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Social Insurance and Retirement: A Cross-Country Perspective

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Abstract

We study the role of old-age pensions, disability insurance and healthcare in accounting for the differing labor supply patterns of older individuals across countries. We develop a life cycle model of labor supply and health with heterogeneous agents. In our framework, people choose when to stop working and when/if to apply for disability and pension benefits. We find that the incentives faced by older workers differ hugely across countries. In fact, based solely on differences in social insurance programs, the model predicts even more cross-country variation in the employment rates of people aged 55-69 than we observe in the data.

JEL classification: E24; J22; J26

Keywords: Life cycle; Retirement; Disability insurance; Health

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1 Introduction

While the employment rates of prime-aged males are very similar across OECD countries, the employment rates of older workers differ considerably. The employment rates of males aged 60-64 in France, Germany and the Netherlands are below 60% of the U.S. level. Australia, Canada, Denmark and Spain exhibit intermediate rates of employment, with employment rates of men aged 60-64 at above 80% of the U.S. level. The employment rates for men aged 60-64 are high in the U.K. and Sweden, with employment in the U.K. at roughly the same level as in the U.S. and even slightly higher in Sweden. The differences in employment rates become even more pronounced above age 65. There are also sizable differences in the disability incidence rates across countries. Canada, France and Germany have low rates of disability insurance incidence, with below 6% of the population aged 50-64 collecting benefits. Conversely, the U.S., the U.K., Spain and Australia exhibit intermediate rates of between 6% and 10%, whereas the Netherlands, Sweden and Denmark have high rates of between 13% and 16%.

Simultaneously, we observe big cross-country differences in government programs, notably in old-age pensions, disability insurance and healthcare, as well as the tax rates needed to fund said programs. Countries differ in the generosity of retirement benefits and in the access to early retirement. Most working-age Americans receive healthcare through their employer, and for a substantial share of them health insurance coverage is contingent on working. Medicare eligibility starts at age 65. All of the European countries, as well as Canada and Australia, have a public healthcare system. The large differences in social insurance programs result in large cross-country variation in the tax wedge. The average effective labor tax burden in the U.S. is less than 0.3, in continental Europe it is around 0.5 and in the Scandinavian countries it is close to 0.6. The European tax schemes also exhibit a greater degree of progressivity than the U.S. tax scheme.

The differences in government programs create very different incentives for workers nearing the retirement age. In this paper we study the role of old-age pension benefits, disability insurance and healthcare in accounting for the cross-country differences in the labor supply behavior of older workers. To this end, we develop a life cycle model of labor supply and health. Individuals differ with respect to educational attainment, health insurance coverage and their preference for leisure. Individuals choose when to stop working and when/if to apply for disability and old-age pension benefits. The granting of disability insurance benefits is correlated with health, but the screening process is imperfect. In equilibrium, some people who are granted benefits are in fact healthy, while some of the people denied benefits are truly disabled. Individuals care about their health and can partially insure against health shocks by investing in health. Health expenditures are dependent on health insurance coverage.

We calibrate the model to U.S. data. We then alter the old-age pension, disability insurance and healthcare programs to reflect those in place in Australia, Canada, Denmark, France, Germany, the Netherlands, Spain, Sweden and the U.K., in turn.

We find that older workers face very different incentives for continued employment in the various OECD countries under study. Generous social insurance programs create large incentives for early retirement in France, Spain, Sweden, the Netherlands and Denmark. With the exception of France, the incentives for early retirement in these countries arise in large part from the generous disability insurance schemes. In France, the old-age pension scheme creates strong incentives for early retirement. Conversely, less generous social security programs encourage older workers to remain employed in the U.K., Canada, Australia and Germany. Public health insurance dampens the incentives for continued employment in all of the countries under study. Comparing the model predictions to the data, we note that the model predicted employment rates for older workers in Canada, the U.K. and Germany are somewhat too high relative to the data. Conversely, the model predicted employment rates for Spain, Sweden, Denmark and the Netherlands are somewhat too low relative to the data. For Spain and the Netherlands, this is in large part due to over-predicted disability insurance incidence rates. The model predicted employment rates for France and Australia are more in line with the data. Our results carry over when we add cross-country variation in earnings profiles to the model.

We find that, based on differences in social insurance programs, the model actually predicts even larger differences in the labor supply patterns of people aged 55-69 than we observe in the data. It is worth stressing that modeling endogenous disability insurance is important for capturing the differences in incentives for early retirement across countries. In light of our findings, the puzzle is not so much why Europeans work less than Americans, but rather why, given the incentives built into the social insurance systems, some Europeans work as much as they do. Our results suggest that something outside our model dampens the labor supply effects arising purely from the incentives built into institutions. We explore possible candidate explanations in the Sensitivity Analysis section.

There is a vast literature on retirement and disability insurance claiming, and a growing literature on health insurance.[1] From a modeling standpoint, the paper closest to ours is French (2005). The estimation in French (2005), exploiting micro-data for the U.S. and using a method of simulated moments, is clearly more involved than our approach of exploiting more aggregated data in the calibration. The richness of our framework comes from the endogeneity of health and from modeling additional social insurance programs not present in his paper. In our framework, individuals can influence their health, and thereby their likelihood of ending up on disability insurance, by investing in health. Also, individuals decide whether or not to apply for disability insurance benefits. Based on Low, Meghir, and Pistaferri (2010) we allow for imperfect screening in the granting of disability insurance benefits. Moreover, our framework draws from French and Jones (2011) in distinguishing between types of health insurance coverage. Our paper also contributes to a growing literature on the role of tax and transfer programs in accounting for cross-country differences in labor supply. See, e.g., Prescott (2004), Ohanian, Raffo, and Rogerson (2008),Wallenius (2013), McDaniel (2011) and Erosa, Fuster, and

[1] See for example Gustman and Steinmeier (1986), Pozzebon and Mitchell (1989), Stock and Wise (1990), Berkovec and Stern (1991), Rust and Phelan (1997), French (2005), Gruber and Wise (2004), Gruber and Wise (2009), Coile and Gruber (2007), Coile and Levine (2007), French and Song (2009), Low, Meghir, and Pistaferri (2010) and French and Jones (2011).

