Health, Ageing, and Retirement in Europe (SHARE) as well as the US Health and Retirement Study (HRS) to consistently document facts on labor supply late in the life cycle (over the age of 50) across many European countries and the U.S. Then, we build a structural life-cycle model of labor supply and retirement decisions that explicitly models the key institutional differences across countries (in their social security, disability, and taxation systems) and use the model to assess the role of government policy in accounting for the micro-level observations documented in the empirical analysis. Our main findings are that the model accounts fairly well for the decrease in labor supply late in the life cycle for most countries. Our findings support the view that government policies can go a long way towards accounting for the low labor supply late in the life cycle in the European countries relatively to the United States, with social security rules accounting for the bulk of these effects and income taxation having much milder effects on labor supply. The results underscore that the interaction of non-linear wages with social security rules is important for understanding retirement decisions.

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1 Introduction

This paper studies the role of social security, disability insurance, and taxation for understanding differences in labor supply late in the life cycle across European countries and the United States. The paper makes three contributions to the recent literature in macroeconomics studying government policies and labor supply across countries.[1] First, we use a newly released dataset − the Survey of Health, Ageing, and Retirement in Europe (SHARE) − as well as the US Health and Retirement Study (HRS) to consistently document facts on labor supply late in the life cycle (over the age of 50) across many European countries and the U.S. Second, we document how the social security, disability, and taxation institutions vary across the countries in our empirical analysis. Third, we build a structural life-cycle model of labor supply and retirement decisions that explicitly models the key institutional differences across countries and use the model to assess the role of government policy in accounting for the micro level observations documented in the empirical analysis.

The paper is motivated by the fact that there are substantial differences in the observed labor supply behavior within the European countries as well as between the U.S. and Europe as a whole. Figure 1 documents that the differences in the employment rates and annual hours worked for 8 European countries in the dataset increase dramatically late in the life cycle − for example, while differences in employment rates are in the order of 15 percentage points for the 50-54 age group, they increase to 35 percentage points for the 55-59 age group and to more than 50 percentage points for the 60-64 age group. Our paper focuses on the effect of three government programs on labor supply late in the life cycle: social security, disability insurance, and the tax system. Using data from national surveys, Gruber and Wise (1999) and Blondal and Scarpetta (1999) provide empirical evidence on the importance of social security rules in affecting retirement incentives for many countries. Several empirical studies (Gruber and Wise (1999)) have also emphasized the potential importance of the so-called "early retirement programs" in Europe such as disability insurance. The SHARE, however, with its harmonized cross-country methodology, allows us to document the facts on employment consistently across several European countries. Finally, while it is well known that the taxation of capital and labor income vary substantially across countries, there is substantial debate in the profession about its impact on labor supply decisions.

We develop a life-cycle model of labor supply and retirement decisions that builds on French (2005) and Imrohoroglu and Kitao (2010). As in Erosa, Fuster, and Kambourov (2011), we develop a neoclassical model of labor markets with non-linear wages that accounts

[1] See for example Prescott (2002, 2004), Ljungqvist and Sargent (2006), Ohanian, Raffo, and Rogerson (2008), and Rogerson and Wallenius (2009).

for labor supply choices both along the intensive and the extensive margins. The key feature of our theory for delivering periods of non-participation is the non-linear mapping between hours and earnings, which is convex at low hours of work. This mapping is the competitive equilibrium outcome of an economy with a production technology in which hours of work and number of workers are imperfect substitutes (see Hornstein and Prescott (1993) and Osuna and Ríos-Rull (2003)). We model in great detail the social security, disability insurance, and taxation systems in the United States and European countries in our study. In particular, countries in the model economies vary in terms of the (i) social security rules − such as early and normal age of entitlement, replacement rates, adjustments for early and late withdrawal, the presence of early retirement schemes and occupational pensions, and the contributions to the social security system, (ii) the fraction of people on disability and the payments to disabled individuals, and (iii) the taxation of consumption, capital income, and labor earnings. We model two education groups − college and non-college − since we observe important differences between these two groups in the data and the fraction of men with college education varies importantly across countries. The baseline economy is calibrated to U.S. micro and macro data. Our calibration methodology follows the approach in Erosa, Fuster, and Kambourov (2011) to pin down the value of some key parameters that are important for the quantitative response of labor supply decisions to policy changes in our theory. First, we set the intertemporal elasticity of leisure to 0.5 because this value allows our model of non-linear wages to be consistent with a rich set of micro facts on labor supply (see Erosa, Fuster, and Kambourov (2011)). Second, to estimate the age-profile and shock process on labor productivity we follow an indirect inference approach that allows us to control for the selection problems that make the calibration of these parameters difficult. Given that wages are only observed for workers, the estimation of the wage process is affected by non-random selection into employment. This problem is likely to be more severe for individuals close to the retirement age. Moreover, this is a serious problem because the labor productivity process late in the life cycle plays a crucial role in determining how social security impacts on retirement decisions. To control for selection into employment, we use a GMM procedure to estimate − for each education group − a wage profile and a wage process both in the PSID and in the model simulated data. Our procedure requires simulating the model economy for different values of the parameters determining the age profile of wages and the stochastic process of wages until the GMM estimates in the simulated data recovers the estimates obtained in the PSID data.

We find that the baseline economy matches very well the life-cycle patterns in hours worked for college and non-college individuals in the U.S., even though these patterns were not explicitly targeted by the calibration. The baseline economy is quantitatively consistent with the fact that the profile for average annual hours is relatively flat until the age of 50 and starts declining after that age. Moreover, the decline of working hours late in the life cycle is quantitatively consistent with the data both along the intensive and extensive margins underscoring that the baseline economy represents a good theory of the U.S. labor supply decisions late in the life cycle. We then perform a set of quantitative experiments in which we replace the U.S. government policy with the policies of Switzerland, the Netherlands, Spain, Italy, and France. Our main findings are that the model accounts fairly well for how labor supply decreases late in the life cycle for most countries. The model matches

remarkably well the large decline in the aggregate labor supply after age 50 in Spain, Italy, and the Netherlands. Our findings support the view that government policies can go a long way in accounting for the low labor supply late in the life cycle for these European countries relatively to the United States, with social security rules accounting for the bulk of these effects and income taxation having much milder effects on labor supply. Our quantitative experiments predict that relative to the United States, the hours worked by men aged 60-64 is 43% in the Netherlands, 57% in Spain, 36% in Italy, and 37% in France. In the data, these figures are 49% in the Netherlands, 66% in Spain, 44% in Italy, and 29% in France.

Our findings imply that labor supply is much less responsive to taxes than previous papers in the literature (Prescott (2002, 2004). While Prescott (2002) finds that differences in taxes in France and the United States account for virtually all of the 30-percent difference in labor input per person between these countries, our findings only account for a 10-percent difference in labor supply. A deeper comparison of the results, should consider that Prescott assumes that all tax receipts are distributed lump-sum back to households based on the idea that public goods are good substitutes for private consumption (eg. public schools and hospitals are good substitutes for private schools and hospitals). This assumption is crucial for generating a large response of labor supply to tax changes, as discussed by Prescott (2002, 2004). On the other hand, our quantitative experiments assume that none of the tax receipts are rebated back to consumers. Hence, in an experiment we simulate in our model economy the French and the U.S. policies under the assumption that all tax receipts are rebated back to households. We find that the aggregate labor supply under French policies is now 24% lower than under U.S. policies, a result that is close to the findings in Prescott (2002, 2004) and more than twice the value of 10% that we obtained in our baseline experiment with no rebates.

A natural question is whether modeling non-linear wages is important for the quantitative effects of policies on labor supply. To investigate this issue, we consider a new baseline economy with linear wages and simulate the introduction of French policies into this economy. Two main findings emerge: Aggregate hours worked in France relative to the United States are approximately the same as in the economy with non-linear wages (10% lower). Second, however, non-linear wages matter importantly for labor supply responses after age 60. While for the age group 60 to 64 labor supply in France is 0.56 with linear wages, it is the much lower 0.37 with non-linear wages. This results underscores that the interaction of non-linear wages with social security rules is important for understanding retirement decisions across countries.

Relative to the recent literature analyzing the role of taxation on labor supply differences across countries Prescott (2002, 2004), Ohanian, Raffo, and Rogerson (2008), Alonso-Ortiz (2009)), a distinguishing feature of our paper is that we model the progressivity of taxes on earnings. In a quantitative experiment, we find that replacing the progressive tax system on earnings with a flat tax has small effects on labor supply in the U.S. economy (about a 2% increase). On the other hand, the increase in labor supply is much larger in France, with an increase in the hours worked per person aged 25-65 of 6.7%. This finding is due to the fact that earnings are taxed much more progressively in France than in the U.S. We thus conclude that progressivity of the tax system matters for understanding labor supply differences across countries. French (2005) and Imrohoroglu and Kitao (2010) model in

a rich life-cycle model the effect of health on retirement and labor supply decisions. In the same spirit, we studied the effect of disability and evaluate its importance for labor supply differences across countries. We find that disability insurance policies do not play an important role but for the Netherlands and Spain.

2 Empirical Findings

The focus in this paper is on labor supply late in the life cycle after the age of 50, and in order to document the facts we use the newly released Survey of Health, Ageing, and Retirement in Europe (SHARE) as well as the U.S. Health and Retirement Study (HRS). The Survey of Health, Ageing, and Retirement in Europe (SHARE) is a European cross-national panel of micro data on health and socio-economic status which was administered in 2004, 2006, 2008, and 2010. It has data on 11 countries and more than 45,000 individuals aged 50 or older. The survey provides a balanced representation of various European regions: Scandinavia − Denmark and Sweden; Central Europe − Austria, France, Germany, Switzerland, Belgium, and the Netherlands; and Mediterranean − Spain, Italy, and Greece. Israel, the Czech Republic, and Poland were added in the 2006 wave. The dataset provides detailed longitudinal individual data on employment, (sources of) income, (sources of) transfers, health, consumption, and assets. It is harmonized with the U.S. Health and Retirement Study (HRS) and the English Longitudinal Study of Ageing (ELSA). The US Health and Retirement Study (HRS) surveys, over every two years, more than 20,000 Americans over the age of 50. It collects detailed longitudinal individual data on variables such as income, work, assets, pension plans, health insurance, disability, physical health and functioning, cognitive functioning, and health care expenditures. We are using the 2004 wave.

2.1 Labour Supply

Figure 1 reports mean annual hours worked after the age of 50 for eight European countries − Switzerland, Sweden, Denmark, the Netherlands, Germany, Spain, Italy, and France. In the analysis we use data from the 2006 SHARE.[2, 3] We can immediately see that the labor supply behavior of the various European countries in the sample is dramatically different. In particular, even though there are some differences in hours worked at the of 50-54, they appear relatively small. However, those differences become quite substantial later in the life cycle at the age of 55-59 and especially 60-64. For example, for the 60-64 age group, mean annual hours worked are as large as 1500 in Switzerland and Sweden, around 1000 in Germany, around 500 in the Netherlands and Italy, and around 300 in France. As the other two panels in Figure 1 indicate, most of the observed changes are driven by the extensive margin (the fraction of workers who report positive hours worked). However, the countries in the sample also exhibit differences on the intensive margin as well (mean hours worked for those who report positive hours worked). This evidence is also summarized in Table 1.

[2]Appendix V reports the same facts from the 2004 SHARE. The overall patterns are quantitatively very similar across both waves.

[3]Appendix I provides a detailed description of the variables from SHARE used in the analysis.

Finally, Figure 2 shows that the cross-country differences in labor supply late in the life cycle are much more pronounced for non-college than for college individuals.[4]

Figure 3 puts the European labor supply experience in perspective by comparing the patterns in labor supply in Switzerland, Spain, and France to those in the United States. The facts on hours worked in the United States are obtained from the 2004 US Health and Retirement Study (HRS).[5] As the figure indicates, hours worked in the United States between the ages of 50 and 74 are higher than in France and Spain but lower than in Switzerland. Indeed, US hours worked are higher than all of the eight European countries except Switzerland and Sweden.

2.2 Program Participation Late in the Life Cycle

In order to get a preliminary look at the effect of various income support programs on labor market participation after the age of 50, we present in Table 2 the fraction of individuals receiving the following benefits: (i) Social Security (SS) retired worker benefits, (ii) SS survivor's benefits, (iii) Disability Insurance (DI) benefits, (iv) Unemployment Insurance (UI) benefits, and (v) Private pension benefits.[6]

Three things stand out when analyzing the evidence from Tables 1 and 2. First, for a given country, older individuals have more program participation and lower labor market participation. Second, the fraction of people not working is highly correlated with the availability of income support programs across countries − for a given age group, countries with more program participation tend to have a lower labor market participation. Third, the relative importance of the different programs varies substantially across countries. For example, for the 55-59 age group, while DI programs are important for some countries such as Sweden, Denmark and the Netherlands, UI programs are relatively more important for countries such as Germany and France. Furthermore, early retirement appears crucial for countries such as Italy, France, and Sweden.

Thus, the various programs available across the countries in the sample present individuals in those countries with alternative paths to retirement, and the relative importance of each of these programs varies substantially across all the countries.

2.3 Disability Enrollment

In this subsection, we take a more detailed look at the disability insurance programs in Europe and the United States. We use the 2004 and 2006 waves of the SHARE to document the facts on disability insurance enrollment in the European countries in the sample. Appendix I provides a detailed description of the variables related to disability insurance payments

[4]Tables A-1 and A-2 present the labor market participation results separately for non-college and college individuals.

[5]Appendix II provides a detailed description of the variables from the HRS used in the analysis. Furthermore, it illustrates that the mean annuals hours worked for college and non-college individuals in the 50-74 age group in the HRS are quantitatively very similar to those in the PSID.

[6]Tables A-3 and A-4 present the program participation results separately for non-college and college individuals.

from the SHARE used in the analysis. The questions in the 2004 and the 2006 wave differ which partially accounts for some of the quantitative differences reported below. However, the qualitative message is very similar.

Figure 4 reports the fraction of individuals receiving disability insurance payments. For year 2004, we use information on income sources last year and classify individuals as disability insurance recipients if they report having received public disability insurance, or a public invalidity or incapacity pension, or private (occupational) disability or invalidity insurance. For the year 2006, we classify individuals as disability insurance recipients if they report having received in the previous year main public disability insurance pension or sickness benefits, or secondary public disability insurance pension or sickness benefits, or occupational disability or invalidity insurance.

Figure 4 shows that the fraction of individuals receiving disability insurance varies substantially across the eight European countries in the sample. In particular, the fraction of disability insurance recipients in Sweden, Denmark, and the Netherlands is higher than in Germany, Italy, and France.[7] It is clear that in order to understand the behavior of labor supply late in the life cycle it would be important to incorporate the effects of disability insurance in the analysis. Large differences in the fraction of disability insurance recipients might manifest itself in cross-country differences in the observed participation rates as most of the disability insurance recipients do not work − for example, the 2004 SHARE reveals that the fraction of individuals on disability who report working is 15% in Spain, 26% in Italy, 23% in the Netherlands, and 27% in Denmark. In addition, those on disability who continue to work report much lower hours worked than those who are not on disability. One major exception, however, is Sweden − in the 2004 SHARE data, 60% of the disability insurance recepients in Sweden reported positive work hours.

3 The Model

We develop a life-cycle theory to evaluate how various government policies affect labor supply decisions across countries. We consider a world of small open economies that differ in their social security and taxation systems.[8] While the evidence shows that countries differ in terms of their total factor productivity (TFP), we emphasize that the level of TFP does not affect labor supply in our model economy because preferences and technology are chosen

[7]Disability Enrollment: 2006 SHARE additional questions. The 2006 questionnaire also asks individuals about receiving public benefits since the last interview two years ago (in 2004). We use this information to construct an alternative measure of the fraction of disability insurance recipients. In particular, we classify as a disability insurance recipient all those who report to have received either sickness benefits or disability insurance benefits since the previous interview in 2004 two years ago. The results, reported in Figure 5, are similar to those obtained from the other measures. Figure 5 reveals that the fraction of individuals receiving disability insurance payments is higher in Sweden, Denmark, and the Netherlands than in Switzerland, Italy, and France.

[8]For the purpose of our paper, we think that the assumption of a small open economy is a better description of reality than assuming a world of small close economies. Moreover, since the model abstracts from altruistic agents, assuming a close economy would imply implausibly large effects of social security on the aggregate stock of capital and interest rates (Fuster (1999) and Fuster, Imrohoroglu, and Imrohoroglu (2003)).

to be consistent with balance growth. The baseline economy is calibrated to US micro and macro data. The calibrated model economy is then used to simulate government policies for various European countries. These experiments are used to quantitatively assess how the variation in government policies accounts for the cross-country variation in labor supply and retirement decisions. The model economy features heterogeneous agents but, for simplicity, we abstract from the labor supply decisions of women and only model males.

3.1 Individuals: preferences, endowments, and shocks

The baseline economy is populated by overlapping generations of individuals. Individuals face uncertain lifetimes and can live, at most, J periods. They differ in terms of their education (college versus non-college). Each period individuals face disability, mortality, and labor productivity shocks. The stochastic processes driving these shocks depends on age and education. Individuals maximize lifetime expected discounted utility

$$E_t \sum_{j=t}^{J} \beta^{t-j} u(c_j, 1 - n_j),$$

where E_t denotes expectations at date-t, c_t is consumption, and $1 - n_t$ represents leisure. An individual's time endowment in each period is one. The date-t utility function takes the form

$$u_t = u(c_t, l_t, h_t) = \alpha \ln c_t + (1 - \alpha) \frac{(1 - n_t)^{1-\sigma}}{1 - \sigma},$$

The utility function is consistent with balance growth and allows for an active extensive margin on labor supply decisions. The modeling of preferences is motivated by the observation that there are no important cohort effects in the labor supply of men. It also allows the theory to be consistent with the fact that there are large permanent differences in labor productivity across individuals (heterogeneity in fixed effects) but not in their lifetime labor supply (see the discussion in Erosa, Fuster, and Kambourov (2011)). The Frisch elasticity of leisure is given by $\frac{-1}{\sigma}$. Individuals enter the model with age 25 and the college decision is exogenous.