Kambourov (2012). Relative to this literature, the novel features of our framework are again the endogeneity of both health and disability insurance claiming. While many of the key ingredients of our model, namely old-age pension benefits, disability insurance and health insurance, have been studied extensively separately, we stress that combining these features in one framework is extremely important for the model predictions. Our result regarding the over-prediction of disability insurance incidence in some European countries is similar in spirit to that of Ljungqvist and Sargent (2007), who find it hard to reconcile generous unemployment insurance benefits with the observed employment rates in Europe.

An outline of the paper follows. Section 2 presents the model, and Section 3 describes the calibration procedure. Section 4 outlines the policy exercise that is carried out in the paper, while Section 5 describes the results from this exercise. Section 6 concludes.

2 Model

We develop a discrete time life cycle model to evaluate the effects of various government programs on labor supply across countries. The economy is populated by overlapping generations of individuals. Individuals differ with respect to education, health, health insurance coverage and their preference for leisure. We model two education groups, college and non-college. The motivation for this is that the labor supply behavior of these groups differs substantially, as does the share of college educated workers across countries. We assume no heterogeneity in the initial health of agents, but subsequently allow for divergence in health due to both shocks to and investments in health. Health expenditures vary substantially with health insurance coverage. Whether health insurance coverage is contingent on working (tied health insurance) or whether it continues even after the individual is no longer employed (retiree health insurance) has potentially important labor supply implications. This is particularly important since Medicare coverage does not start before age 65. We therefore model three health insurance categories: retiree health insurance, tied health insurance and no health insurance.[2] We assume people differ in their preference for leisure; in particular, we model a low and high type. Moreover, we allow the disutility from work to depend on health and education. The reason for introducing some preference heterogeneity is that variation in health and skill is not enough to generate sufficient variation in retirement ages. One can also think of the preference heterogeneity as capturing features not explicitly modeled here, such as job characteristics, the number and age of grandchildren, the health and age of a spouse etc. All together, there are 12 combinations of education, health insurance coverage and preference for leisure, which we term types.

A model period is a year, and individuals live for 56 periods with certainty. We do not model educational attainment. Hence, model age zero corresponds to age 25 in the data.

Preferences

Letting a denote model age, an individual of type s has preferences over sequences of consumption (c), labor supply (l) and health (h) given by:

$$E\sum_{a=0}^{55}\beta^{a}\left[\ln(c_{a,s})-b(h_{a,s},s)l_{a,s}+h_{a,s}\right], \tag{1}$$

where β is the discount factor. Individuals are endowed with one unit of time each period. Preferences are assumed to be separable and consistent with balanced growth, thereby dictating the $\ln(c)$ choice. We assume that the disutility from working is dependent on preference type (low or high disutility type), education and health. Specifically, we posit that working is more unpleasant the worse one's health.[3] The health of an individual also enters directly in the utility function.[4]

[2]Note that this implies that if an individual with tied health insurance coverage retires before age 65, he/she is without health insurance from the time of retirement up to the age of 65.

[3]This is an alternative to assuming that productivity (or the wage) is health dependent, since both result in a distribution of retirement ages. French (2005) finds surprisingly little difference in the wages of healthy and unhealthy individuals in the United States. Kemptner (2013) also finds that the coefficient for health is small and insignificant when estimating a wage equation for Germany.

[4]We also experimented with a specification with decreasing returns to health. The results are essentially unaffected.

Budget Constraint

Each period there are markets for consumption, labor, capital (k) and health investment (i^h). The exogenous age-varying wage profile differs based on educational attainment and is denoted by $w_{a,s}$. Let r denote the interest rate and $p_{a,s}$ the cost of health investment as a function of health insurance status (or type). The individual faces a sequence of budget constraints given by:

$$(1+\tau_c)c_{a,s}+k_{a+1,s}-(1+r)k_{a,s}+p_{a,s}i^h_{a,s}=(1-\tau_y(y_{a,s}))y_{a,s}+DI_{a,s}-c^{DI}_{a,s}+R_{a,s} \quad (2)$$

where $y_{a,s}$ denotes labor income, $R_{a,s}$ retirement benefits, $DI_{a,s}$ disability benefits and $c^{DI}_{a,s}$ the cost of applying for disability benefits. τ_c denotes a proportional tax on consumption and $\tau_y(\cdot)$ a progressive tax on labor income.

We impose a no-borrowing constraint, $k_{a,s} \geq 0$, as a way of ensuring that people work when young, even at a low wage.[5] We abstract from bequests.

Labor income is the product of the exogenous, age-dependent wage and labor supply, $y_{a,s} = w_{a,s}l_{a,s}$.[6] We assume a discrete labor choice. The individual either works full-time or not at all, $l_{a,s} \in \{0, \bar{l}\}$.[7]

Health

Following the OECD self-assessed health measure, we discretize health into five states: very good, good, fair, bad and very bad. All individuals start out in very good health. Health is endogenous and individuals can partially insure against health shocks by investing in health. Health investments take the value of zero or one. Health evolves

[5] In the absence of a borrowing constraint, and with exogenous wages and individuals choosing the timing of work, people would choose not to work when young but rather at a higher wage later on. This is contrary to what we observe in the data.

[6] The price per efficiency unit of labor has been normalized to one.

[7] This assumption is motivated by the observation that the dominant form of retirement in the data is a transition from full-time work to no work. See Rogerson and Wallenius (2013) .

according to the following law of motion:

$$h_{a+1,s} = h_{a,s} + I^{HI}_{a,s} i^{h}_{a,s} + \varepsilon^{h}_{a,s}. \tag{3}$$

$I^{HI}_{a,s}$ is an indicator function, which takes the value one if the health investment is effective and zero otherwise. The probability that the health investment is effective is dependent on both the age and the health of the individual. $\varepsilon^{h}_{a,s}$ denotes the exogenous health shock, the probability of which is also age- and health-dependent.

Social Security

Both retirement and disability benefits depend on the age and past earnings of the claimant. Specifically, a worker's retirement benefit is based on average monthly earnings from the 35 highest years of earnings, or $AIME$ for Average Indexed Monthly Earnings. Since the benefit is based on earnings from 35 years, when the worker has worked fewer than 35 years the benefit increases unambiguously:

$$AIME_{a+1,s} = AIME_{a,s} + \frac{w_{a,s} l_{a,s}}{35} \quad \text{if} \quad a < 35. \tag{4}$$

Once the worker has worked for more than 35 years, the benefit only increases if earnings exceed average earnings:

$$AIME_{a+1,s} = AIME_{a,s} + \max\left\{0, \frac{w_{a,s} l_{a,s} - AIME_{a,s}}{35}\right\} \quad \text{if} \quad a \geq 35. \tag{5}$$

For simplicity, we throw out an average year of earnings, instead of the lowest year. This is in line with French (2005). The Primary Insurance Amount (PIA) is a piece-wise linear function of average monthly earnings, specifically, 90% of average monthly income up to the first kink (b_1), and 32% of the excess of monthly income over the first kink but not in excess of the second kink (b_2), plus 15% of monthly income in excess of the second kink:

$$PIA = \begin{cases} 0.9AIME & \text{if} \quad AIME \in [0, b_1] \\ 0.9b_1 + 0.32(AIME - b_1) & \text{if} \quad AIME \in (b_1, b_2] \\ 0.9b_1 + 0.32(b_2 - b_1) + 0.15(AIME - b_2) & \text{if} \quad AIME > b_2 \end{cases} \tag{6}$$

In 2007, the first kink occurred at \$680 and the second kink at \$4,100. The actual retirement benefit depends on the *PIA* and the age at which the individual starts collecting benefits. The first age at which people can start collecting social security retirement benefits is 62. However, for an individual whose full-retirement age is 65, benefits are adjusted downward by 5/9 of 1 percent per month for each month in which benefits are received in the three years immediately prior to the full-retirement age. Workers claiming benefits after the full-retirement age earn a delayed retirement credit, which is 2/3 of 1 percent for each month up to age 70.[8] One does not have to stop working to collect benefits.[9] For simplicity, we do not allow for cycling between working and not working in the model. So, while individuals can continue working while collecting retirement benefits, once they stop working they cannot return to work. The social security wage base is capped; in 2007 the cap was set at \$97,500.

The disability insurance benefit is computed similarly to the retirement benefit with the exception that benefits are not based on the 35 highest years of earnings. Rather, disability insurance benefits are based on lifetime earnings with the five lowest earnings years excluded from the calculation for awardees over the age of 43 (fewer years for younger awardees). Disability insurance eligibility also requires that a person has worked in five of the ten years preceding the application for disability benefits. People cannot work while collecting disability insurance. In the model we assume that disability insurance claiming is an absorbing state. All disability insurance claimants are automatically transferred into

[8]The full-retirement age is gradually being raised from 65 to 67, depending on birth year.

[9]If a person is below the full-retirement age and works while collecting social security benefits, he/she is subject to an earnings test and benefits are reduced if earnings exceed a certain threshold. However, these individuals are compensated after reaching the full-retirement age, and the adjustments are considered roughly actuarially fair. We therefore abstract from the earnings test.

retirement at the age of 65. Benefits are unaffected by this transition.

The collection of disability insurance benefits is contingent on both applying for benefits and being awarded them. The probability of being awarded said benefits is dependent on the health and age of the applicant. While the probability of receiving benefits is higher the worse the health of the individual, the imperfections associated with screening are captured by assuming a positive probability of receiving benefits in all health states. Moreover, the probability of receiving benefits when not truly disabled is increasing in the applicant's age. In equilibrium, some of the individuals awarded disability insurance will be in quite good health and conversely, not everyone in bad health will be awarded benefits. The cost of applying for disability insurance benefits is denoted by $c^{DI}_{a,s}$, and incurred irrespective of whether the individual is granted disability insurance benefits or not. This cost is proportional to earnings prior to applying for disability insurance, and intended to capture lost earnings associated with applying for disability insurance.

Taxes

The government levies a proportional tax on consumption (τ_c) and a progressive tax on labor income ($\tau_y(y_{a,s})$). The government uses the proceeds from these taxes to finance the retirement and disability insurance benefits. We assume that the remaining tax revenue is thrown away. This is equivalent to assuming that the additional tax revenue is spent on government consumption which the agent values, as long as the government consumption does not affect the marginal utility of private consumption. An often cited example of this nature is defense spending.

Recursive Formulation

We can write the individual's decision problem in recursive form. In order to simplify the notation, here we suppress the dependence on type s. The state x of an individual is given by age a, assets k, health h, average income from best 35 years $AIME$, pension status *page* (age at which started claiming pension benefits, if claiming), disability status *dage* (age at which started claiming disability benefits, if claiming), work status *rage*

(age at which stopped working, if no longer working). Individuals know x at the start of the period and decide how much to consume, how much to save, whether or not to invest in health, weather or not to work, and, if applicable, whether or not to apply for pension/disability benefits (denoted by app^R and app^{DI}, respectively). We assume that individuals claiming pension benefits can work, whereas individuals collecting disability benefits cannot. Moreover, we assume that benefit claiming and retirement are absorbing states (i.e, once the individual stops working, he/she cannot return to work).

The value of state x is:

$$V(x) = \max_{\substack{c,k',i^h,l,\\ app^{DI},app^R}} u(c,l,h) + \beta EV(x') \tag{7}$$

$$s.t. \quad (1+\tau_c)c + k' - (1+r)k + p(x)i^h = (1-\tau_y(x))w(x)l + DI(x) - c^{DI}(x) + R(x). \tag{8}$$

The Computational Appendix provides a detailed description of how this model is solved.