3.2 Technology

There are a large number of plants and each plant is a collection of jobs. We assume that plants can operate jobs at zero costs. The production function of a job at date t is given by

$$f(K, h, A\ z) = h^{\varepsilon} K^{1-\theta} (A_t\ z)^{\theta}, \quad \text{with } \theta \leq \varepsilon \leq 1$$

where h denotes the workweek, K is the amount of capital for the job, and $A_t z$ is effective labor in the job. Capital is assumed to depreciate at a rate δ per period. Effective labor in the job is given by the product of the worker productivity z and the level of technology A_t, which grows over time at an exogenous rate g. Note that, for a fixed workweek, the job technology exhibits constant returns to scale in capital and effective labor. Moreover, as discussed in

Osuna and Ríos-Rull (2003), when $\varepsilon = \theta$ the job technology reduces to the standard Cobb-Douglas technology where total hours of effective labor is what matters. When $\varepsilon > \theta$ the hours and effective labor are imperfect substitutes and the composition between these two inputs matters. When $\varepsilon = 1$ the technology is linear in hours and corresponds to the case where workers are not subject to fatigue.

3.3 The plant's problem

The plant's production plan is given by the choice of hours of operation h, capital K, and effective labor N. The plant takes as given the wage schedule $\tilde{w}(h, N)$ and the interest rate r. In equilibrium, the wage schedule is a non-linear function of the workweek h and a linear function of effective labor N. To show this point, consider a plant operating h hours and hiring N units of effective labor. The optimal amount of capital K solves

$$\pi = \max_{K} h^{\varepsilon} K^{1-\theta} N^{\theta} - Kr - \tilde{w}(h, N).$$

The solution to this problem implies

$$\frac{K}{N} = k^*(h, r) = \left[\frac{(1-\theta)h^{\varepsilon}}{r}\right]^{1/\theta}.$$

Next, notice that plants will only operate if profits are non-negative. Free entry, and the fact that plants can be created at zero costs, imply that in equilibrium plants will make zero profits (will not extract economic rents from workers). Hence, competition for workers implies that the wage bill $\tilde{w}(h, N)$ is determined from

$$\pi = h^{\varepsilon} \left[N k^*(h, r)\right]^{1-\theta} N^{\theta} - N \; k^*(h, r) r - \tilde{w}(h, N) = 0,$$

which gives

$$\begin{aligned} \tilde{w}(h, N) &= w(h) \; N, \text{ where} \\ w(h) &\equiv (r) \frac{\theta}{1-\theta} \left[\frac{(1-\theta)h^{\varepsilon}}{r}\right]^{1/\theta}. \end{aligned}$$

It follows that the wage schedule $\tilde{w}(h, N)$ is linear in effective labor N and non-linear in hours of work h. When $\varepsilon = \theta$ earnings are also linear in h. When $\varepsilon > \theta$ the wage rate increases with h. In this case, households would be better off by selling employment lotteries to firms (Hornstein and Prescott (1993)). However, we rule out this possibility by assuming that households cannot commit to work when the realization of the employment lottery implies that they should work.

3.4 Government Policy: Taxation, Social Security, and Disability Insurance.

Government policy varies across countries along many dimensions. To evaluate the effects of government policy on labor supply late in the life-cycle, we model the cross-country variation

in the social security system, disability insurance, and tax institutions. In particular, we calibrate the baseline economy to salient features of the U.S. tax and social security system and we then evaluate the effects of replacing US government policy with the policies pursued in various European countries. Below, the government policy is described in general terms. The detail description of government policy for each country considered in this study is left to appendix B.

Social Security. In our model the social security system specifies an early retirement age. Once individuals attain the early retirement age, individuals can choose to file for social security benefits (e.g. collect pension benefits). Retired individual can choose to work but their earnings might be taxed at a very high rate due to progressive taxation of earnings. It is assumed that individuals can't work any longer after age of 75 so that this is the oldest possible age of retirement in the model economy. In equilibrium, the age of retirement will differ across individuals because of heterogeneity in earnings, disability status, and assets. We carefully model the incentives for early/late retirement by modeling how pensions - the replacement rate - vary with the age of retirement of individuals. In this way, the model captures how the cross-country variation in accrual rates affects the age of retirement.[9] Pensions also depend on the ability type of workers (education and fixed effects). In particular, for each ability type, pensions depend on the average lifetime earnings across workers of that ability type. This assumption considerably simplifies the computation of the model since modeling pensions as a function of the actual earnings of individuals requires adding an extra state variable in an already difficult dynamic programming program.[10]

We model cross-country variation in social security rules along many dimensions: *i*) the normal and early retirement ages; *ii*) the benefit formula determining how pensions vary with average lifetime earnings, such as the progressivity of the formula and the rules determining minimum and maximum pensions; *iii*) how pensions vary with the age of workers at retirement (accrual rates); *iv*) the formula used to compute average lifetime earnings such as the number of years considered in the computation and whether wages are adjusted by real wage growth or by inflation when computing lifetime average wages; *v*) the formula determining the payroll taxes paid to finance social security since the tax rate may vary with earnings and the taxation of earnings may be capped at high levels of earnings; *vi*) whether pensions are kept constant in real terms during retirement or they increase with real wage growth; *vii*) the presence of occupational pensions or early retirement programs (such as in Switzerland, Netherlands, and France)

Disability insurance. We model the probability of becoming disabled as determined by government policy. This approach is motivated by the following evidence from SHARE: First, Hendrik Jurges (2005) documents that there are small differences in objective measures of health status across countries. Second, Axel-Borsh-Supan (2005) shows that the large cross-country differences in disability cannot be explained by differences in health or demographics and concludes that institutional differences account for the variation in disability across

[9]The number of years since retirement may also affect pensions if pensions are not adjusted by productivity growth (mean real wage growth) during retirement. In this case, "normalized" pensions decrease during retirement at the rate of productivity growth in the economy.

[10]Our model is not convex since it features an active extensive margin (due to non-linear wages) and a retirement decision.

countries. As documented in Section 2 most of the disability-insurance receipients in SHARE do not work. Hence, the model assumes that individuals can't work while on disability. It is also assumed that disabled individuals remain disabled for the rest of their lives and that they collect a social security payment which depends on the ability-type (college and fixed effect type), the age when "forced" into retirement, and the number of years since retirement because pensions may be adjusted by productivity growth during retirement.

Taxes. Following McDaniel (2007), we assume that the government taxes consumption (τ^c), investment expenditures (τ^I), capital income (τ^k), and labor earnings ($T(y)$). We use her estimates to pin down the cross-country variation in the first three tax rates (τ^c, τ^I, τ^k). Differently from McDaniel (2007), we assume that labor earnings are taxed according to a progressive tax function that we estimate using OECD data. We assume that labor earnings and capital income are taxed based on the country of residency of the individual supplying the factors of production. Investment taxes are levied by the government of the country where investment is located, independently of the nationality of the owner of the factor of production. As described in McDaniel (2007), investment taxes stand for the general taxes (including sales and value added taxes) paid on investment expenditures as well as customs and import duties, and taxes on use of goods to perform investments activities (such as motor vehicle taxes, highway taxes). Taxes on consumption include property taxes paid by households, general taxes on good and services, excise taxes, customs and import duties, taxes on specific services and taxes on the use of goods to perform activities.

Government expenditures. The government uses the tax revenue to purchase a public good that does not provide utility to individuals or, equivalently, entering the period utility function in an additive separable fashion. Later in a senstivity analysis, we shall assume that tax revenues are rebated back to individuals.

3.5 Capital markets

We assume that there are a large number of financial intermediaries that take deposits from consumers (D) and make investments in (potentially) many countries. When an intermediary purchases I_c units of capital in country c, it pays an investment tax $\tau_c^I\ I_c$. The purchases of capital are constrained by the amounts of deposits D as follows

$$\sum_c I_c(1+\tau_c) = D \tag{1}$$

Intermediaries take as given the international interest rate i, the return on capital r_c, and the tax rate τ_c^I. The present value of the return to one unit of capital invested in country c is

$$PV_c = \frac{r_c}{1+i}\left[1 + \frac{1-\delta}{1+i} + \left(\frac{1-\delta}{1+i}\right)^2 + ...\right] = \frac{r_c}{i+\delta}$$

The investment problem faced by the representative intermediary is

$$\max_{D,I_c} -D + \sum_c I_c \frac{r_c}{i+\delta}$$

s.t.(1)

Profit maximization implies the following arbitrage condition

$$\frac{r_c}{1+\tau_c^I} = i + \delta \text{ for all } c.$$

In a world of open economies, differences in the investment taxes across countries are arbitraged away so that the return on capital per unit of expenditure is equated to the international (gross) interest rate.

Due to free entry in the financial industry, financial intermediaries make zero profits. We assume that financial intermediaries sell annuity contracts to individuals so that the gross interest rate on deposits paid to an age j individual is $\frac{1+i}{\pi_j}$. The after tax gross return on deposits of an age j individual in country c is

$$R_{c,j} = 1 + \left(\frac{1+i}{\pi_j} - 1\right)(1-\tau_c^k)$$

Note that the taxation of capital income is based on the country of residence.

3.6 The Individual's Problem

We use the recursive language to describe the problem of an individual. To simplify the notation, we abstract from the fact that the education type of an individual determines his earnings, disability, and mortality processes. The state x of an individual is given by his age j, assets a, earnings shock z, disability status d, and social security status f (age of retirement if individual has filed for social security benefits). The timing of events within each period is as follows. Individuals start the period knowing x. Individuals decide how much to consume, work, save, and, if applicable, whether to apply for social security benefits or not. We assume that individuals with disability can't work and that retired individuals can work as long as their able.

The value of a person in state x is

$$\begin{aligned} V(x) &= Max_{\{c,n,s,f'\}}\{u(c,n) + \beta\pi_{j+1}E[V(x')]\} \\ &\quad \textit{subject to} \\ (1+\tau^c)\ c\ + a' &= R_j\ a + w(n)\ z_j\ + b(x) - T(x), \\ a' &\geq 0, \end{aligned}$$

where R denotes the gross interest rate (net of taxes), $T(x)$ represents total taxes paid on labor earnings net of earnings-tested transfers, and $b(x)$ denote social security benefits received (pension and disability benefits).

4 Calibration

The baseline economy is calibrated to the U.S. economy in the year 2004. While we consider a world of small open economies, we calibrate the international interest rate so that the net

capital flows in the baseline economy are zero. We follow the calibration strategy in Erosa, Fuster, and Kambourov (2011). In particular, we calibrate the age-profile and the shock process on labor productivity using an indirect inference approach. Moreover, we set σ so that the intertemporal elasticity of leisure of 0.5. In our previous paper, we found that this value of the Frisch-elasticity of leisure allow us to best match the micro facts on labor supply. Below we show that this finding also applies in our current model economy with endogenous retirement.

Model period. The model period is set at an year.

Preference parameters, time endowments, mortality rates, and disability risk. Following Prescott (2004) and Osuna and Ríos-Rull (2003), the time endowment is set at 5200 hours a year (100 hours per week) and the discount rate β is chosen to match an asset to income ratio of 3. The preference parameter α determining the consumption weight in the utility function is set to 0.5 so that prime age individuals work about 42% of their available time. The mortality risk for college and non-college individuals is taken from Bhattacharya and Lakdawalla (2006). To calibrate disability risk we use data from the Health and Retirement Survey to compute the fraction of men claiming to be disabled by age and education groups (see Appendix II). We assume that non-college men follow a constant probability of becoming disabled from age 30 to age 40 and that after age 40 disability risk increases exponentially with age:

$$p_j = \begin{cases} p_1 & if \quad j \in [30, 40) \\ p_1 \ e^{(j-39) \ p_2} & if \quad j \in [40, 65] \end{cases}$$

The probability of becoming disabled for college men is assumed to be a constant fraction of that for non-college men: $p_{col,j} = p_{col} p_j$, where $p_{col} \in (0, 1)$. The parameter p_{col} is pinned down so that the model is consistent with the fact that the fraction of college individuals who are disabled is about half the fraction of non-college individuals who are disabled in the Health and Retirement Survey in the year 2004. The other two parameters target the fraction of individuals disabled in the age groups 50-54 (7.3%), 55-59 (8.9%) , and 60-64 (9.1%). The calibration sets $p_1 = 0.0029, \ p_2 = 0.054, \ p_{col} = 0.59$.

Technology parameters. We find that an international (pre-tax) interest rate of 4.9% achieves our target of zero net international capital flows. The rate of depreciation of capital is set at 5.3%, the labor share θ at 0.69, and the rate of labor augmenting technological progress $g = 0.014$ per year, which is the average productivity growth in the US during the postwar period (Fuster, Imrohoroglu, and Imrohoroglu (2007)). To calibrate the parameter ε, we use the fact that in equilibrium the elasticity of the hourly wage to a change in hours worked is given by $\varepsilon/\theta - 1$ (see the discussion in Erosa, Fuster, and Kambourov (2011)). Aaronson and French (2004) estimate this elasticy to be 0.40 so that we set $\varepsilon = 1.4 \ \theta$.

Tax rates on consumption, investment, capital income and labor earnings. Following McDaniel (2007), the tax rate on consumption is set to $\tau_c = 0.075$, the investment tax rate is set to $\tau_x = 0.032$, and the tax rate on capital income is fixed at $\tau_k = 0.232$. To parameterize taxes on labor earnings, we follow Guvenen, Serdar, and Kuruscu (2010) and fit the following effective average tax function to data from the OECD tax database:

$$\overline{\tau}(y/W) = a_0 + a_1(y/W) + a_2(y/W)^{\phi},$$

where $\overline{\tau}$ gives the average tax rate paid by an individual with earnings y -normalized by average earnings in the economy W- . We use the OECD data to compute effective labor income taxes for various points of the wage distribution and include in the calculation central government, local, and state taxes net of tax credits. Differently from Guvenen, Serdar, and Kuruscu (2010) we exclude social security contributions (which we model explicitly) and cash benefits (such as social assistance and housing assistance).[11] Table A-5 reports the regression results for all countries. Note that the reported R^2 are quite close to 1.

Social security and disability. The social security tax rate is set to $\tau_{ss} = 0.124$ with a cap $\widehat{y}$ on social security taxation fixed at 2.47 of average earnings in the economy (W). Half of the social security taxes are paid by the employer and are not subject to the personal income tax on earnings. Social security benefits depend on average lifetime earnings (adjusted by the rate of growth in the economy) according to the benefit formula in the US economy (see Fuster, Imrohoroglu, and Imrohoroglu (2007)). The early and normal retirement ages are set at 62 and 65 years of age. If an individual retires before the normal retirement age of 65, her pension is reduced by 6.7% per year of early retirement. When individuals retired after the normal retirement age, the pension is increased by 3% per year of delayed retirement up to age 69. Disabled individuals receive a pension equal to the pension benefit they would have received had they retire at the normal retirement age.

Calibration of labor productivity We emphasize that this is a crucial step in our calibration strategy. While the age profile of productivity and the parameterization of wage shocks have a first order effect on the retirement decisions of individuals, these objects are hard to calibrate. First, note that labor productivity is not directly observed in the data. While we do observe wages, wages are observed with error since it is well known that there is measurement error in hours and, hence, wages in the PSID data. Second, wages are only observed for individuals that work. To the extent that there is an active extensive margin late in the life cycle, the estimation of a wage process for individuals close to the retirement age is going to be affected by selection issues. This is a serious problem because the labor productivity process late in the life cycle plays a crucial role in determining how social security impacts on retirement decisions. To deal with these problems we follow and indirect inference approach. Building on our previous work, we use a GMM procedure to estimate for college and non-college individuals the following annual wage process both in the PSID and in the model-simulated data:

$$\ln w_{ij} = x_j\ \kappa + \alpha_i + u_j + \lambda_j, \tag{2}$$

where x_j is a quartic polynomial in age, κ is a vector of coefficients, $\alpha_i \sim N(0, \sigma_\alpha^2)$ is a fixed effect determined at birth, $\lambda_j \sim N(0, \sigma_\lambda^2)$ is an idiosyncratic transitory shock, and u_j follows a first-order autoregression:

$$u_j = \rho u_{j-1} + \eta_j, \quad \eta_j \sim N(0, \sigma_\eta^2), u_0 = 0. \tag{3}$$

[11] In the US case, the regression is run with data on taxes for 35 points of the wage distribution, which expressed as a percentage of average earnings W are given by $10\%, 20\%, 30\%, 40\%, 50\%, 75\%, 100\%, ..., 800\%$ of W. For many European countries there is an initial range of income for which the average tax rate is constant and equal to a minimum level, which is often equal to 0. In this case, we only run the regression for income levels for which the tax function increases with income.