3 Calibration

In this section we discuss the process of assigning values for the model parameters. We calibrate the model to the United States. Note that the data is for males.

Recall that the length of a period is calibrated to a year, and that model age zero corresponds to age 25 in the data. All agents enter the model in very good health and with zero assets. We assume an annual interest rate equal to 3%. Individuals differ with respect to education, health insurance coverage and their preference for leisure. We group individuals into two education categories, college and non-college, three health insurance categories, retiree, tied and none, and two disutility from work categories, low and high. This yields 12 types. The weights for the education and health insurance categories are taken from the data. The weights for the low and high disutility types are calibrated to match the retirement age distribution. In our sample, 42% of men have a college degree. Less than 10% of college educated men in the U.S. have no health insurance coverage, whereas roughly 20% of non-college educated men are without health insurance. Approximately 65% of men aged 55-64 have health insurance through their employer, with employer-based health insurance more prevalent among college educated men (85%) than non-college educated men (57%). Moreover, more than half of college educated men have retiree health insurance, whereas roughly a third of non-college educated men have retiree health insurance.[10]

Preference Parameters

The preference parameters that need to be assigned a value are the discount factor, β, and the parameters governing the disutility from working, $b(h,s)$. β is chosen to match an asset to income ratio of 3. The parameters governing the disutility from working are critical for matching the retirement age distribution. We assume two disutility from work types, low and high, and moreover allow the disutility from working to differ by health and education. Here we group the three best health categories into one, which we term 'good', and the two worst into one, which we term 'bad'. This results in four disutility from work parameters for each educational type: low disutility and good health, low disutility and bad health, high disutility and good health, and high disutility and bad health. As previously noted, these parameters are chosen to match the employment rates of older men by education attainment. The target distribution is shown in Table A1 in the Appendix.[11]

Life Cycle Earnings Profiles

We use the Luxembourg Income Study (LIS) [12] to construct life cycle earnings profiles for college and non-college educated workers in the United States.[13] We limit the sample

[10] See Iams, Phillips, Robinson, Deang, and Dushi (2008) and Johnson and Crystal (1997) for a more complete description of health insurance coverage by age, education and gender.

[11] Since there is nothing in the model that could explain why some people never work, the employment and disability insurance rates are conditioned on everyone who is not on disability insurance working at age 50.

[12] See LIS-Microdata (2015).

[13] The choice of dataset is motivated by the fact that LIS is a harmonized cross-country dataset containing

to men aged 25-62 working full-time. To trim outliers, we drop the top and bottom 1% of observations. The data is for year 2004. To construct the age-earnings profiles we regress labor income on age and age squared. This is done separately for the two education groups. We use the sample weights provided by LIS. The coefficients of the earnings function are reported in Table A2 in the Appendix. Since we are dealing with cross-sectional data, we need to be mindful of selection issues. This is particularly relevant at older ages. In light of this, we hold earnings above age 62 fixed at the age 62 level.

Taxes

We follow Guvenen, Kuruscu, and Ozkan (2014) in constructing the progressive tax function for the United States. The OECD tax database provides estimates of total labor income taxes for all income levels between half of average wage earnings (AW) and two times average wage earnings. The tax measures include income taxes (central government, local and state) and social security contributions, as well as many types of deductions. We use these estimates to calculate the average tax rate at 50%, 75%, 100%, 125%, 150%, 175% and 200% of AW. We then fit the following function to these data points:

$$\tau_y(y/AW) = a_0 + a_1(y/AW) + a_2(y/AW)^{\phi}. \quad (9)$$

The estimated parameter values are reported in Table A3 in the Appendix.

Half of social security benefits are counted toward total taxable income in the United States. Social security benefits are exempt from tax when total taxable income is below $25,000. One is, thus, unlikely to pay tax on social security benefits if social security benefits are the only source of income. If, however, one continues to work while collecting social security benefits, part of the social security benefits may be taxable. One does not pay social security contributions on benefits.

micro data on income for a large number of countries. Ideally we would have micro data on wages for all of the countries we study, but this would require us to examine several distinct micro datasets. That is beyond the scope of this paper. Moreover, given that we model a discrete labor supply choice, we feel that the earnings of full-time workers are a reasonable measure for our purposes.

We take the consumption tax rates from McDaniel (2007).

The government uses the tax revenue to finance the social insurance programs. We assume that the leftover tax revenue is thrown away. This is equivalent to assuming that it is spent on government consumption, as long as the government consumption does not affect the marginal utility of private consumption.

Health Expenditures

We parameterize the cost of health investment to match health expenditures. We assume one gross price per unit of health investment, but allow the net price paid by individuals to vary based on health insurance type and work status. Medicare coverage begins at age 65. Table A4 in the Appendix reports average health expenditures by health insurance type and work status. These numbers are based on those reported by French and Jones (2011).[14] Health expenditures are higher for individuals who do not work than for those that do. This is particularly true for those whose health insurance coverage is tied to working. Unsurprisingly, health expenditures are greatest for those without health insurance coverage. Conditional on not working, Medicare eligibility lowers average health expenditures.

Health and Disability Risk

We assume two health shocks, a small shock and a large shock. The small shock corresponds to a one unit drop in health, while the large shock corresponds to a three unit drop. Given that health investments take the value zero or one, and are not always effective, individuals can only partially insure against health shocks. The shock probabilities are health- and age-dependent, with the probability of the shock greater the older the individual and the worse the health of the individual. The dependency of the shock on health status is intended to mimic the persistence of health shocks. We also allow the shock prob-

[14]We do not distinguish costs by health status or age (other than Medicare eligibility). When aggregating the numbers reported by French and Jones (2011) we assume the weights for good and bad health reported in the OECD self-assessed health survey. We interpret bad health as corresponding to the two worst health states and good health as corresponding to the three best ones. The expenditure for those not eligible for Medicare is the expenditure reported for 64 year olds.

abilities to differ based on educational attainment. This is intended to capture the worse health and higher disability incidence rate of non-college educated workers relative to their college educated counterparts. Similarly, the probability that health investments are effective is also age- and health-dependent. Specifically, the probability that investments are effective is lower the older the individual and the worse the health of the individual.

There are strict health criteria associated with disability insurance eligibility. But health is not perfectly observable, and as such the screening process is imperfect. Iyengar and Mastrobuoni (2007) estimate that roughly 40% of applications for social security disability insurance are granted, whereas Low and Pistaferri (2010) estimate it to be 53%. While there are no hard facts about the prevalence of type 1 and type 2 error associated with the awarding of disability benefits, Benitez-Silva, Buchinsky, and Rust (2004) estimate that approximately 22% of disability applicants who are awarded benefits are not truly disabled. Low and Pistaferri (2010) estimate this to be around 10%. Conversely, Benitez-Silva, Buchinsky, and Rust (2004) estimate that 58% of applicants who are denied benefits are in fact disabled; Low and Pistaferri (2010) find it to be 43% of applicants. To capture the type 1 and type 2 error associated with the awarding of disability benefits, we assume a probability of being awarded benefits (conditional on applying) that is positive in all health states but greater the worse the health of the applicant. In order to talk about type 1 and type 2 error in the model, we must take a stand on what constitutes 'truly disabled' in the model. We interpret the two worst health states as disabled. Eligibility for disability insurance benefits also requires that the individual is not working at the time of application. We impose a cost of applying for disability benefits to capture lost earnings associated with applying for disability benefits. The cost is proportional to earnings prior to the application for disability benefits and incurred irrespective of whether the benefits are granted.

We jointly calibrate (1) the probability process governing health shocks, (2) the probability process governing the effectiveness of health investment, (3) the probability process governing the granting of disability benefits, and (4) the cost of applying for disability benefits to match: (1) the application rate for disability benefits, (2) the prevalence of type 1 and type 2 error in the granting of disability benefits, (3) the incidence of disability insurance claiming by age and education, and (4) the health distribution by age and education.

Table A5 in the Appendix summarizes the prevalence of disability insurance claiming among older men by educational attainment, and Table A6 reports the self-assessed health of older men for college and non-college educated workers respectively. For ease of exposition, we again group the three best health categories into 'good' and the two worst into 'bad'.

3.1 Calibrated Economy

Table 1 summarizes the calibrated parameter values for the benchmark U.S. economy. In what follows we briefly discuss some of the parameter values, as well as the fit to the data.

Employment and Disability

We are particularly interested in how well we are able to replicate the labor supply behavior of older workers. Figure 1 shows the employment rates of older men by age and education relative to the data. The calibration places 40% (55%) weight on the low disutility type and 60% (45%) weight on the high disutility type for the non-college (college) workers. The fit of the model is good for the non-college types. In particular, the model is able to match the gradual decline in employment in the 50s, followed by the somewhat steeper decline in the 60s. The model fit for the college types is not as good as for the non-college types, particularly in that the model predicts too high employment in the early 60s relative to the data, but the fit is nevertheless quite good.

There are substantial differences in retirement behavior based on health insurance coverage. Our model predicts that individuals with retiree health insurance stop working on average almost a year earlier than those with tied health insurance coverage. Individuals with tied health insurance in turn stop working on average slightly more than a year be-

Parameter	Value
Utility Parameters	
Discount factor	0.984
Interest rate	0.03
Disutility from work when:	
non-college, health good and disutility type low	1.68
non-college, health bad and disutility type low	2.40
non-college, health good and disutility type high	2.85
non-college, health bad and disutility type high	3.60
college, health good and disutility type low	1.62
college, health bad and disutility type low	2.40
college, health good and disutility type high	2.46
college, health bad and disutility type high	3.60
DI Parameters	
Cost of applying for DI	0.3
Probability of getting DI if health bad	0.55
Probability of getting DI if health good and younger than 50	0.01
Probability of getting DI if health good and 50 or older	0.05
Health Parameters	
Decrease in health from low shock	1
Decrease in health from high shock	3
Probability of low shock, non-college	$0.15 \to 0.58$
Probability of low shock, college	$0.08 \to 0.32$
Probability of low shock when health very bad, non-college	0.58
Probability of low shock when health very bad, college	0.32
Probability of high shock	0.005
Probability of high shock when health very bad	0.1
Probability health investment effective when health good	$0.9 \to 0.5$
Probability health investment effective when health bad	$0.3 \to 0.1$

Table 1: Calibrated Parameter Values

fore those with no health insurance. These patterns are in line with the findings of French and Jones (2011).

Table 2 reports disability insurance claiming by age and educational attainment. The model predicts that disability insurance claiming occurs a bit later than it does in the data. Nevertheless, the model does a relatively good job of matching the incidence of disability insurance claiming.

The calibration implies a cost of applying for disability insurance equal to 30% of