While the parameters $(\kappa, \rho, \sigma_\alpha^2, \sigma_\eta^2)$ vary across education types, this is omitted in the notation to avoid clutter. We simulate the model economy for different parameterizations of the wage process. In particular, we iterate on the parameters determining the age profile of wages (quartic polynomial) and the stochastic process of wages $(\rho, \sigma_\alpha^2, \sigma_\eta^2)$ until the GMM procedure in the simulated data recovers the estimates obtained in the PSID data.[12]

5 Calibration Results

There are 21 parameters that we calibrate by solving the model economy. Table 4 shows the values and the calibration results for three of these parameters: the average earnings W, consumption weight α, and discount factor β. For each education group, the indirect inference approach is used to pin down a quartic polynomial for the wage age-profile (5 parameters), the stochastic process of wages (parameters giving the variance of fixed effects, persistence o and variance of innovations, and variance of transitory shock).[13]

5.1 Hourly Wages: Age-Profile and Stochastic Process.

Because in our baseline economy there is an active extensive margin in labor supply decision, people who work are a non-random selection of the population. Hence, we cannot mechanically plug an age-profile for wages into our model but need to solve for it. The same is true for the stochastic process for hourly wages of college and non-college workers. As a result, we use an indirect inference approach to find the parameters for the trend and the stochastic process for hourly wages − the parameters are such that we obtain the same trend and stochastic process for hourly wages in the model as in the data. Figure 6 shows that the trend in hourly wages for college and non-college workers in the data is exactly the same as in the model. Similarly, Table 3 reports that the stochastic process for hourly wages in the model is the same as in the data. In particular, when we use a GMM estimation in order to obtain the the variance of the fixed effect component, the persistence and the variance of the innovation of the AR(1) shock, and the variance of the transitory component, we obtain the same estimates in the model and in the data.

5.2 Age-Profile of Hours of Work: Performance of the Model.

In the calibration procedure we did not explicitly target the various facts on labor supply. Nevertheless, it is important to point out that the baseline economy does an excellent job in accounting for the facts on labor supply. Figure 7 reports mean annual hours worked over the life cycle between the ages of 25 and 65 both in the model and in the data using various

[12]The transitory shock λ_j estimated in the PSID data represents both genuine transitory shocks and measurement error in wages. We pinned down the measurement error in wages using the estimates in Erosa, Fuster, and Kambourov (2011).

[13]When estimating the process in both the model-simulated and actual data, we allow the variance of the transitory shocks to vary with age according to a cubic polynomial.

cohorts from the US Panel Study of Income Dynamics (PSID).[14] The model does very well in matching the life-cycle pattern in hours worked both for college and non-college individuals. In particular, the model is quantitatively consistent with the fact that the profiles for average annual hours is relatively flat until the age of 50 and start declining after that. As Figures 8 and 9 show, this decline is mainly driven by the extensive margin even though we do also observe a small decline in hours worked at the intensive margin late in the life cycle. The model is quantitatively consistent with these underlying patterns as well − we see on Figure 8 that hours per worker (the intensive margin) decline in the model late in the life cycle, and that this decline is quantitatively the same as in the data. Similarly, as seen in Figure 9, the model quantitatively matches the decline in participation rates late in the life cycle (the extensive margin). We also report in Figure 10 mean annual hours for college and non-college individuals in the 50-74 age groups as we particularly focus on them in this paper. We see that the model is successful in matching quantitatively the decline in average hours worked at that period in the life cycle.

We emphasize that incomplete markets play an important role in generating the life-cycle patterns of working hours predicted by the theory. While young individuals face an increasing age-profile of wages, they work long hours because they need to build a buffer stock of savings to self-insure income risk. By age 50 the stock of assets is sufficiently large that individuals can afford to reduce their labor supply when they receive a low temporary wage shock. This accounts for the pronounced decline in annual working hours late in the life-cycle. Modelling disability is also important for generating the decline in working hours late in the life-cycle.

6 Quantitative Experiments

We are now ready to evaluate the role of government policies in accounting for cross-country differences in labor supply. To this end, we replace the US social security system and taxation institutions of the baseline economy with the policies of Switzerland, the Netherlands, Spain, Italy, and France. Before presenting the results, it should be emphasized that government policies vary across countries in a large number of dimensions. The taxation of earnings, capital income, and consumption varies across countries The social security system differs substantially on many dimensions such as the contributions to the system, the pension benefit formula, the early and normal retirement ages, and the penalties and bonuses for early and late retirement. Due to the complexity of these rules, the detail description of these institutions for each country in our study is left to an appendix. For each country, the policy experiments set the fraction of college individuals to match the ratio of college men among the total population aged 50 and older in SHARE (2004).

[14] See Erosa, Fuster, and Kambourov (2011) for a more detailed description of the facts on labor supply for the United States.

6.1 Cross-country differences in institutional arrangements

We now document that the taxation and social security systems differ importantly across countries.

6.1.1 Consumption, investment, capital Income, and earnings taxes

Table 5 documents how taxation varies across countries. The U.S. is characterized by a low consumption tax relative to the European countries. While the consumption tax is 7.5% in the U.S., it goes from 15.3% in Switzerland to 25.5% in France. Thus, the consumption tax generates important tax wedges that may have an effect on labor supply across countries. Investment taxes also vary across countries, but less than consumption taxes. Moreover, as previously shown, differences in investment taxes are arbitraged away with capital moblity, and they should not affect much the labor supply across countries. Capital income taxes vary in the tight range of 19.0% to 23.2%, with the lowest value in Spain and the highest value in the U.S.

Figure **??** plots earnings taxes across countries. Two observations stand out. First, earnings taxes in the U.S. do not appear to be low relative to European countries. Second, earnings taxes are progressive in all countries. However, they are more progressive in Europe than in the United States as evidenced by the fact that in several European countries (Spain, Italy, and the Netherlands) individuals with earnings below 40% of average earnings pay zero earnings taxes. US earnings taxes are the highest for people with earnings at 50% of mean earnings in the economy, while they are the lowest for individuals with earnings above 300% of mean earnings.

6.1.2 Social security

Social Security Programs vary substantially across countries. They also vary over time as most countries have reformed their social security systems. We model as close as possible the social security rules prevailing in the year 2004. However, for countries where the early retirement rules change substantially after a reform we model the rules that applied to individuals aged 60-64 in SHARE(2004) when making their retirement decisions.[15] The quantitative experiments below will mostly focus on understanding labor supply differences for this age group.

Social security regulations on early retirement differ substantially across countries. While in some countries there is a minimum age requirement for collecting pensions (62 for US, 63 for Switzerland, 60 for Spain and 55 for the Netherlands), in other countries the age requirement is irrelevant since individuals can retire after a number of years contributing to the system (40 years in France and 35 years in Italy). Switzerland and the U.S. penalize early retirement with actuarially fair reductions. Each year of early retirement (after the early retirement age but before the normal retirement age) is penalized with a reduction of

[15]For Italy, we model the rules prevailing before 1993 because for workers with 15 years of contributions at the end of 1992, the rules of the pre-1992 regime apply and people will retire under the pre-1993 regime until the year 2015 (see Gruber and Wise). For similar reasons, in the Netherlands we model the early retirement schemes of the ABP plan for workers born after 1942 and according to the rules prevailing after 1997.

about 6.8% in the pension. Each year of retirement deferral is reward with a 3% increase in the U.S. (this is not actuarially fair) and much more generously in Switzerland (5.2% for 1 year of deferral, 10.8% for 2 year of deferral and up to 31.5% for 5 years of deferral). Italy (prior to the 1993 reform) provided the strongest incentives for early retirement. A worker with 40 years of contributions collects a pension with the maximum replacement rate of 80%, implying that most workers by age 60 would not see their pension increase by postponing retirement. Moreover, a worker with 35 years of contributions (and an age around 55) can retire with a pension with a replacement rate of 70%. Postponing retirement by 5 years would only increase the replacement rate by 10%, which is grossly actuarially unfair. France also provides strong incentives for early retirement. At age 60, individuals can retire with no penalty if they have contributed for 40 years to the system.[16] Each missing year of contribution is penalized by 5%, which is actuarially unfair. In the Netherlands, the early retirement schemes imply that individuals see no change in pension benefits if their retire after age 60. In this case, the replacement rate is set at 70% regardless of the age of retirement. Individuals can retire as early as age 55 but with a replacement rate of 25%, which increases up to 55% for individuals retiring at age 60.

Table 6 documents that social security taxes vary substantially across countries, with taxes being the lowest in the U.S. and Switzerland and the highest in Spain and Italy. In all countries but Italy, payroll taxes are capped at a sufficiently high level of earnings. Hence, average social security taxes tend to decrease with the level of earnings.

6.1.3 Disability pensions

We model the fraction of individuals on disability as determined by government policy. Hence, for each country, we re-calibrate the parameters (p_1, p_2, p_{col}) determining the probability of becoming disable. We use data from SHARE (3004) to target the fractions of disable individuals in the age groups 55-60 and 55-60 and the ratio between the fractions of disabled individuals in the college and non-college categories at age 55-60. The model assumes that the government pays a disability pension to disabled individuals. The replacement rate of disability pensions is pinned down using data from the "Social Security Programs Throughout the World."

6.1.4 Tax wedges

Table 7 summarizes the tax-distortions of labor supply decisions across countries. The table reports tax wedges for different levels of earnings, where the tax wedge is computed as the amount of consumption goods that can be purchased with the last dollar of earnings once consumption, earnings, and social security taxes are subtracted. Note that a tax wedge of 1 means no labor supply distortions and that the latter decrease with the tax wedge. Table 7 reveals that tax wedges are substantially below 1 and they tend to decrease with the level of earnings across individuals in the same country. The U.S. and Switzerland tend to have the

[16]For France, we assume that by age 60 non-college individuals have 40 years of contribution and that college individuals have 40 years of contribution at age 63. For Italy, we assume that 35 years of contributions are attained at age 57 by non-college and at age 62 by college.

highest tax wedges (relatively low distortions of labor supply) and France and Italy tend to have the lowest tax wedges (relatively high distortions of labor supply)

6.2 Main results

Figure 11 present the main findings of the paper. The model accounts very well for how labor supply decreases late in the life cycle for most countries. In particular, the model matches remarkably well the large decline in aggregate labor supply after age 50 in Spain, Italy and the Netherlands. The results show that government policies can go a long way in accounting for the low labor supply late in the life-cycle in these countries. The main discrepancy between the quantitative experiments and the data is that the model tends to underpredict the aggregate hours of work for individuals aged under 60 in Switzerland and to overpredict the hours of work for individuals aged 55-59 in France.

6.3 Labor supply differences late in the life-cycle: Driving forces

Table 9 compares the predictions of the model with the data for hours of worked in each country relative to the US. In evaluating these predictions, we find most interesting to focus on individuals aged 60-64 since these are the ages where the variation in social security rules are likely to have more impact on labor supply behavior. Moreover, the data reported on Table 10 shows that after age 60 there are huge differences in labor between the US and European countries (but for Switzerland). Relative to the United States, the hours worked by men aged 60-64 is 49% in the Netherlands, 66% in Spain, 44% in Italy, and 29% in France. Our quantitative experiment predicts a value of 43% for the Netherlands, 57% for Spain, 36% for Italy, and 37% for France. On the other hand, the data show that men aged 60-64 work 26% more hours in Switzerland than in the U.S. The theory predicts that men in Switzerland work 4% less hours.

The experiment just discussed changed for each country four "primitives": (i) the social security system; (ii) the tax code (consumption, investment, labor earnings, and capital income taxes); the fractions of individuals with (iii) disability and with (iv) college education. We now evaluate the relative importance of these mechanisms in generating labor supply differences across countries. In a first experiment, we simulate the model economy assuming that all countries have the U.S. tax system (consumption, investment, earnings, and capital income taxes) but differ in terms of the other country-specific policy parameters (social security system and the fraction of individuals with disability and with college education). The results from this experiment are reported on Table 9 in the row labeled "US taxes." The results indicate that the tax system accounts for a only a small part of the decline in the labor supply of men late in the life-cycle in European countries relative to the U.S. Focusing on the age group 60-64, the labor supply of men in Spain relative to the United States increases from 57% to 59% when replacing the Spanish tax system with the U.S. tax system. While this effect is sizable, it accounts for a small fraction of the overall change in labor supply predicted by the model for Spanish men aged 60-64 (2% out of total of 43% percentage points). For the other countries, replacing their tax systems with the US tax system delivers an increase in labor supply of 0% for Switzerland, 6% for the Netherlands,

6% for Italy, and 5% for France. As in Spain, taxation accounts for a small fraction of the cross-country differences in labor supply predicted by the theory.

In a second experiment, we keep constant the fraction of college individuals in the baseline economy and vary all the other policy parameters across countries. The results are reported in the row labeled "US Fraction of College." We find that the effects of this experiment are only quantitatively important for Spain and Italy. The relative labor supplied of men aged 60-64 increases by 8% (from 57% to 65%) in the case of Spain and by 4% (from 36% to 40%) in the case of Italy. Recall that the fraction of disable individuals varies across countries. To isolate how this factor matters for labor supply differences across countries, we compute average labor supply among the able population (see row labeled "Disability"). We find that disability policies matter importantly for The Netherlands and Spain. When focusing on able people, the labor supply of individuals aged 60-64 increases from .43 to .50 in The Netherlands and from .57 to .67 in Spain. For all the other countries, disability policies do not play an important role in accounting for the low labor supply relative to the U.S.

Altogether, our results indicate that social security accounts for most of the variation in labor supply across countries. This is true even in the case of Spain where the low fraction of college people and the large number of people on disability play an important role. While these two effects account for (at most) a reduction in Spanish labor supply of .18, the theory predicts that Spanish individuals aged 60-64 have a labor supply of .43 relative to the U.S. [17] As a result, the social security system in Spain accounts for more than 60% of the differences in labor supply between aged 60-64 individuals in Spain and in the U.S. Moreover, the social security system accounts for almost the of the low labor supply of aged 60-64 individuals in France and Italy relative to the U.S.

Social security is also important for understanding cross-country differences in labor supply late in the life-cycle across education groups. With the exception of Switzerland, for all European countries the labor supply of individuals aged 60-64 relative to the U.S. is lower for non-college than for college individuals. Our theory accounts well for this pattern in the data. We find that the social security rules in European countries have a particularly strong negative effect on the labor supply of non-college individuals.

6.4 Aggregate labor supply differences: ages 25-65

Table 8 reports aggregate hours of work relative to the United States for individuals aged 25-65. The theory predicts that men in Switzerland work as much as in the United States. For all other countries, men work less than in the US with aggregate hours ratios ranging from 0.90 in France to 0.83 in Italy. A comparison between Tables 8 and 9 shows that the labor supply differences late in the life cycle are much larger than the ones observed across all age groups.

[17] We have found that if Spain had the U.S. disability and the U.S. college attainment rate, the Spanish relative labor supply would increase by .10 and .08, respectively. However, the joint effect of these two factors is likely to be lower than .18 as disability tends to be more prevalent among the non-college population.

7 Discussion on taxes and labor supply

7.1 Rebating tax receipts with lump sum transfers

At first sight, our findings imply that labor supply is much less responsive to taxes than previous papers in the literature (Prescott (2002, 2004) and Ohanian et. al. (2008)). While Prescott (2002) finds that differences in taxes in France and the United States account for virtually all of the 30-percent difference in labor input per person between these countries, our findings only account for a 10-percent difference in labor supply. A deeper comparison of the results, should consider that Prescott assumes that all tax receipts are distributed lump-sum back to households based on the idea that public goods are good substitutes for private consumption (eg. public schools and hospitals are good substitutes for private schools and hospitals). This assumption is crucial for generating a large response of labor supply to tax changes, as discussed by Prescott (2002, 2004).[18] On the other hand, our quantitative experiments assume that none of the tax receipts are rebated back to consumers. Hence, we now simulate in our model economy the French and the U.S. policies under the assumption that all tax receipts are rebated back to households. We find that the aggregate labor supply under French policies is now 24% lower than under U.S. policies, a result that is close to the findings in Prescott (2002, 2004) and more than twice the value of 10% that we obtained in our baseline experiment with no rebates.

7.2 Assuming linear wages

The modeling of non-linear wages allows the baseline economy to match reasonably well the decrease in labor hours after the age of 50 in the U.S. data. A natural question is whether this feature matters for the effects of policies on labor supply. To investigate this issue, we now consider a new baseline economy with linear wages. As before, we recalibrate β to match the asset to income ratio, W to match average earnings, and the international interest rate is set so that the baseline economy with U.S. policies has zero net capital flows. French policies are then introduced into the new baseline economy with linear wages. Two main findings emerge: First, aggregate hours worked in France relative to the U.S. are approximately the same as in the economy with non-linear wages (10% lower).[19] Second, however, non-linear wages matter importantly for labor supply responses after age 60. Table 10 shows that, after age 60, labor supply in France relative to the U.S. is much higher in the experiment with linear wages: While for the age group 60 to 64 labor supply in France is 0.56 with linear wages, it is the much lower 0.37 with non-linear wages. The larger change under non-linear wages is accounted for by labor supply responses along the extensive margin.

[18] Tax rebates eliminate the wealth effects of tax changes, which affect labor supply in the opposite direction of the substitution effect.

[19] This finding is consistent with the message in Erosa, Fuster, and Kambourov (2011) who show that non-linear wages do not affect the quantitative response of labor supply to a permanent tax change, though they amplify substantially the response to temporary wage and tax variations.

7.3 Assuming proportional taxes

Relative to the literature analyzing the role of taxation on labor supply differences across countries, a distinguishing feature of our paper is that we model the progressivity of taxes on earnings. To investigate the importance of this feature, we computed in the baseline economy the average tax rate on labor earnings. We then compute a new baseline economy with a flat tax on labor earnings equal to the average tax in the original baseline economy. We then repeat this procedure in France. We find that replacing the progressive tax system on earnings with a flat tax has small effects on labor supply in the U.S. economy (about a 2% increase). On the other hand, the increase in labor supply is much larger in France, with an increase in the hours worked per person aged 25-65 of 6.7%. This finding is due to the fact that the progressivity of the taxation of earnings is much higher in France than in the U.S. We thus conclude that progressivity of the tax system matters for understanding labor supply differences across countries.

8 Concluding Remarks

Table 1: Labor Market Participation, Men, SHARE 2004.

	Age				
	50-54	55-59	60-64	65-69	70-74
			Switzerland		
Working full time	79.4	82.1	56.0	28.1	11.5
Working part time	10.3	5.1	6.7	8.8	4.9
Not working	10.3	12.8	37.3	63.1	83.6
			Sweden		
Working full time	90.1	76.4	53.6	7.1	1.7
Working part time	2.5	4.2	10.8	11.7	68.8
Not working	7.4	19.4	35.6	81.2	91.5
			Denmark		
Working full time	79.9	69.7	46.2	7.6	0.0
Working part time	1.8	4.2	5.3	16.3	11.0
Not working	18.3	26.1	48.5	76.1	89.0
			Netherlands		
Working full time	84.6	68.7	23.3	2.0	2.1
Working part time	2.5	5.1	3.3	4.0	2.9
Not working	12.9	26.2	73.4	94.0	95.0
			Germany		
Working full time	77.1	70.9	25.9	6.5	0.7
Working part time	2.4	2.5	6.2	4.0	2.0
Not working	20.5	26.6	67.9	89.5	97.3
			Spain		
Working full time	71.2	60.4	28.0	2.5	1.8
Working part time	7.2	8.7	8.7	0.6	0.6
Not working	21.6	30.9	63.3	96.9	97.6
			Italy		
Working full time	62.4	45.8	19.2	8.3	4.0
Working part time	19.5	5.3	7.0	3.6	1.2
Not working	18.1	48.9	73.8	88.1	94.8
			France		
Working full time	76.2	54.8	11.7	2.3	0.6
Working part time	3.0	1.9	3.1	0.6	0.0
Not working	20.8	43.3	85.2	97.1	99.4
			United States		
Working full time	77.6	70.8	46.4	25.1	12.3
Working part time	3.3	4.0	9.3	10.9	11.6
Not working	19.1	25.2	44.3	64.0	76.1

Note: Authors' computations from the 2004 SHARE for the European countries and the 2004 HRS for the U.S.

Table 2: Program Participation, Men, SHARE 2004.

	Age				
	50-54	55-59	60-64	65-69	70-74
			Switzerland		
SS retired worker benefits	0.0	1.3	2.5	88.5	98.3
SS survivor's benefits	0.0	1.3	0.0	1.6	3.4
DI benefits	5.9	10.1	11.3	3.3	6.8
UI benefits	7.1	1.3	2.5	1.6	1.7
Private pension benefits	0.0	6.3	25.0	37.7	55.9
			Sweden		
SS retired worker benefits	1.9	12.4	21.1	83.3	99.0
SS survivor's benefits	0.0	1.5	3.2	30.7	23.3
DI benefits	11.7	13.5	15.5	14.0	13.1
UI benefits	0.5	0.8	2.0	15.3	14.2
Private pension benefits	5.3	4.9	11.2	20.5	10.8
			Denmark		
SS retired worker benefits	0.0	3.6	34.1	76.1	99.0
SS survivor's benefits	0.0	0.0	0.7	0.0	3.7
DI benefits	12.6	14.4	13.3	7.6	0.0
UI benefits	9.0	13.7	4.4	1.1	0.0
Private pension benefits	1.2	0.7	14.1	39.1	39.0
			Netherlands		
SS retired worker benefits	0.0	1.0	2.1	83.2	99.3
SS survivor's benefits	1.2	1.0	2.5	0.0	0.7
DI benefits	12.3	17.1	20.0	6.4	0.0
UI benefits	3.7	6.0	5.8	1.0	0.0
Private pension benefits	0.0	5.4	43.3	73.8	79.3
			Germany		
SS retired worker benefits	1.9	5.2	46.6	91.4	96.1
SS survivor's benefits	0.0	0.9	0.4	1.8	1.3
DI benefits	5.4	8.0	7.6	1.1	2.0
UI benefits	11.6	9.9	8.0	0.0	0.0
Private pension benefits	0.0	1.4	10.2	22.3	28.1
			Spain		
SS retired worker benefits	2.8	9.9	34.8	88.1	91.4
SS survivor's benefits	0.0	0.0	0.0	0.6	0.0
DI benefits	13.4	10.6	11.0	5.0	4.3
UI benefits	6.3	4.6	8.4	0.0	0.0
Private pension benefits	1.4	0.0	3.2	0.0	0.6
			Italy		
SS retired worker benefits	6.8	35.1	66.1	81.3	86.1
SS survivor's benefits	0.0	0.4	0.4	0.0	1.2
DI benefits	6.9	7.5	7.0	8.9	5.8
UI benefits	0.7	1.3	1.3	0.0	0.0
Private pension benefits	0.0	2.2	5.7	5.2	6.9
			France		
SS retired worker benefits	2.1	14.3	70.6	96.5	99.0
SS survivor's benefits	0.3	0.4	0.0	2.3	1.9
DI benefits	6.2	7.5	0.5	4.1	3.2
UI benefits	5.2	7.5	6.4	1.2	0.0
Private pension benefits	0.7	4.5	47.1	66.1	74.2
			United States		
SS retired worker benefits	0.0	0.0	26.9	85.9	95.3
SS survivor's benefits	0.0	0.0	0.4	0.1	0.1
DI benefits	5.7	9.0	12.9	0.0	0.0
UI benefits	5.1	3.8	3.4	1.0	0.2
Private pension benefits	4.8	13.2	27.4	45.2	48.5

Notes: Authors' computations from the 2004 SHARE for the European countries. The evidence for the U.S. is from Coile and Gruber (2004) for the U.S.

Table 3: Stochastic Process of Hourly Wages, United States: Model vs. Data

	Non-college		College	
	Data	Model	Data	Model
Var(α)	0.10	0.11	0.07	0.07
ρ	0.94	0.96	0.97	0.97
Var(η)	0.02	0.03	0.02	0.02

Table 4: Parameters on Preferences and Pension Formula

Parameter	Value	Variable	Target	Result
$\overline{W}$	2.9	Ratio $\overline{W}$ to Males average earnings	.80	.80
α	0.5	Fraction of hours worked	42%	42%
β	0.983	Asset to income ratio	3.0	2.93

Table 5: Consumption, Investment, Capital Income, and Earnings Taxes

	US	Spain	France	Switzerland	Netherlands	Italy
			Consumption, Investment, and Capital Income Taxes			
τ^c	0.075	0.196	0.255	0.153	0.238	0.226
τ^I	0.032	0.089	0.145	0.085	0.155	0.150
τ^k	0.232	0.190	0.193	0.216	0.202	0.216
			Earnings Taxes			
Min. taxed ($\frac{y}{W}$)	0.02	0.44	0.00	0.13	0.40	0.44
Min. Tax	0.0	0.0	0.076	0.0	0.0	0.0
Max. Tax	0.354	0.383	0.468	0.364	0.463	0.406
$\overline{\tau}(0.5)$	0.118	0.022	0.079	0.057	0.043	0.051
$\overline{\tau}(1.0)$	0.174	0.112	0.146	0.112	0.137	0.168
$\overline{\tau}(3.0)$	0.272	0.267	0.310	0.246	0.349	0.329

Notes: The consumption, investment, and capital income taxes are taken from McDaniel (2007) while the earnings taxes are computed by the authors from OECD data. W indicates average earnings in the economy while y indicates individual earnings. $\overline{\tau}(x)$ denotes the average tax on earnings for an individual whose earnings are a fraction x of average earnings.

Table 6: Social Security Taxes

	Public Pensions		Occupational Pensions	
US	0.124	if $y \in [0, 2.47W]$		
	0	if $y > 2.47W$		
Spain	0.283	if $y \in [0, 1.64W]$		
	0	if $y > 1.64W$		
France	0.1575	if $y \in [0, W]$	0.095	if $y \in [0, W]$
	0.027	if $y > W$	0.22	if $y \in (W, 8W]$
			0	if $y > 8W$
Italy	0.27			
Netherlands	0.238	if $y \in [0, 0.79W]$		
	0.0585	if $y \in (0.79W, 1.16W]$		
	0	if $y > 1.16W$		
Switzerland	0.101		0	if $y \in [0, 0.27W]$
			τ_j	if $y \in (0.27W, 1.07W]$
			0	if $y > 1.07W$

Notes: Social security taxes are computed by the authors from OECD data. W indicates average earnings in the economy while y indicates individual earnings. τ^{ss} for public pensions in Switzerland equals zero if $y < 0.27W$ and the individuals is older than the normal retirement age. τ_j^{ss} for occupational pensions in Switzerland depends on the individual's age: 0.07 until 35, 0.10 for the 35-45 age group, 0.15 for the 45-55 age group, 0.18 for the 55-65 age group and 0 for those older than 65.

Table 7: The Tax Wedge, μ

	US	Spain	France	Switzerland	Netherlands	Italy
$\mu(0.5)$	0.63	0.48	0.47	0.55	0.49	0.41
$\mu(1.0)$	0.57	0.39	0.39	0.47	0.52	0.32
$\mu(2.0)$	0.51	0.54	0.28	0.50	0.43	0.25
$\mu(3.0)$	0.59	0.50	0.21	0.44	0.36	0.23

Note: $\mu(x) = \frac{1-\tau'_E(x)-\tau'_{ss}(x)}{1+\tau^c}$ denotes the tax wedge for an individual whose earnings are a fraction x of average earnings.

Table 8: Annual Hours Worked per Person, Model, Age 25-65: Actual Hours and Relative to the United States.

United States	2025	1.00
Switzerland	1998	0.99
Netherlands	1769	0.87
Spain	1803	0.89
Italy	1682	0.83
France	1817	0.90

Table 9: Hours Worked, Men, Model vs Data (HRS and SHARE 2006): All, Relative to the US

	Model			Data (HRS and SHARE 2006)		
Age	55-59	60-64	65-69	55-59	60-64	65-69
Switzerland						
Baseline	0.95	0.96	1.52	1.23	1.26	0.71
US Taxes	0.95	0.96	1.55			
US Fraction of College	0.95	0.96	1.52			
Disability	0.93	0.94	1.47			
Netherlands						
Baseline	0.65	0.43	0.17	0.84	0.49	0.16
US Taxes	0.62	0.49	0.26			
US Fraction of College	0.66	0.43	0.17			
Disability	0.72	0.50	0.21			
Spain						
Baseline	0.83	0.53	0.03	0.76	0.66	0.11
US Taxes	0.85	0.54	0.04			
US Fraction of College	0.87	0.62	0.04			
Disability	0.94	0.63	0.04			
Italy						
Baseline	0.60	0.36	0.39	0.65	0.44	0.29
US Taxes	0.66	0.42	0.48			
US Fraction of College	0.66	0.40	0.35			
Disability	0.59	0.34	0.36			
France						
Baseline	0.94	0.37	0.44	0.67	0.29	0.09
US Taxes	0.98	0.42	0.46			
US Fraction of College	0.95	0.38	0.44			
Disability	0.93	0.36	0.42			

Table 10: Hours Worked in France Relative to the United States, Model: Linear vs. Non-linear Wages.

Age Group	50-54	55-59	60-64	65-69	70-74
Linear Wages	0.91	0.93	0.56	0.58	0.56
Non-linear Wages	0.93	0.94	0.37	0.44	0.42

Figure 1: Mean Annual Hours Worked, 2006, SHARE, Men: All, Extensive, and Intensive Margin.

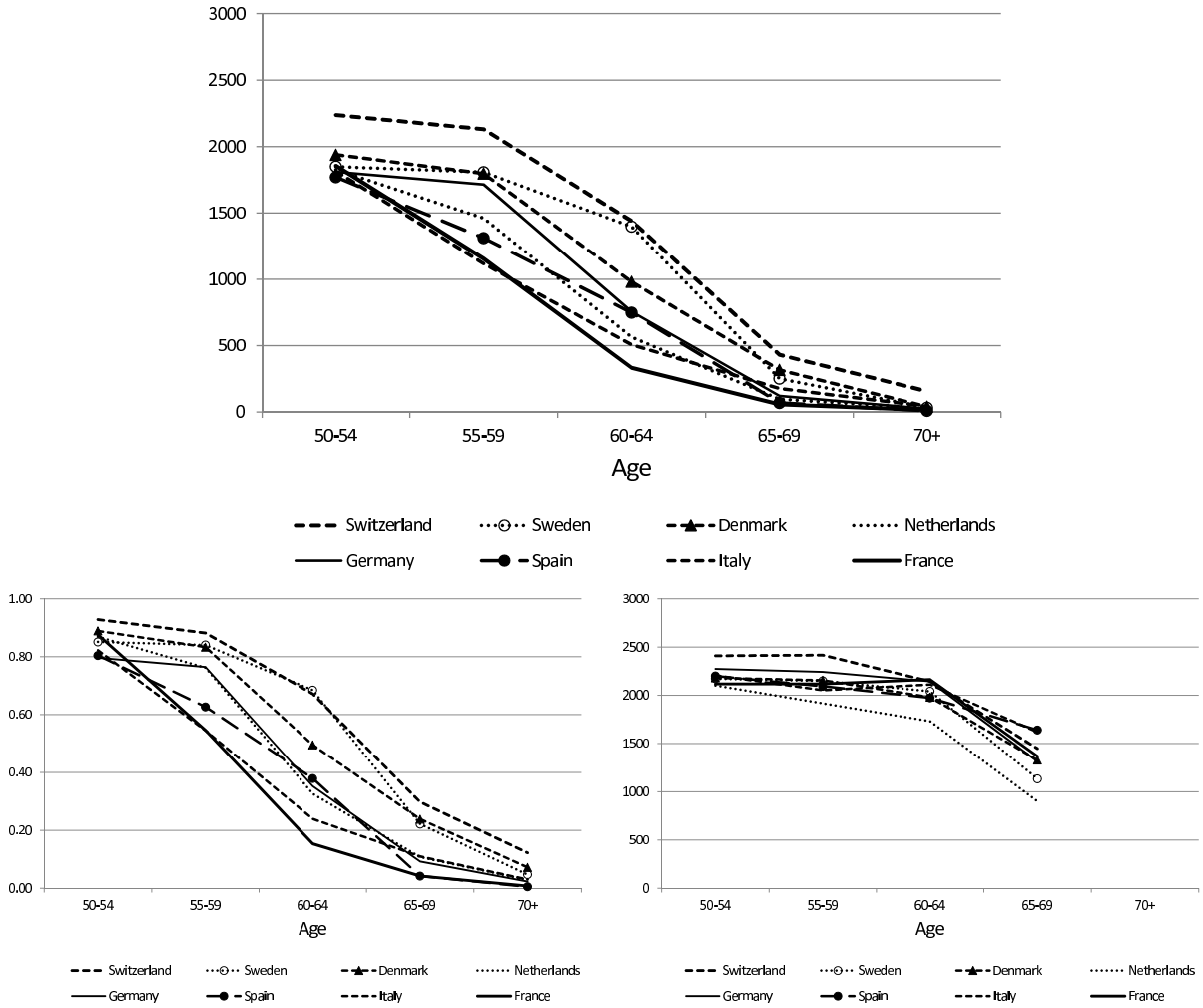


Figure 2: Mean Annual Hours Worked, 2006, SHARE, Men: Non-college and College.

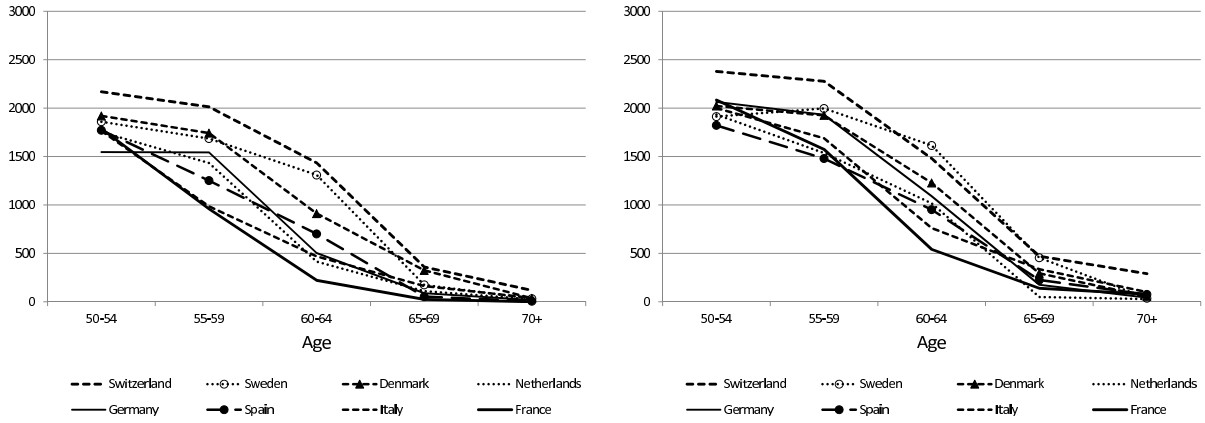


Figure 3: Mean Annual Hours Worked, United States vs. Europe, HRS and 2006 SHARE, Men: All, Non-college, and College.