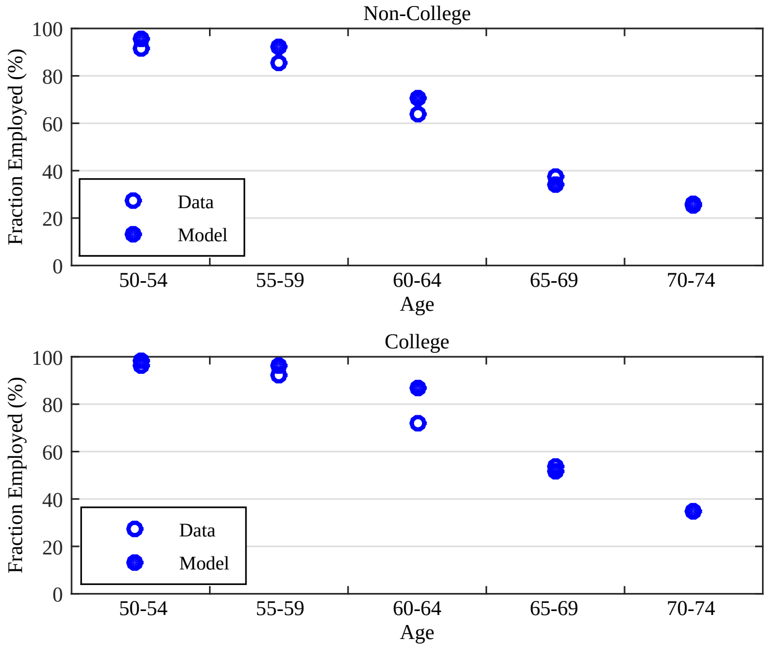

Figure 1: Employment Rates by Age and Education: Model vs. Data

labor earnings in the period in which the individual applies for disability benefits. This value seems reasonable given the fact that in the U.S. disability insurance applicants are required to have a period of 6 months of no work prior to applying for benefits. In the calibration, the probability of being awarded disability insurance benefits when in the two worst health states is 0.55, whereas the probability in all other health states is 0.01 when younger than 50 and 0.05 otherwise. This results in an acceptance rate of 30.6%. Moreover, our model predicts that 7.2% of disability insurance claimants are not truly disabled (i.e., in very good, good or fair health), whereas 36.2% of those denied benefits are in fact disabled. The acceptance rate and the prevalence of type 1 and 2 error are a bit lower than the estimates of Low and Pistaferri (2010) and Benitez-Silva, Buchinsky, and Rust (2004), but nevertheless in a reasonable range.

Savings

Savings in the model is governed by the discount rate β, which is chosen to match an assets to income ratio of 3. In the calibration we reach an assets to income ratio of 2.99.

Non-College		
Age	Model	Data
50-54	4.7	8.7
55-59	7.9	10.0
60-64	12.0	11.2
College		
Age	Model	Data
50-54	1.7	3.4
55-59	3.4	4.6
60-64	4.6	4.6

Table 2: Disability Insurance Incidence (%) by Age and Education: Model vs. Data.

Health

One dimension along which the model struggles a little bit is in matching the health distribution at older ages. As is evident from Table 3, in the age group 60-64 the model somewhat over predicts the share of healthy individuals. By age 70-74, this largely corrects itself and the fit to the data is quite good.

Non-College			
Age	Health	Data	Model
60-64	Good	69.2	87.2
60-64	Bad	30.8	12.8
70-74	Good	64.8	69.3
70-74	Bad	35.2	30.7
College			
Age	Health	Data	Model
60-64	Good	89.1	95.4
60-64	Bad	10.9	4.6
70-74	Good	85.4	90.8
70-74	Bad	14.6	9.2

Table 3: Health Distribution (%) by Age and Education: Model vs. Data

This fit to the data is achieved by assuming that the probability of being hit by the small health shock increases linearly with age. In the calibration it rises from 0.15 to 0.58 for the non-college types and from 0.08 to 0.32 for the college types over the life cycle. However, if the individual is in the worst health state, the probability of being hit by the small shock is 0.58 for the non-college educated worker and 0.32 for the college educated worker, regardless of age. We assume that the probability of being hit by the big health shock is only dependent on health. Specifically, the probability is 0.005 in the four best health states and 0.1 in the worst health state. As noted previously, the dependency of the shock probability on health status mimics persistence.

The probability that the health investment is effective is also dependent on age and health. We assume that, given a particular level of health, the probability that health investment is effective decreases linearly with age. A decline in health, however, shifts the probabilities to a lower trajectory. Here we group the three best health states into one (good) and the two worst into one (bad). Table 1 reports the boundary values for the two health states.

There is some tension in matching the data on disability insurance incidence, health and the moments pertaining to the granting of disability benefits. This could well be due to either measurement issues with the self-reported health data or with the measurement of type 1 and 2 error associated with the granting of disability benefits.

Employment by Health

One metric that we have not explicitly targeted is employment by health status. Given that the only source of uncertainty in the model is health risk, one might be concerned that health shocks play too large a role in driving retirement behavior. This is not the case. In fact, our model slightly understates the role of health shocks in retirement transitions. Blau and Shvydko (2011) document that 13% of the transitions from employment to retirement among individuals aged 52-71 are associated with a change in self-reported health status from good to bad, whereas the majority of individuals, 69%, report being in good health both before and after the transition into retirement. In our model, 9.4% of the transitions from employment to retirement are associated with a decline in health from good to bad and 81.5% agents in the model are in good health before and after the transition to retirement. Upon reflection, this is not that surprising, since individuals in our model are a bit too healthy relative to the data.[15]

4 Quantitative Exercise: Social Insurance Around the World

Having developed and calibrated the model, we turn to the policy analysis. Our goal is to quantify the role of social insurance programs in accounting for the cross-country differences in the labor supply behavior of older workers.

As documented previously, there are large differences in labor supply across countries. The differences are particularly pronounced at older ages. The employment rates of people aged 50-54 in all of the countries under study, namely Australia, Canada, Denmark, France, Germany, the Netherlands, Spain, Sweden and the U.K., are similar to the United States. However, by age 60-64, the differences grow large. The employment rates of people aged 60-64 in France, Germany and the Netherlands are 26%, 56% and 57% of the U.S. level, respectively. The employment rates in Australia, Canada, Denmark and Spain are noticeably higher at 88%, 89%, 88% and 83% of the U.S. level, respectively. The U.K. reports an employment rate similar to the U.S., at 98% of the U.S. level and Sweden an even higher employment rate at 110% of the U.S. level.

Similarly, there are sizable cross-country differences in the claiming of disability insurance benefits. France, Germany and Canada report low rates of disability insurance incidence, with below 6% of the population aged 50-64 claiming disability benefits. Conversely, the U.S., the U.K., Spain and Australia exhibit intermediate rates of disability insurance incidence with between 6% and 11% the population aged 50-64 claiming benefits. Denmark, Sweden and the Netherlands have high rates of disability insurance incidence with between 13% and 16% of the population aged 50-64 claiming disability benefits.