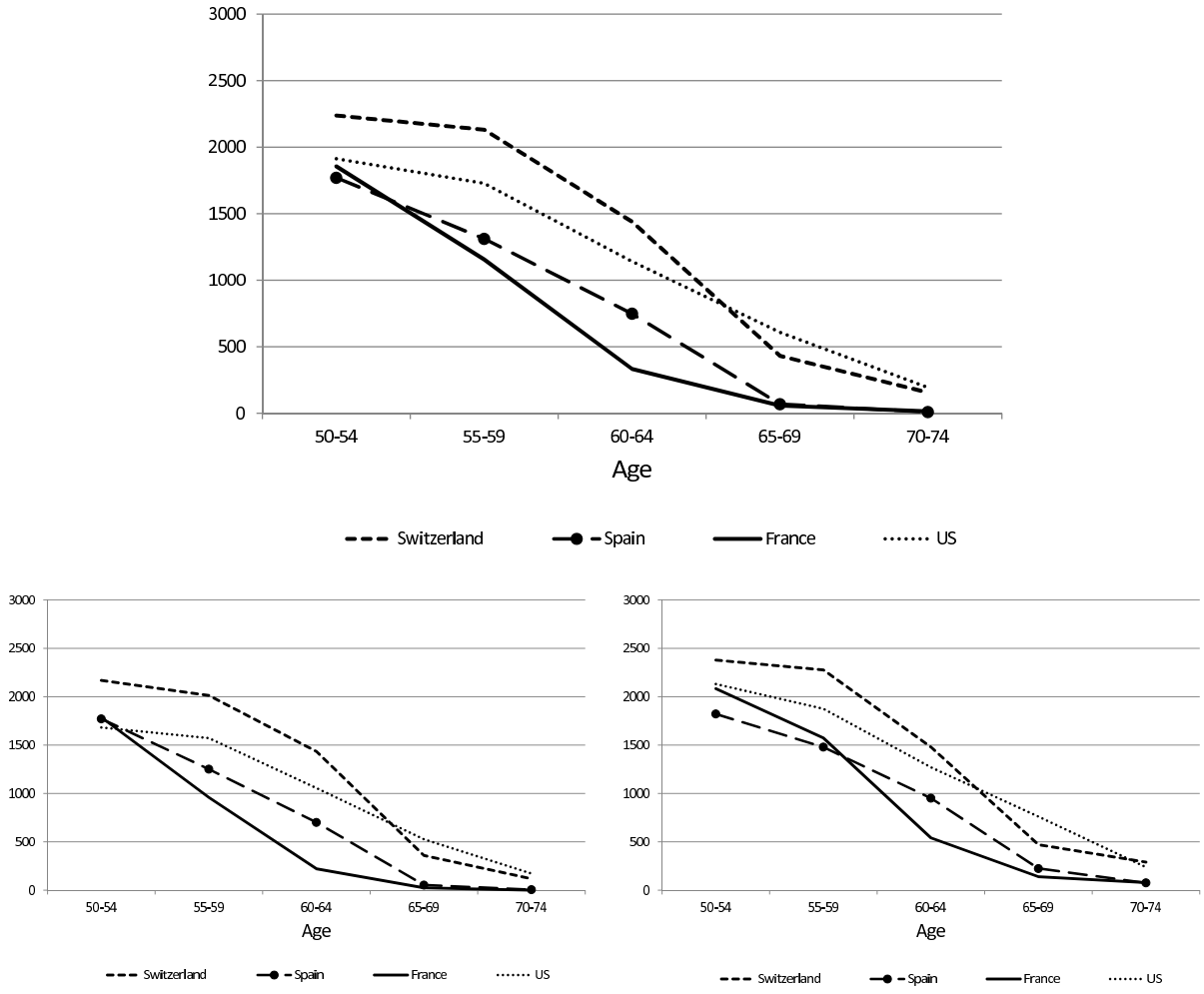


Figure 4: Disability Enrollment, SHARE, Men, Age 50-64: 2004 and 2006.

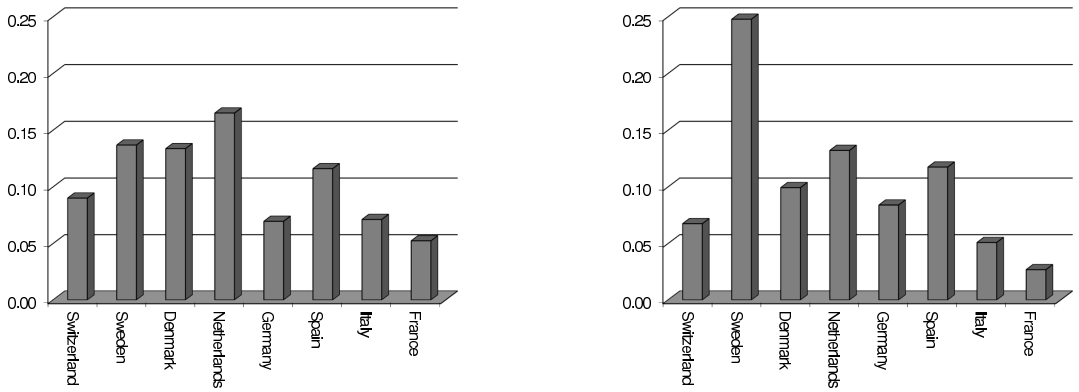


Figure 5: SHARE, 2006, Men, Age 50-64, over the Last Two Years: Disability Enrollment.

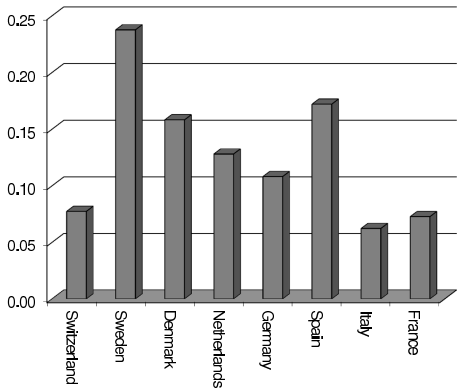


Figure 6: The Life-cycle Deterministic Component of Wages, by Education, Model vs. Data.

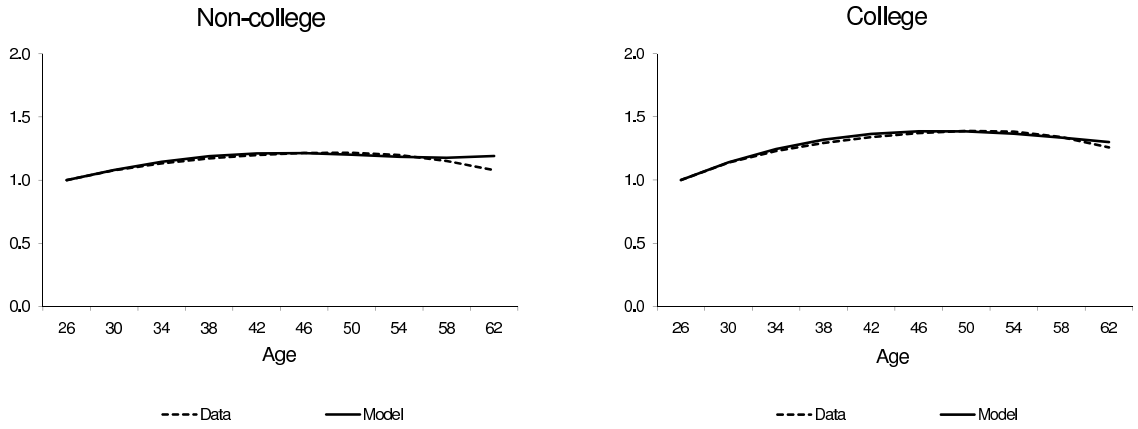


Figure 7: Mean Annual Hours Worked, United States, Data vs. Model: Non-college and College.

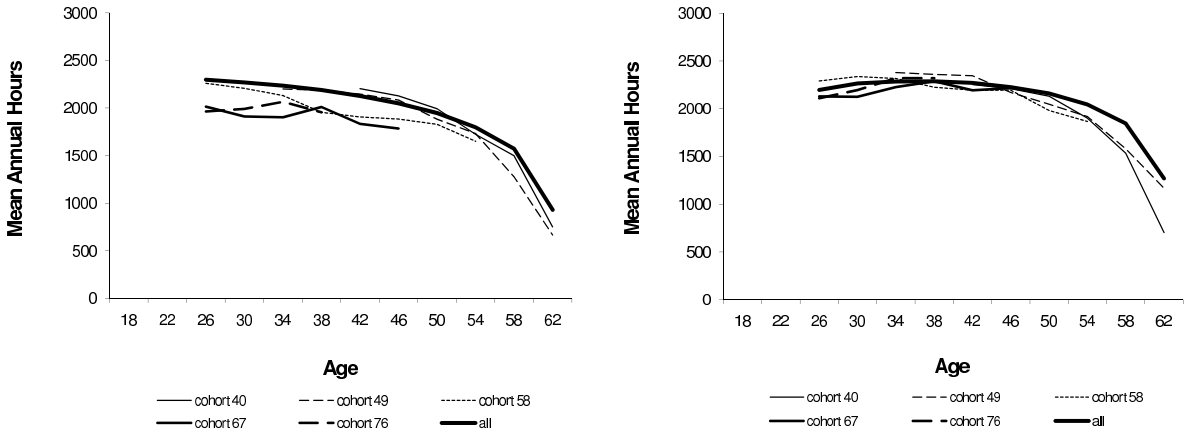


Figure 8: Mean Annual Hours Worked, United States, Intensive Margin, Data vs. Model: Non-college and College.

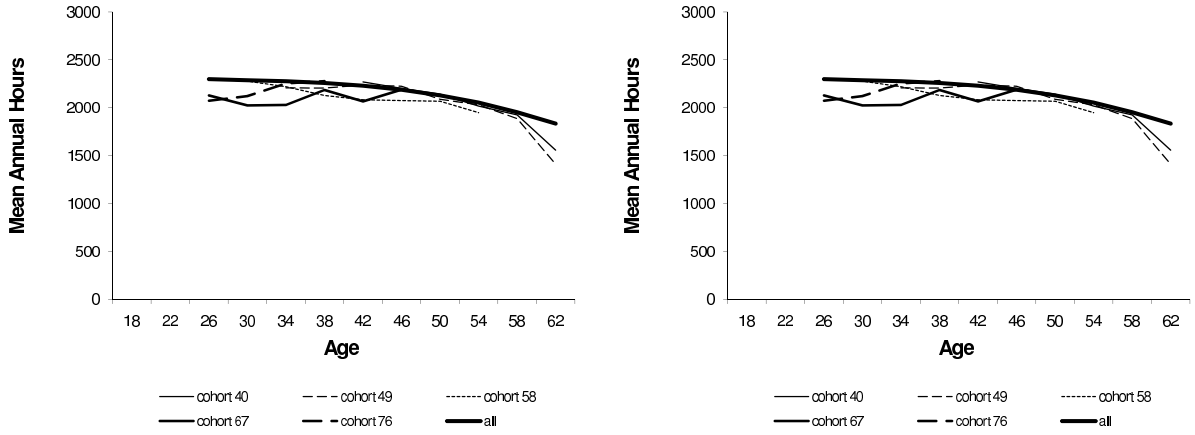


Figure 9: Mean Annual Hours Worked, United States, Extensive Margin, Data vs. Model: Non-college and College.

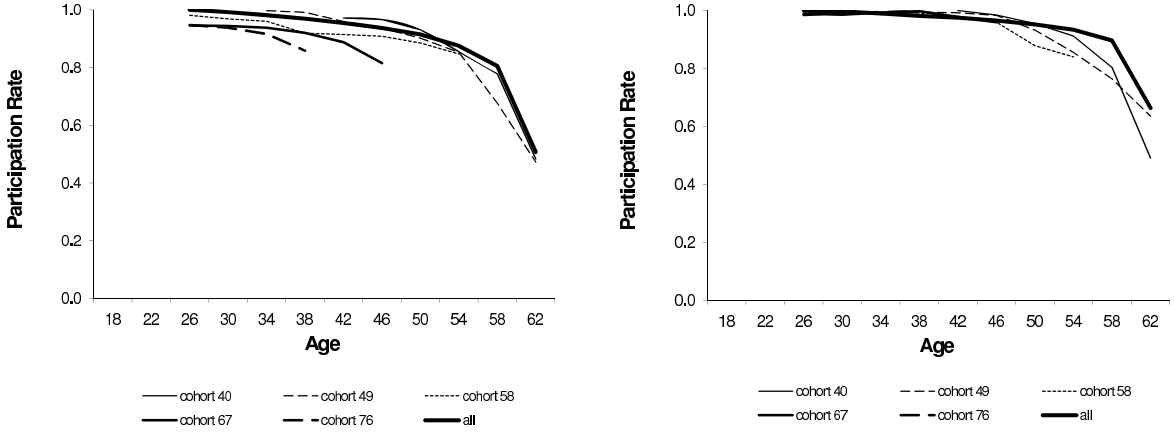


Figure 10: Mean Annual Hours Worked, United States, Age 50-74, Data vs. Model: Non-college and College.

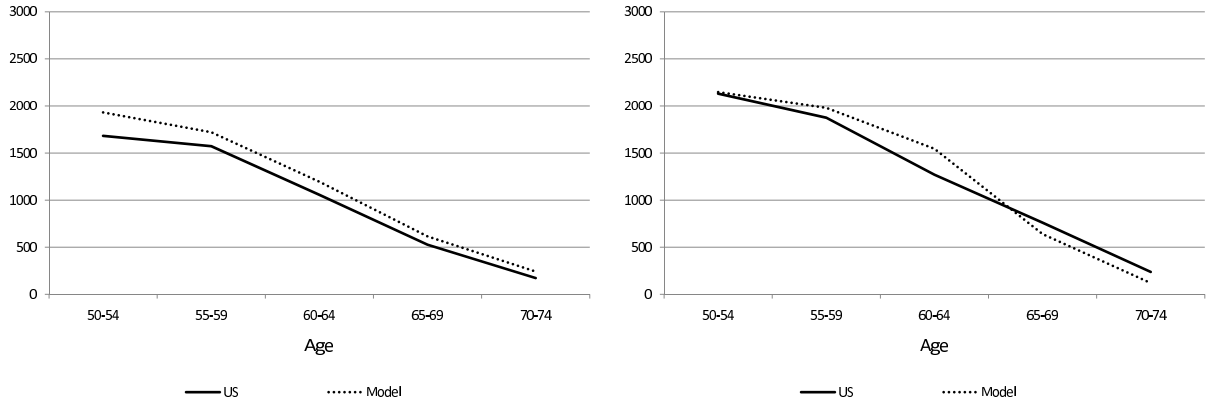


Figure 11: Annual Hours Worked, All, Model vs. Data: Share 2006.

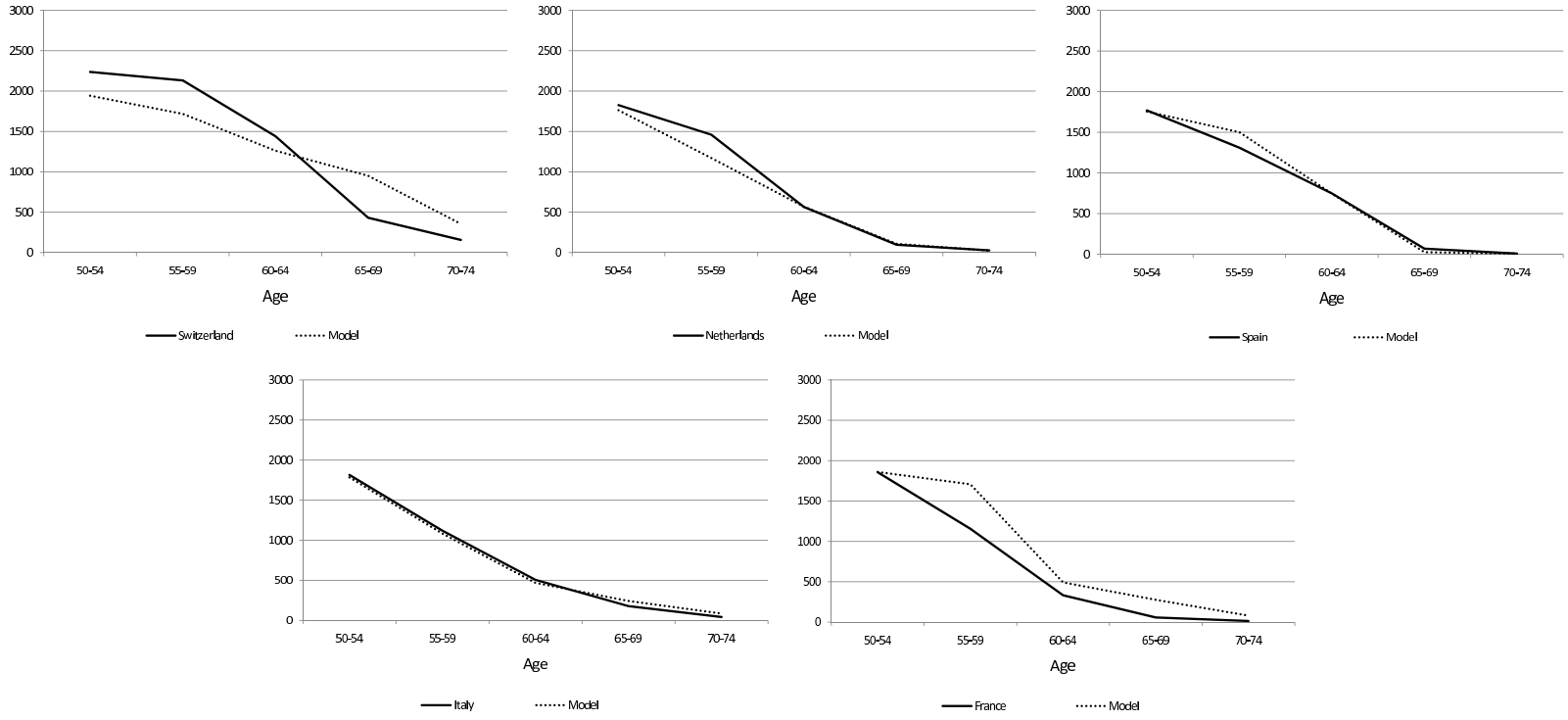


Figure 12: Annual Hours Worked, Non-college, Model vs. Data: Share 2006.

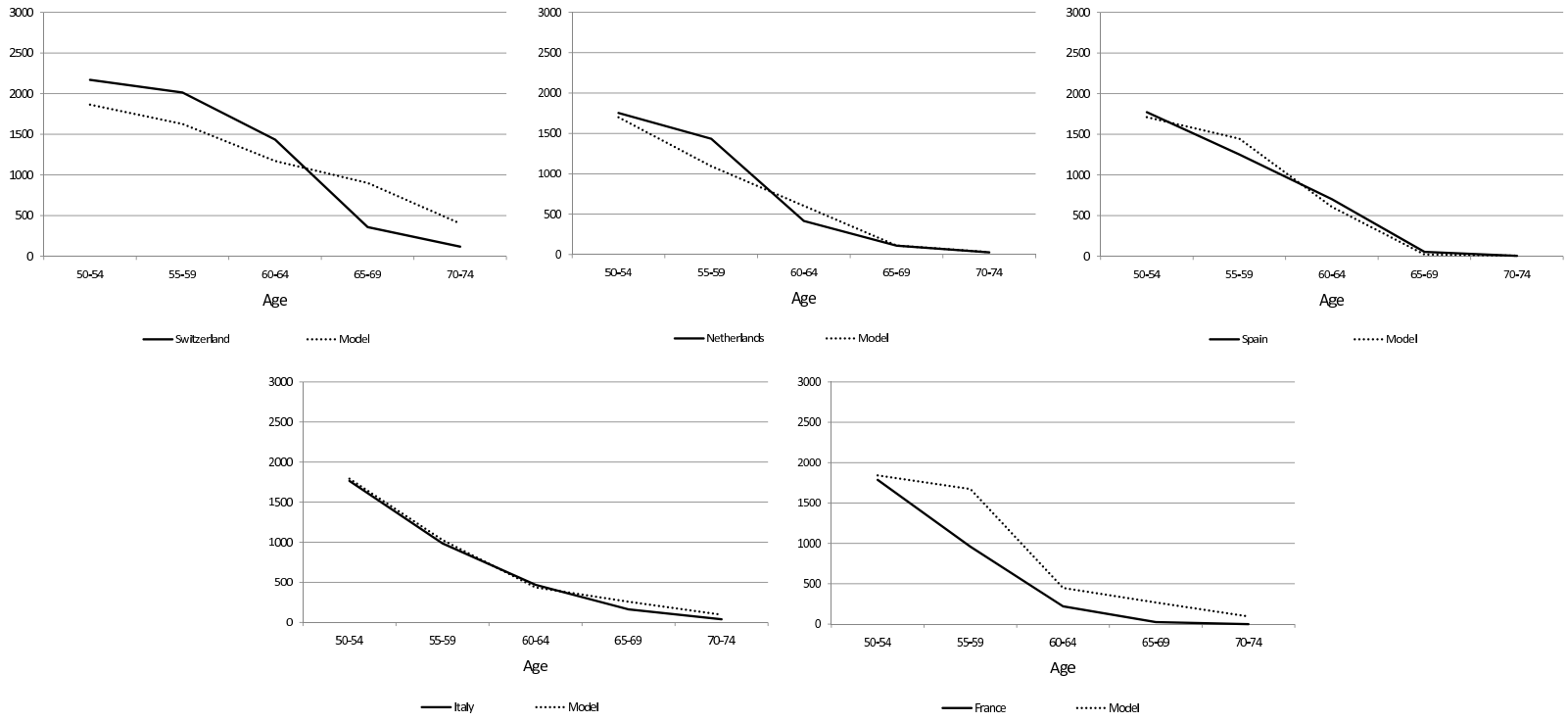
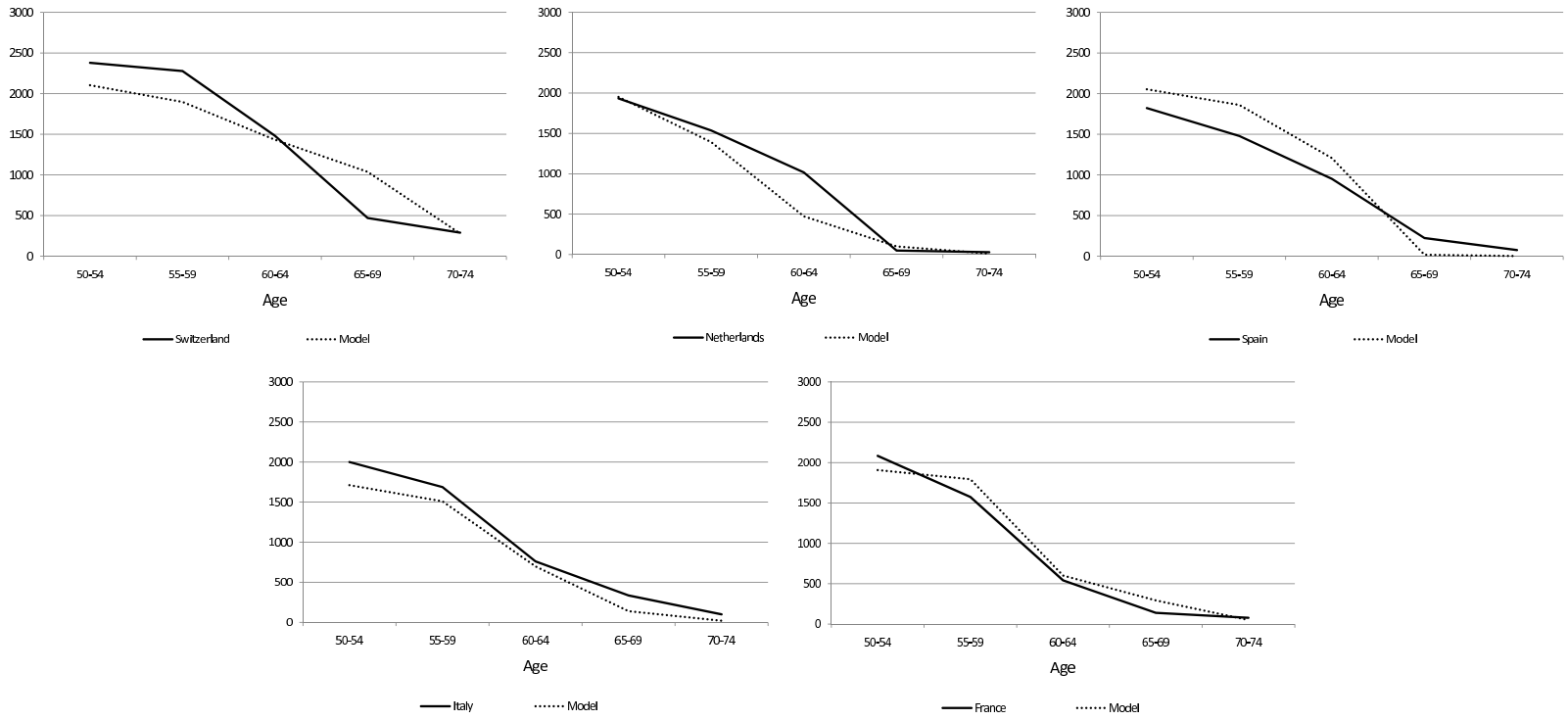


Figure 13: Annual Hours Worked, College, Model vs. Data: Share 2006.



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APPENDICES

I The Survey of Health and Retirement in Europe (SHARE).

The Survey of Health, Ageing, and Retirement in Europe (SHARE) is a European cross-national panel of micro data on health and socio-economic status which was administered in 2004, 2006, 2008, and 2010. It has data on 11 countries and more than 45,000 individuals aged 50 or older. The survey provides a balanced representation of various European regions: Scandinavia − Denmark and Sweden; Central Europe − Austria, France, Germany, Switzerland, Belgium, and the Netherlands; and Mediterranean − Spain, Italy, and Greece. Israel, the Czech Republic, and Poland were added in the 2006 wave. The dataset provides detailed longitudinal individual data on employment, (sources of) income, (sources of) transfers, health, consumption, and assets. It is harmonized with the U.S. Health and Retirement Study (HRS) and the English Longitudinal Study of Ageing (ELSA).

We are using the 2004 and 2006 waves − the 2008 wave has been only recently released while the 2010 wave will be released in the near future.

I.1 Countries

The 2004 wave includes the following countries: Austria, Germany, Sweden, Netherlands, Spain, Italy, France, Denmark, Greece, Switzerland, Belgium, and Israel. The 2006 wave includes the following countries: Austria, Germany, Sweden, Netherlands, Spain, Italy, France, Denmark, Greece, Switzerland, Belgium, Czech Republic, Poland, and Ireland. We exclude Israel, the Czech Republic, Poland, and Ireland since they are covered in only one of the waves. In addition, we also exclude Austria, Greece, and Belgium − the facts from these countries do not change the main message of the paper while excluding them makes cleaner the presentation of the facts. The facts on all the available countries are available from the authors upon request.

I.2 Hours Worked

I.2.1 2004

In the 2004 questionnaire, individuals are asked detailed questions about their main and secondary job in the last month in which they worked. Questions regarding work hours are asked to those individuals who are currently employed or have worked in the last four weeks or are temporary away from their work. We use information on (i) total hours worked per week (EP013) and (ii) months worked in the job (EP014) in order to compute total annual hours for each individual. If an individual has a secondary job, then we add the hours reported on the second job. We drop those who refused to answer the questions or answered that they do not know.

- **EP013 TOTAL HOURS WORKED PER WEEK:** [Regardless of your basic contracted hours] [how many/How many] hours a week do you usually work in this job, excluding meal breaks [but including any paid or unpaid overtime]?
- **EP014 MONTHS WORKED IN THE JOB (NUMBER):** How many months a year are you normally working in this job (including paid holidays)?

We use the information on annual hours worked in order to classify individuals' labor market participation: (i) not working: 0 hours, (ii) working part time: 1-1040 hours, and (iii) working full time: more than 1040 hours.

I.2.2 2006

In the 2006 questionnaire, individuals are asked detailed questions about their main job. Questions regarding work hours are asked to those individuals who are currently employed or have worked in the last four weeks. We use information on (i) total hours worked per week (EP013) and (ii) months worked in the job (EP014) in order to compute total annual hours for each individual. If an individual reports also a secondary job, then we add the hours reported on the second job using the information on (i) total hours worked per week (in the second job EP321) and (ii) months worked in the second job (EP322). We drop those who refused to answer the questions or answered that they do not know.

- **EP013 TOTAL HOURS WORKED PER WEEK:** [Regardless of your basic contracted hours] [how many/How many] hours a week do you usually work in this job, excluding meal breaks [but including any paid or unpaid overtime]?
- **EP014 MONTHS WORKED IN THE JOB (NUMBER):** How many months a year are you normally working in this job (including paid holidays)?
- **EP321 TOTAL HOURS WORKED PER WEEK SECOND JOB:** [Regardless of your basic contracted hours] [how many/How many] hours a week do you usually work in this job, excluding meal breaks [but including any paid or unpaid overtime]?
- **EP014 MONTHS WORKED IN SECOND JOB (NUMBER):** How many months a year are you normally working in this job (including paid holidays)?

We use the information on annual hours worked in order to classify individuals' labor market participation: (i) not working: 0 hours, (ii) working part time: 1-1040 hours, and (iii) working full time: more than 1040 hours.

I.3 Disability

I.3.1 2004

In the 2004 questionnaire, individuals are asked detailed questions about their income sources in the year 2003. In order to identify disability insurance recipients, we use information provided in question EP071.

- **EP071 INCOME SOURCES IN LAST YEAR:** Please look at card 24.Have you received income from any of these sources in the year 2003? IWER: CODE ALL THAT APPLY.

  1. Public old age pension
  2. Public early retirement or pre-retirement pension
  3. Public disability insurance
  4. Public unemployment benefit or insurance
  5. Public survivor pension from your spouse or partner
  6. Public invalidity or incapacity pension
  7. War pension
  8. Private (occupational) old age pension
  9. Private (occupational) early retirement pension
  10. Private (occupational) disability or invalidity insurance
  11. Private (occupational) survivor pension from your spouse or partner's job
  96. None of these

We classify as disability insurance recipients those who reply that they have received [3.] Public disability insurance, or [6.] Public invalidity or incapacity pension, or [10.] Private (occupational) disability or invalidity insurance.

We use the information on income sources (EP071) in order to classify individuals' program participation: (i) SS retired worker benefits: EP071=1, 2, or 7; (ii) SS survivor's benefits: EP071=5 or 11; (iii) DI benefits: EP071=3, 6, or 10; (iv) UI benefits: EP071=4; and (v) Private pension benefits: EP071= 8 or 9.

I.3.2 2006

In the 2006 questionnaire, individuals are asked detailed questions about their income sources in the year 2005. In order to identify disability insurance recipients, we use information provided in questions EP071 and EP324.

- **EP071 INCOME FROM PUBLIC PENSIONS IN LAST YEAR:** Please look at card 29. Have you received income from any of these sources in the year [previous year]? IWER: CODE ALL THAT APPLY.

  1. Public old age pension
  2. Public old age supplementary pension or public old age second pension
  3. Public early retirement or pre-retirement pension
  4. Main public disability insurance pension, or sickness benefits
  5. Secondary public disability insurance pension, or sickness benefits
  6. Public unemployment benefit or insurance
  7. Main public survivor pension from your spouse or partner
  8. Secondary public survivor pension from your spouse or partner
  9. Public war pension
  10. Public long-term care insurance
  96. None of these

- **EP324 OCCUPATIONAL PENSION INCOME SOURCES:** Please look at card 30. Have you received income from any of these sources in the year [previous year]? IWER: CODE ALL THAT APPLY.

  1. Occupational old age pension from your last job
  2. Occupational old age pension from a second job
  3. Occupational old age pension from a third job
  4. Occupational early retirement pension
  5. Occupational disability or invalidity insurance
  6. Occupational survivor pension from your spouse or partner's job
  96. None of these

We classify as disability insurance recipients those who reply in question EP071 that they have received [4.] Main public disability insurance pension, or sickness benefits, or [5.] Secondary public disability insurance pension, or sickness benefits, or reply in question EP324 [5.] Occupational disability or invalidity insurance.

We use the information on income sources (EP071 and EP324) in order to classify individuals' program participation: (i) SS retired worker benefits: EP071=1, 2, 3, 9, or 10; (ii) SS survivor's benefits: EP071=7 or 8, or EP324=6; (iii) DI benefits: EP071=4 or 5, or EP324=5; (iv) UI benefits: EP071=6; and (v) Private pension benefits: EP324=1, 2, 3, or 4.

The 2006 questionnaire also asks individuals the following question regarding public benefits since the last interview two years ago (in 2004):

- **EP110 RECEIVED PUBLIC BENEFITS:** We would also like to know about times since our last interview through the present in which you received public benefits, such as early retirement benefits or unemployment benefits. Please look at card 23. Since [month year previous interview] have you received any of the benefits listed on this card? IWER: CODE ALL THAT APPLY.

    1. old age pension benefits
    2. early retirement pension benefits
    3. unemployment benefits
    4. sickness benefits
    5. disability insurance benefits
    6. social assistance
    96. None of these

We use this information in order to construct an alternative measure of the fraction of individuals receiving disability insurance payments. We classify as disability insurance recipients those who reply in question EP110 that they have received [4.] sickness benefits, or [5.] disability insurance benefits.

II The Health and Retirement Study (HRS).

The Health and Retirement Study (HRS) is conducted by the Institute for Social Research (ISR) at the University of Michigan in Ann Arbor and supported by the National Institute on Aging (NIA). The study surveys, over every two years, more than 20,000 Americans over the age of 50. It collects detailed longitudinal individual data on variables such as income, work, assets, pension plans, health insurance, disability, physical health and functioning, cognitive functioning, and health care expenditures. We are using the 2004 wave.

II.1 Hours Worked

In the 2004 questionnaire, individuals are asked detailed questions about their main job. We use information on (i) total hours worked per week[20] (J172/Q3509/G44) and (ii) weeks worked during the year (J179/Q3519/G47) in order to compute total annual hours for each individual. If an individual reports also another job, then we add the hours reported on the other job using the information on (i) total hours worked per week (in the other job J556/Q3840/G129) and (ii) weeks worked in the other job (J557/Q3841/G130). We drop those who refused to answer the questions or answered that they do not know.

- **J172/Q3509/G44 TOTAL HOURS WORKED PER WEEK:** How many hours a week do you usually work [on this job/in this business]?
- **J179/Q3519/G47 WEEKS WORKED:** Counting paid vacations as weeks of work, how many weeks a year do you usually work on this job?
- **J556/Q3840/G129 TOTAL HOURS WORKED PER WEEK OTHER JOB:** How many hours a week do you usually work on [this other job/these other jobs]?
- **J557/Q3841/G130 WEEKS WORKED IN OTHER JOB:** Counting paid vacations as weeks of work, how many weeks a year do you usually work on (this other job/these other jobs)?