[15] Good health is again defined as the three best health states and bad health as the two worst.

	Denmark	Netherlands	Spain	Sweden	France
Old-Age					
Eligibility Age	65 occ. 67 flat-rate	55 earn. dep. 65 flat-rate	60	61	60
Full Retirement	n/a	65	65	65	40 years of work
Must Stop Work	yes	yes	yes	no	yes
Flat-rate	$13 100	$12 200	no	$4150	no
Earnings Dependent	max $2 600 (depends on yrs.)	70% of ave. > 40% of ave.	depends on yrs of work	60% of ave. (15 best yrs) + occ. pen.	50% of ave. (25 best yrs) + occ. pen.
Early Claiming Reduction	n/a	depends on age	depends on yrs of work	0.5% per month	5% per year
DI					
Flat-rate	$19 850	no	no	same as regular	no
Earnings Dependent	n/a	70% of ave.	similar to regular (depends on age)	same as regular (as if work to 65)	50% of ave. (10 best years)

	Germany	UK	Canada	Australia	US
Old-Age					
Eligibility Age	63	65	60 earn. dep. 65 flat-rate	55 earn. dep. 65 flat-rate	62
Full Retirement	65	65	65	65	65
Must Stop Work	yes	no	yes, if collect earn. dep. before 65	yes, if collect earn. dep. before 65	no
Flat-rate	no	$6 400	$4 700	$8 800	no
Earnings Dependent	depends on relative earnings	25% of ave. (20 best yrs)	25% of ave. (drop lowest 15%)	accrue 9% per year	piece-wise lin. (35 best yrs)
Early Claiming Reduction	0.3% per month	n/a	0.5% per month	no for earn. dep. n/a for flat-rate	0.56% per month
DI					
Flat-rate	no	$5 900	$3 800	$8 800	no
Earnings Dependent	same as regular (as if work to 60)	no	75% of regular earn. dep. portion	no	similar to regular

Table 4: Program Rules

Simultaneously, we observe big cross-country differences in social security programs. Table 4 summarizes the key features of the old-age pension and disability insurance programs in place in the countries under study.[16] A more detailed description of the programs can be found in the Appendix. At one end of the spectrum lie France, Spain and the Netherlands, where old-age pension benefits are generous and one can claim them at a rather young age. Canada, Australia, the U.K. and Denmark are at the opposite end of the spectrum, with considerably more modest benefit levels. Germany and Sweden are intermediate cases in terms of the generosity of old-age pension benefits. In the majority of the continental European countries one is required to stop working in order to collect pension benefits.[17] Disability insurance benefits are very generous in Spain, Sweden and the Netherlands, and to a slightly lesser degree also in Denmark.

All the European countries, as well as Canada and Australia have a public healthcare system. This is quite different from the U.S., where expected health expenditures differ greatly based on health insurance status. As a result, health insurance coverage can be a big incentive for continued employment in the United States. We capture the public healthcare systems in a very stylized way, by assuming a subsidy on health expenditures. We assume one price per unit of health investment within a country, but vary this price across countries so that average health expenditures in the model match average per capita health expenditures in the data for each country in question. The subsidy on health expenditures is set to match the share of public health expenditures in the country in question. Table A7 in the Appendix reports average per capita health expenditures as well as the public share of all health expenditures. Per capita health expenditures range from roughly \$2 500 in Spain to roughly \$4 200 in the Netherlands. The public share of health expenditures is large in all of the European countries as well as in Australia and Canada. It ranges from roughly 68% in Australia to approximately 85% in Denmark.

[16] Source: http://www.ssa.gov/policy/docs/progdesc/ssptw/

[17] One can earn a small amount while collecting social security in some of the countries, but the limit is tight enough to result in the same behavior as if one were required to stop working to collect social security benefits.

There is considerable variation in the taxation of labor income across countries, both in terms of average levels and in the progressivity of taxation. We use the same method for constructing progressive tax functions for all of the countries in our study that we did for the United States. The parameters of the tax functions are reported in Table A3 the Appendix. The tax functions for Canada, Australia and the UK are similar to that in the United States. The tax functions for the Northern European countries exhibit the highest degree of progressivity and also the highest average rates. The tax functions for the continental European countries lie in between the two extremes.

In our policy analysis, we take great care in accurately modeling the details of the old-age pension and disability insurance programs across countries, including entitlement ages, dependence on income, adjustments for early claiming, restrictions associated with work when collecting benefits and the taxation of benefits. For an illustration of how the country specific program rules in Table 4 are mapped to the model, see the Appendix. We vary the tax schedules and the health costs across countries, as outlined above. We set the share of college educated workers in each country to match the share in our sample from the LIS dataset. The parameters governing the disutility of working and the health process are kept at the benchmark U.S. level. Similarly, the cost of applying for disability insurance benefits and the probabilities of being awarded benefits (conditional on health status) are kept at the U.S. level for now, although we revisit this assumption later. In our benchmark specification we keep the labor earnings profiles fixed across countries. Subsequently we study the effect of also varying earnings profiles across countries.

5 Cross-Country Analysis

5.1 Results

In this section we present the results from our quantitative analysis. In Table 5, we present results from three related policy exercises. The first policy exercise, referred to as Model

1 in the table, is to modify the old-age pension and disability insurance programs to reflect those in place in Australia, Canada, Denmark, France, Germany, the Netherlands, Spain, Sweden and the U.K. in turn. The tax schedules are also set to the country specific ones. As noted previously, all other parameters are kept at the benchmark U.S. values. The second exercise, Model 2, encompasses the first exercise but has the additional feature of modeling the country specific health costs. Lastly, our third exercise, Model 3, encompasses Model 2 with the additional feature of varying earnings profiles across countries (for the countries where data is available in the LIS database). In essence, we are asking what would happen if the U.S. were to implement the social insurance programs in place in, for example, France, or alternatively Australia. We then compare this to the actual observations from these countries in order to understand the role various institutional features play in accounting for the differing labor supply outcomes.