We use the information on annual hours worked in order to classify individuals' labor market participation: (i) not working: 0 hours, (ii) working part time: 1-1040 hours, and (iii) working full time: more than 1040 hours.

Overall, as seen on Figure A-1, the annual hours worked after the age of 50 in the HRS and the PSID are similar for both non-college and college individuals.

II.2 Disability

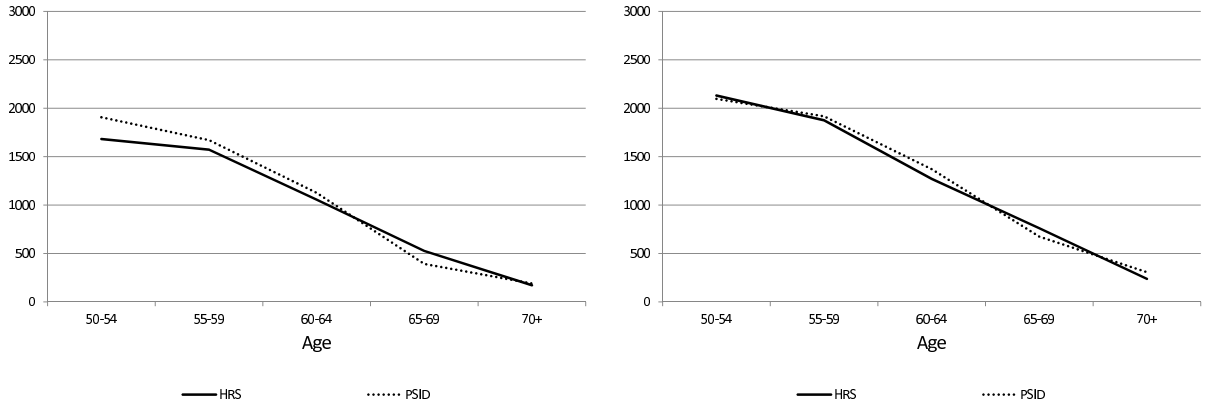
In the 2004 questionnaire, individuals are asked a series of very detailed disability questions.[21] Individuals face different sets of questions depending on whether they have been interviewed before or not.

- **First Interview.** Individuals who are interviewed for the first time are asked detailed questions about whether they have ever applied to the following disability insurance programs: (i) Social Security Disability program (SSDI), (ii) Supplemental Security Income Program (SSIP), (iii) Veterans Administration (VA), (iv) Workers' Compensation Program (WCP), and (v) Other Public Disability Income Program (OPDIP). We classify workers as disability insurance recipients if they reply that they have applied in the past to one of these disability insurance programs, their application was accepter, and they are still receiving the benefits. In addition, we also consider to be disability insurance recipients those who have applied in the past to one of these disability insurance programs, their application was rejected, they appealed, their application was eventually accepted, and they are still receiving the benefits.

[20] The HRS also collects information regarding whether weekly hours worked vary a lot from week to week. If they do vary a lot, then the HRS asks about weekly hours in a relatively short and long week.

[21] The structure of disability questions in the HRS differs from the on in the SHARE.

Figure A-1: Mean Annual Hours Worked, HRS and PSID, Men: Non-college and College.



- **Interviewed in the Past.** Individuals who have been interviewed in the past are divided into three groups depending on whether at the last interview they reported that: (i) they were receiving SSDI, SSI, VA, or WCP benefits, (ii) they had applied for SSDI, SSI, VA, or WCP benefits, and (iii) they were not receiving and had not applied for SSDI, SSI, VA, or WCP benefits. We classify as disability insurance recipients all those who meet at least one of the following criteria:

  (i) For those receiving SSDI, SSI, VA, or WCP benefits at the last interview:
  - still receiving these benefits.

  (ii) For those that had applied for SSDI, SSI, VA, or WCP benefits at the last interview:
  - their application was accepted, and they are still receiving the benefits; or
  - their application was rejected, they appealed, their application was eventually accepted, and they are still receiving the benefits.

  (iii) For those that were not receiving and had not applied for SSDI, SSI, VA, or WCP benefits at the last interview:
  - they applied for benefits since the last interview, their application was accepted, and they are still receiving the benefits; or
  - they applied for benefits since the last interview, their application was rejected, they appealed, their application was eventually accepted, and they are still receiving the benefits.

Finally, the question about the individual's current status also provides information on disability, but this is a less reliable method than the one described above.

- **J005/Q3365/G1 CURRENT STATUS:** Now I'm going to ask you some questions about your current employment situation. Are you working now, temporarily laid off, unemployed and looking for work, disabled and unable to work, retired, a homemaker, or what?

One use this information in order to construct a measure of the fraction of individuals claiming to be disabled. Individual can be classified as disabled if they reply reply in question J005/Q3365/G1 that they are [4.] disabled.

III Social Security Systems: Details.

IV Tables.

Table A-1: Labor Market Participation, Men, SHARE 2004, Non-college.

	Age				
	50-54	55-59	60-64	65-69	70-74
			Switzerland		
Working full time	76.7	84.6	57.8	22.5	13.2
Working part time	11.7	0.0	4.4	5.0	2.6
Not working	11.6	15.4	37.8	72.5	84.2
			Sweden		
Working full time	88.5	72.6	51.6	6.2	1.4
Working part time	3.6	5.1	9.3	10.7	5.5
Not working	7.9	22.3	39.1	83.1	93.1
			Denmark		
Working full time	80.0	74.1	41.0	5.6	0.0
Working part time	1.0	2.4	6.0	14.8	8.9
Not working	19.0	23.5	53.0	79.6	91.1
			Netherlands		
Working full time	79.7	58.8	18.8	2.5	1.2
Working part time	2.9	8.8	2.3	4.9	2.3
Not working	17.4	32.4	78.9	92.6	96.5
			Germany		
Working full time	73.1	59.6	20.2	4.8	0.0
Working part time	3.2	4.4	5.8	3.2	0.9
Not working	23.7	36.0	74.0	92.0	99.1
			Spain		
Working full time	70.1	57.5	27.7	2.8	1.3
Working part time	7.7	9.4	9.5	0.7	0.6
Not working	22.2	33.1	62.8	96.5	98.1
			Italy		
Working full time	59.8	43.1	18.0	6.7	3.6
Working part time	19.7	5.4	5.8	3.9	1.2
Not working	20.5	51.5	76.2	89.4	95.2
			France		
Working full time	76.4	51.0	7.6	0.8	0.7
Working part time	1.9	2.5	2.1	0.0	0.0
Not working	21.7	46.5	90.3	99.3	99.3
			United States		
Working full time	70.6	64.8	44.1	21.3	11.2
Working part time	2.6	3.5	6.9	8.7	9.2
Not working	26.8	31.7	49.0	70.0	79.6

Note: Authors' computations from the 2004 SHARE for the European countries and the 2004 HRS for the U.S.

Table A-2: Labor Market Participation, Men, SHARE 2004, College.

	Age				
	50-54	55-59	60-64	65-69	70-74
			Switzerland		
Working full time	83.9	76.5	53.6	43.8	9.5
Working part time	9.6	11.7	7.1	18.7	9.5
Not working	6.5	11.8	39.3	37.5	81.0
			Sweden		
Working full time	98.3	91.4	58.1	12.1	3.4
Working part time	0.0	1.7	14.5	18.2	13.8
Not working	1.7	6.9	27.4	69.7	82.8
			Denmark		
Working full time	80.6	64.8	55.1	10.5	0.0
Working part time	3.3	7.4	4.1	18.4	15.4
Not working	16.1	27.8	40.8	71.1	84.6
			Netherlands		
Working full time	89.0	77.8	28.4	1.3	3.8
Working part time	2.2	1.9	4.6	2.5	1.9
Not working	8.8	20.3	67.0	96.2	94.3
			Germany		
Working full time	85.3	86.0	36.4	10.2	2.2
Working part time	1.1	0.0	7.0	5.7	4.5
Not working	13.6	14.0	56.6	84.1	93.3
			Spain		
Working full time	70.6	76.9	50.0	0.1	20.0
Working part time	5.9	7.7	0.0	0.0	0.0
Not working	23.5	15.4	50.0	99.9	80.0
			Italy		
Working full time	81.3	73.7	30.4	33.3	12.5
Working part time	18.7	5.2	17.4	0.0	0.0
Not working	0.0	21.1	52.2	66.7	87.5
			France		
Working full time	84.8	68.7	28.6	8.9	0.0
Working part time	6.3	0.0	7.1	2.9	0.1
Not working	8.9	31.3	64.3	88.2	99.9
			United States		
Working full time	84.6	76.4	49.9	32.1	14.2
Working part time	3.4	4.4	12.9	15.0	16.4
Not working	12.0	19.2	37.2	52.9	69.4

Note: Authors' computations from the 2004 SHARE for the European countries and the 2004 HRS for the U.S.

Table A-3: Program Participation, Men, SHARE 2004: Non-college.

	Age				
	50-54	55-59	60-64	65-69	70-74
			Switzerland		
SS retired worker benefits	0.0	0.0	0.0	93.0	97.3
SS survivor's benefits	0.0	2.4	0.0	2.3	2.7
DI benefits	8.1	17.1	13.0	2.3	10.8
UI benefits	10.2	0.0	4.3	2.3	2.7
Private pension benefits	0.0	4.9	21.7	39.5	54.1
			Sweden		
SS retired worker benefits	2.1	14.4	22.2	83.1	99.9
SS survivor's benefits	0.0	1.5	3.2	28.1	21.5
DI benefits	14.1	14.9	16.2	12.4	13.2
UI benefits	0.7	1.0	2.7	17.4	17.4
Private pension benefits	6.3	5.0	10.3	22.5	13.2
			Denmark		
SS retired worker benefits	0.0	3.6	38.1	83.6	99.9
SS survivor's benefits	0.0	0.0	0.0	0.0	1.8
DI benefits	13.7	15.5	11.9	7.2	0.0
UI benefits	8.8	11.9	2.4	1.8	0.0
Private pension benefits	1.0	0.0	14.3	29.1	26.8
			Netherlands		
SS retired worker benefits	0.0	1.4	2.3	84.4	99.9
SS survivor's benefits	0.0	1.4	2.3	0.0	1.2
DI benefits	18.1	23.2	25.8	8.2	0.0
UI benefits	4.8	7.2	5.5	0.0	0.0
Private pension benefits	0.0	3.6	43.8	69.7	74.1
			Germany		
SS retired worker benefits	1.2	6.0	48.6	93.1	97.2
SS survivor's benefits	0.0	0.9	0.6	2.1	1.9
DI benefits	8.4	9.5	9.2	1.6	2.8
UI benefits	13.2	15.5	7.5	0.0	0.0
Private pension benefits	0.0	0.9	10.4	23.4	29.9
			Spain		
SS retired worker benefits	3.4	10.1	34.8	88.0	91.6
SS survivor's benefits	0.0	0.0	0.0	0.7	0.0
DI benefits	16.0	12.4	11.3	4.9	4.5
UI benefits	6.7	3.1	8.5	0.0	0.0
Private pension benefits	0.8	0.0	2.8	0.0	0.6
			Italy		
SS retired worker benefits	7.8	37.0	66.7	82.8	86.7
SS survivor's benefits	0.0	0.5	0.5	0.0	0.6
DI benefits	7.0	8.2	7.7	8.3	6.1
UI benefits	0.9	1.4	1.4	0.0	0.0
Private pension benefits	0.0	2.4	5.3	5.0	6.1
			France		
SS retired worker benefits	2.9	16.2	74.8	97.0	99.9
SS survivor's benefits	0.0	0.5	0.0	2.2	1.5
DI benefits	7.2	9.1	0.7	3.7	3.8
UI benefits	6.7	9.1	6.3	1.5	0.0
Private pension benefits	1.0	5.1	52.4	69.6	72.9

Note: Authors' computations from the 2004 SHARE.

Table A-4: Program Participation, Men, SHARE 2004: College.

	Age				
	50-54	55-59	60-64	65-69	70-74
			Switzerland		
SS retired worker benefits	0.0	3.0	6.3	76.5	99.9
SS survivor's benefits	0.0	0.0	0.0	0.0	5.0
DI benefits	3.1	3.0	6.3	5.9	0.0
UI benefits	3.1	3.0	0.0	0.0	0.0
Private pension benefits	0.0	9.0	28.1	29.4	65.0
			Sweden		
SS retired worker benefits	0.0	3.3	19.4	82.4	99.9
SS survivor's benefits	0.0	1.7	3.2	47.1	33.3
DI benefits	5.1	8.3	12.9	23.5	13.3
UI benefits	0.0	0.0	0.0	5.9	0.0
Private pension benefits	1.7	5.0	14.5	5.9	0.0
			Denmark		
SS retired worker benefits	0.0	3.7	27.5	64.9	99.9
SS survivor's benefits	0.0	0.0	2.0	0.0	7.7
DI benefits	10.9	13.0	15.7	8.0	0.0
UI benefits	9.4	16.7	7.8	0.0	0.0
Private pension benefits	1.6	1.9	13.7	54.1	65.4
			Netherlands		
SS retired worker benefits	0.0	0.6	1.8	82.1	98.1
SS survivor's benefits	2.2	0.6	2.8	0.0	0.0
DI benefits	8.0	11.5	12.8	3.8	0.0
UI benefits	2.9	4.5	6.4	2.6	0.0
Private pension benefits	0.0	7.0	42.2	80.8	88.5
			Germany		
SS retired worker benefits	3.3	4.3	43.0	87.6	93.3
SS survivor's benefits	0.0	1.1	0.0	1.1	0.0
DI benefits	0.0	5.3	5.0	0.0	0.0
UI benefits	8.9	3.2	8.0	0.0	0.0
Private pension benefits	0.0	2.1	10.0	20.2	24.4
			Spain		
SS retired worker benefits	0.0	7.7	40.0	83.3	80.0
SS survivor's benefits	0.0	0.0	0.0	0.0	0.0
DI benefits	0.0	0.0	0.0	8.3	0.0
UI benefits	5.9	15.4	0.0	0.0	0.0
Private pension benefits	5.9	0.0	0.0	0.0	0.0
			Italy		
SS retired worker benefits	0.0	15.8	60.9	58.3	75.0
SS survivor's benefits	0.0	0.0	0.0	0.0	12.5
DI benefits	6.3	0.0	0.0	16.7	0.0
UI benefits	0.0	0.0	0.0	0.0	0.0
Private pension benefits	0.0	0.0	8.7	8.3	25.0
			France		
SS retired worker benefits	0.0	9.1	54.8	97.1	99.9
SS survivor's benefits	1.2	0.0	0.0	2.9	0.0
DI benefits	3.7	3.0	0.0	5.9	0.0
UI benefits	1.2	3.0	7.1	0.0	0.0
Private pension benefits	0.0	3.0	28.6	52.9	80.0

Note: Authors' computations from the 2004 SHARE.

Table A-5: Tax Function Parameters

	US	Spain	France	Switzerland	Netherlands	Italy
Min. taxed ($\frac{y}{W}$)	0.02	0.44	0.00	0.13	0.40	0.44
Min. Tax	0.0	0.0	0.076	0.0	0.0	0.0
Max. Tax	0.354	0.383	0.468	0.364	0.463	0.406
a_0	-0.24	-0.53	-0.02	-0.03	-0.11	-9.87
a_1	-0.0097	-0.022	-1.87	-2.13	-3.97	-0.024
a_2	0.42	0.67	2.04	2.27	4.21	10.06
ϕ	0.22	0.24	0.97	0.98	0.98	0.018
R^2	0.997	0.998	0.993	0.998	0.977	0.995

Table A-6: Hours Worked, Men, Model vs Data (HRS and SHARE 2006): Non-College, Relative to the US

	Model			Data (HRS and SHARE 2006)		
Age	55-59	60-64	65-69	55-59	60-64	65-69
Switzerland						
Baseline	0.95	0.98	1.48	1.28	1.36	0.68
US Taxes	0.95	0.98	1.50			
Disability	0.93	0.96	1.43			
Netherlands						
Baseline	0.65	0.43	0.17	0.91	0.39	0.21
US Taxes	0.60	0.53	0.25			
Disability	0.73	0.60	0.23			
Spain						
Baseline	0.83	0.53	0.03	0.80	0.66	0.10
US Taxes	0.85	0.53	0.04			
Disability	0.95	0.61	0.05			
Italy						
Baseline	0.60	0.36	0.39	0.63	0.44	0.31
US Taxes	0.67	0.45	0.51			
Disability	0.58	0.34	0.38			
France						
Baseline	0.94	0.37	0.44	0.61	0.21	0.05
US Taxes	1.00	0.41	0.45			
Disability	0.95	0.36	0.41			

Table A-7: Hours Worked, Men, Model vs Data (HRS and SHARE 2006): College, Relative to the US

	Model			Data (HRS and SHARE 2006)		
Age	55-59	60-64	65-69	55-59	60-64	65-69
Switzerland						
Baseline	0.96	0.93	1.62	1.21	1.17	0.62
US Taxes	0.96	0.92	1.64			
Disability	0.94	0.90	1.55			
Netherlands						
Baseline	0.70	0.31	0.16	0.82	0.80	0.06
US Taxes	0.69	0.43	0.28			
Disability	0.73	0.32	0.17			
Spain						
Baseline	0.94	0.78	0.03	0.79	0.75	0.29
US Taxes	0.96	0.79	0.04			
Disability	0.95	0.80	0.03			
Italy						
Baseline	0.76	0.45	0.22	0.90	0.60	0.44
US Taxes	0.78	0.47	0.30			
Disability	0.78	0.45	0.22			
France						
Baseline	0.91	0.39	0.46	0.84	0.43	0.18
US Taxes	0.95	0.45	0.48			
Disability	0.89	0.38	0.44			

V Figures: 2004 Survey of Health and Retirement in Europe (SHARE).

Figure A-2: Mean Annual Hours Worked, 2004, SHARE, Men: All, Extensive, and Intensive Margin.

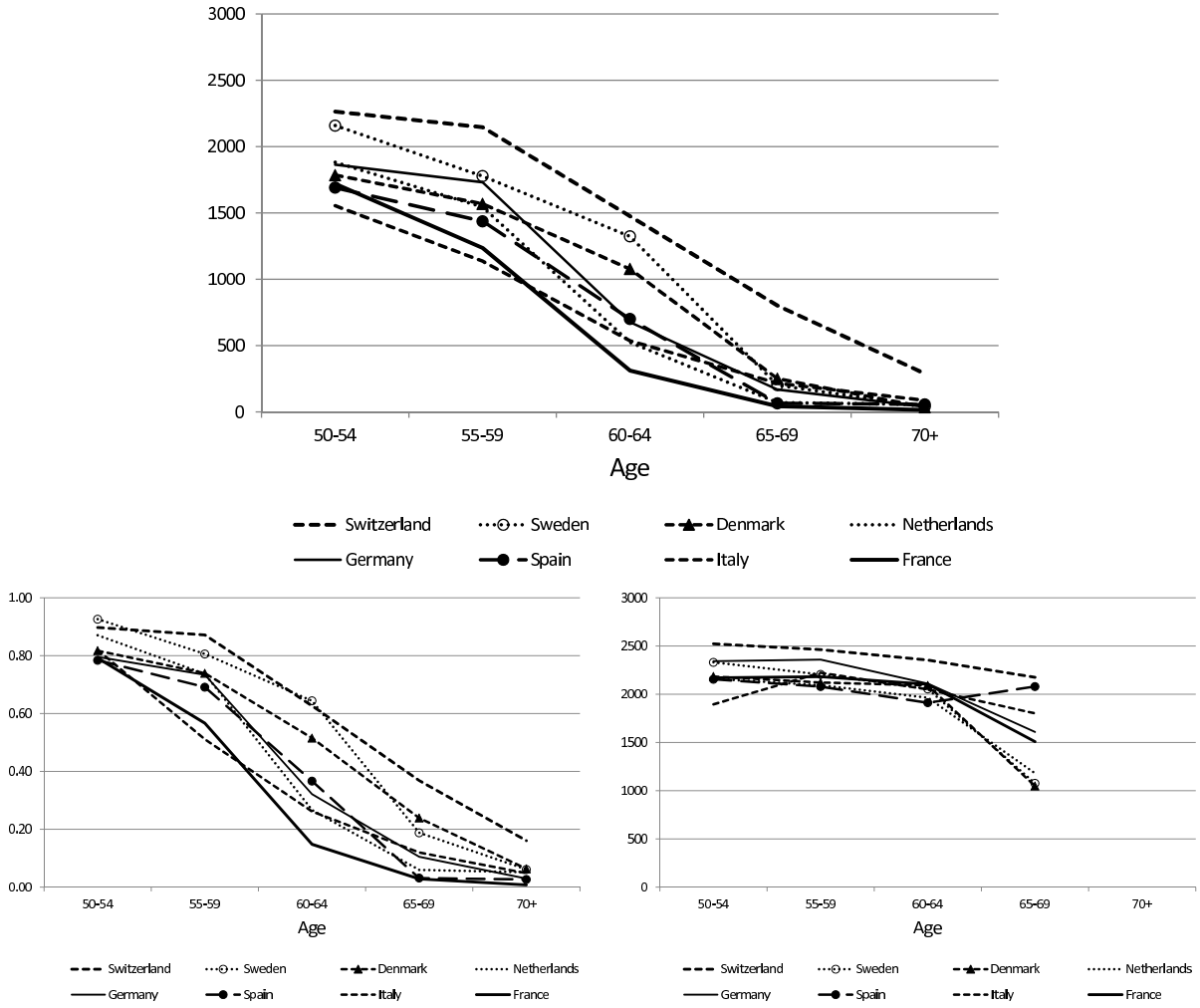


Figure A-3: Mean Annual Hours Worked, 2004, SHARE, Men: Non-college and College.

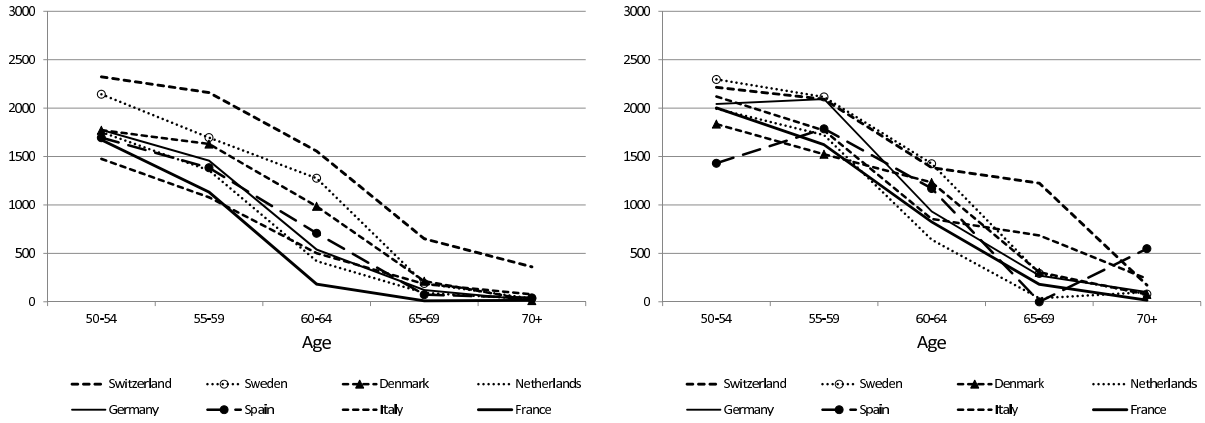


Figure A-4: Mean Annual Hours Worked, United States vs. Europe, HRS and 2004 SHARE, Men: All, Non-college, and College.

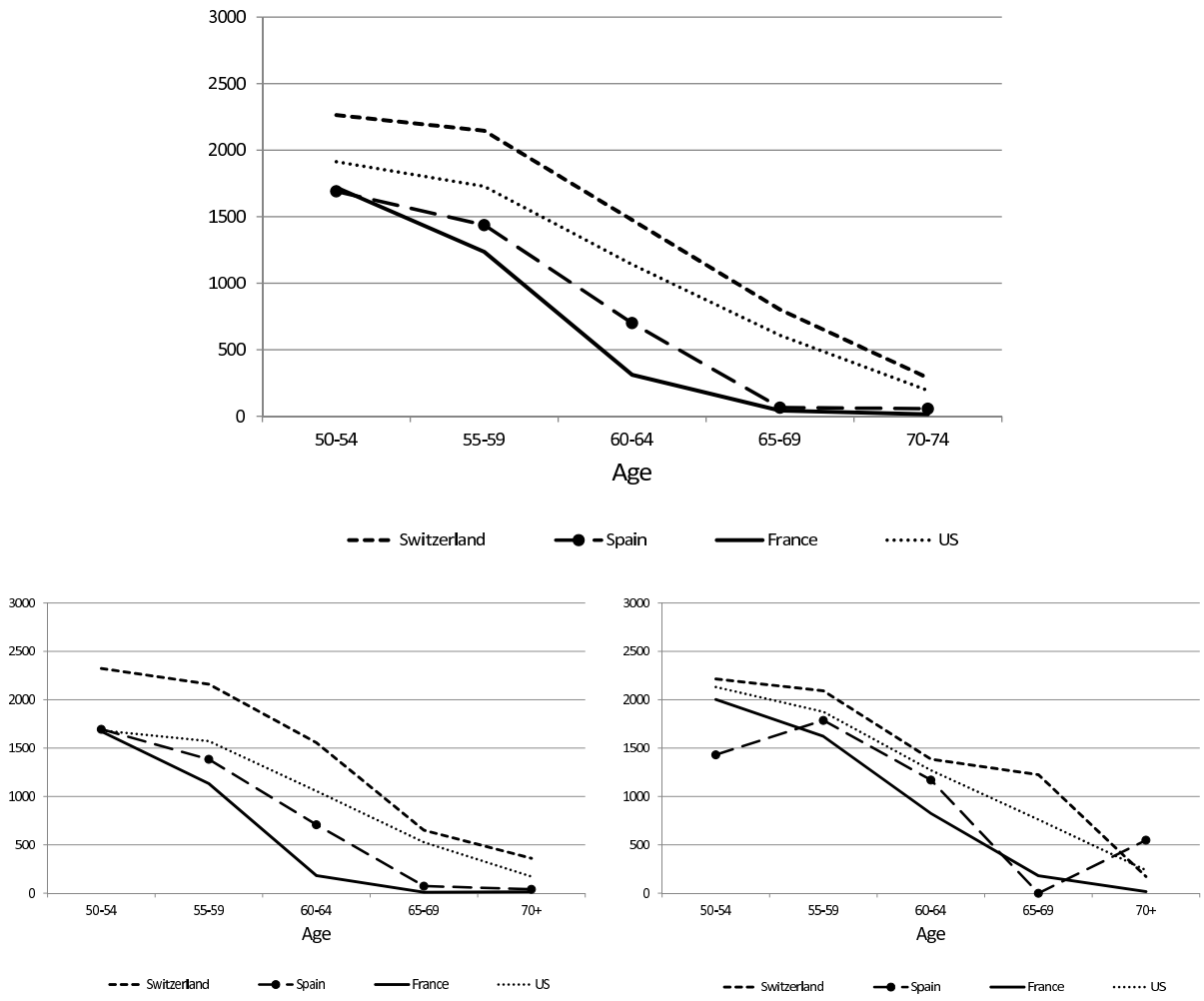


Figure A-5: Annual Hours Worked, All, Model vs. Data: Share 2004.

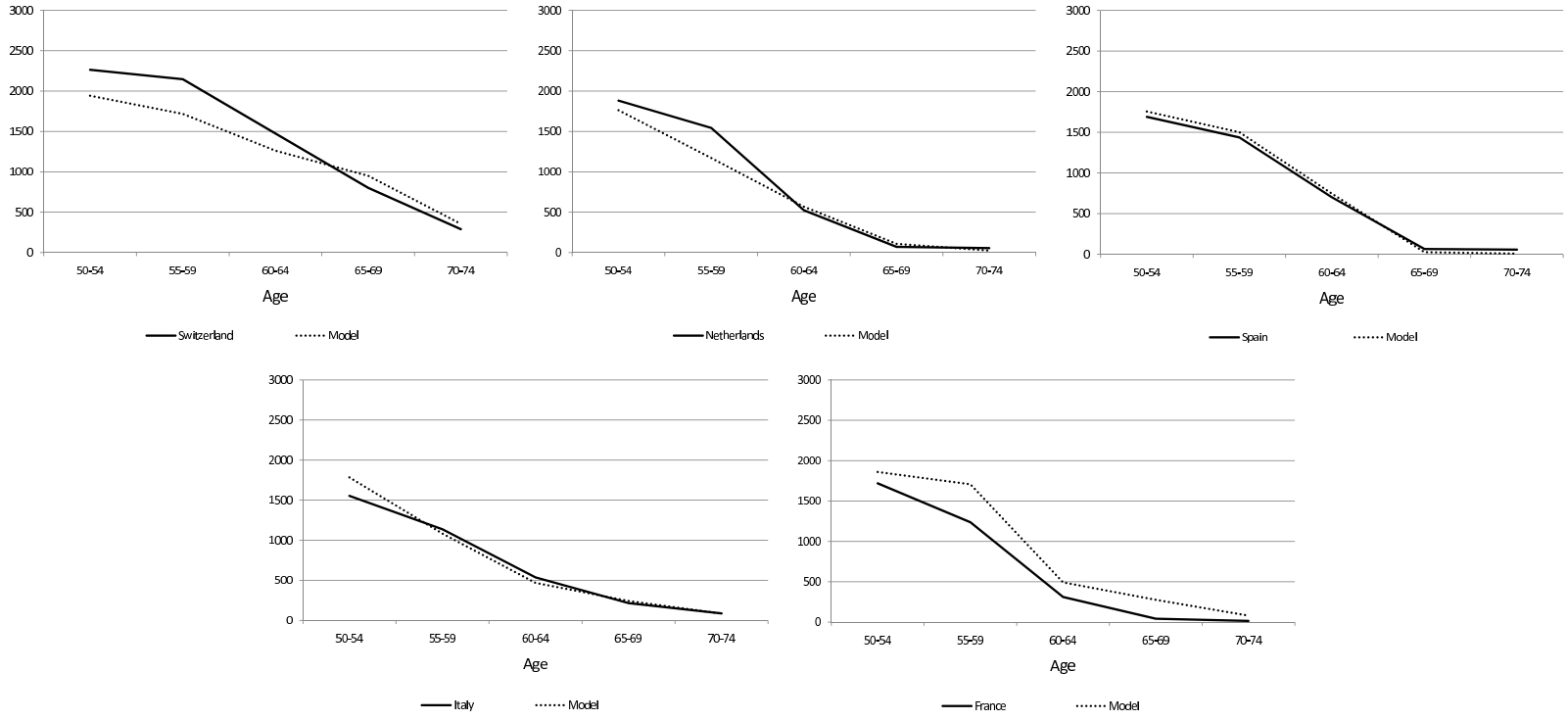


Figure A-6: Annual Hours Worked, Non-college, Model vs. Data: Share 2004.

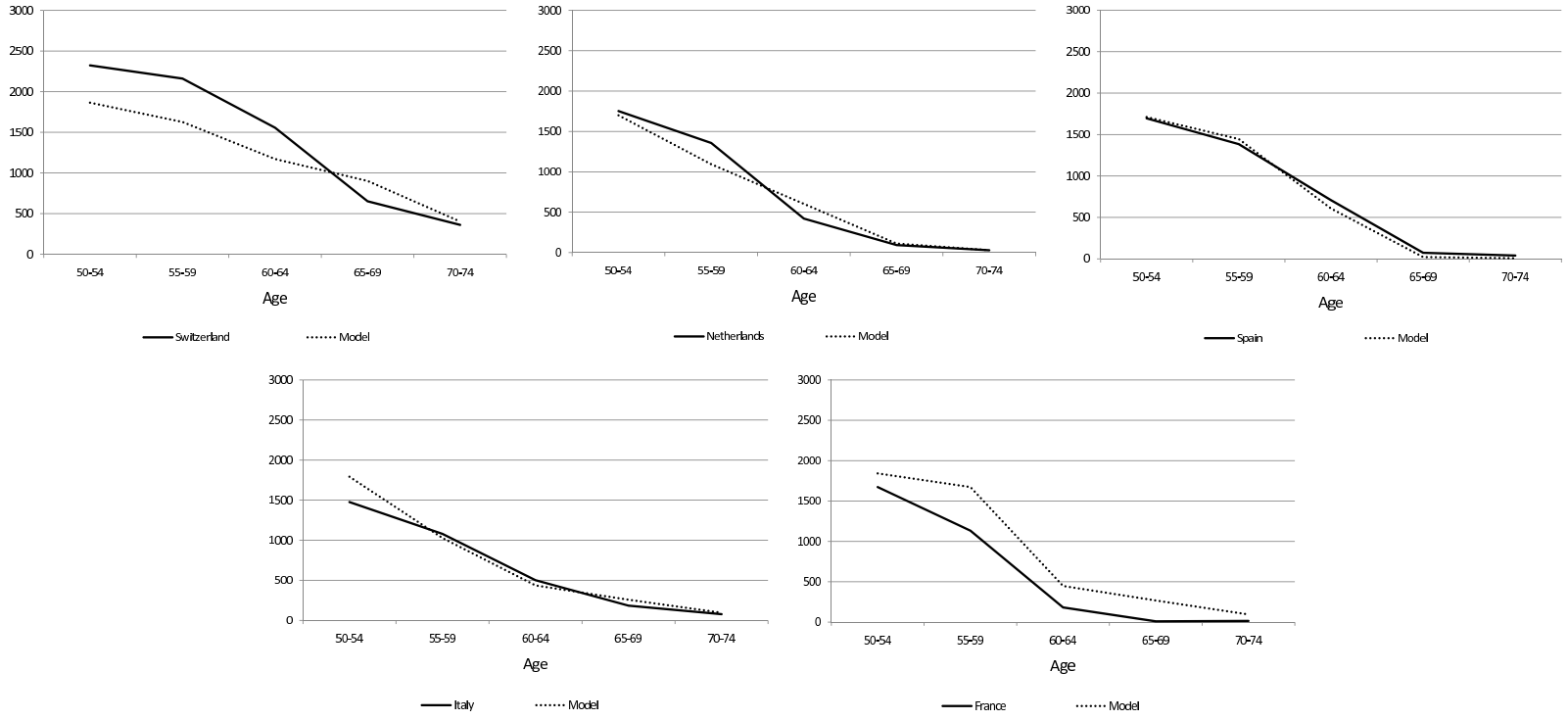


Figure A-7: Annual Hours Worked, College, Model vs. Data: Share 2004.