Let us now turn to the first set of results. The pension and disability insurance programs in place in the OECD countries under study create very different incentives for the labor supply behavior of older workers. The model predicts high employment rates for older workers with the old-age pension and disability insurance programs in place in Canada, Australia, the U.K. and Germany. The model predicted employment rates for these economies are similar to or even higher than the corresponding values for the benchmark U.S. economy. The model also predicts low disability insurance claiming rates for the four aforementioned countries. Conversely, the model predicted employment rates for older workers under the pension and disability insurance programs in place in France, Spain, Sweden, the Netherlands and Denmark are considerably lower, particularly among people aged 65 and above. The model predicts high disability insurance claiming rates for Spain and the Netherlands.

Recall that Model 1 assumes the health expenditure structure of the U.S. benchmark economy. In the benchmark U.S. economy, there is an incentive for the workers with either tied health insurance coverage or no health insurance coverage to continue working until age 65, when they become eligible for Medicare. With public healthcare, this motive is absent. Model 2 encompasses Model 1, but with the addition of public health insurance, captured through country specific subsidy rates on health expenditures. The model predicts a decline in employment rates of older workers in all of the countries under study following the introduction of public health insurance. Disability insurance incidence also rises. Comparing the model predictions to the data, we note that, despite the dampening effect of public health insurance, the model predicted employment rates for older workers in Canada, the U.K. and Germany are somewhat too high relative to the data.[18] In Canada and the U.K. this is particularly true of workers aged 65 and above. The model predicted disability incidence rates are also too low for the U.K. and Canada. The over-predicted employment rates in Germany may be due to the fact that unemployment, a channel absent from our model, is an important pathway to early retirement in Germany. Conversely, the model predicted employment rates for Spain, Sweden, Denmark and the Netherlands are somewhat too low relative to the data. For Spain, Sweden and Denmark this is particularly true above age 60, whereas in the Netherlands the model under-predicts employment already in the 55-59 age bin. For the cases of Spain and the Netherlands the low predicted employment is largely due to over-predicted disability insurance incidence rates. The model predicted employment rates for France and Australia are more in line with the data, although the model predicted disability incidence rate is somewhat too high for France, and conversely too low for Australia. The model captures the strong incentive for retirement at age 60 under the French pension scheme. This effect is a bit overstated by the model though, resulting in too low predicted employment above age 60.

[18] Again, the data on employment and disability insurance rates are conditioned on everyone who is not on disability insurance working at age 50.

Country	Employment			DI
	55-59	60-64	65-69	50-64
Spain				
Model 1	72.3	53.5	6.9	24.4
Model 2	70.0	32.9	6.1	26.5
Model 3	73.3	39.7	7.0	23.0
Data	77.5	49.9	6.0	8.4
France				
Model 1	93.2	0	0	6.4
Model 2	93.1	0	0	6.5
Data	67.9	16.2	4.3	4.4
Sweden				
Model 1	87.7	60.4	21.3	9.9
Model 2	72.1	36.3	9.8	15.2
Data	79.3	59.9	16.4	14.7
Denmark				
Model 1	93.3	86.4	19.8	6.9
Model 2	89.3	45.3	15.3	10.6
Model 3	74.9	44.9	15.2	12.1
Data	79.3	59.9	16.4	14.7
Netherlands				
Model 1	78.1	67.8	0	19.8
Model 2	41.9	36.3	0	26.0
Model 3	47.5	45.9	0	26.0
Data	73.4	31.1	10.3	13.0
Germany				
Model 1	93.8	77.3	31.3	6.0
Model 2	93.5	71.5	24.0	6.5
Model 3	93.6	72.1	24.3	6.2
Data	78.3	34.8	8.2	5.5
UK				
Model 1	96.6	85.5	45.5	2.9
Model 2	88.0	48.1	42.0	3.3
Data	79.0	57.0	18.7	10.3
Canada				
Model 1	97.0	58.4	48.0	2.7
Model 2	92.1	47.6	45.7	3.4
Model 3	86.3	46.0	43.8	4.8
Data	80.0	55.0	22.9	5.7
Australia				
Model 1	96.2	88.6	38.7	3.3
Model 2	95.7	48.5	26.1	3.8
Data	76.2	51.9	21.4	10.8

Table 5: Employment and Disability Incidence Across Countries: Model vs. Data. Data Source: OECD, 2003.

So far we have assumed the U.S. earnings profile for all countries. Several authors have documented that the life cycle profiles for wages/earnings differ substantially across countries (see Guvenen, Kuruscu, and Ozkan (2014) and Lagakos, Moll, Porzio, Qian, and Schoellman (2012)). This has potential implications for how attractive pension and disability insurance programs appear across countries. Moreover, there is potential interaction between the earnings profile and the details of the pension system. One example of this is that the number of years on which the pension benefit is based differs substantially across countries. To address these concerns, we include results from an exercise where we also vary earnings profiles across countries. We label this Model 3. Of the countries in our sample, the LIS dataset includes the necessary variables to construct life cycle earnings profiles for Canada, Denmark, Germany, the Netherlands and Spain. The earnings profiles for these countries are constructed in the same way as for the U.S.; the coefficients of the earnings functions are reported in Table A2 in the Appendix. We chose not to limit our sample to these five countries, as doing so would eliminate some of the interesting cross-country variation in social insurance schemes. As seen from Table 5, the model predicted employment rates for Spain, the Netherlands and Germany are slightly higher with the country specific earnings profiles than with the U.S. earnings profiles. Conversely, the model predicted employment rates for Denmark and Canada are slightly lower with the country specific earnings profiles than with the U.S. earnings profiles. All in all, the effect of varying earnings profiles across countries is relatively small and does not alter our main findings.

From the model it is clear that there are large incentives for early retirement built into the social insurance systems in place in France, Spain, Sweden, the Netherlands and Denmark. With the exception of France, the incentives for early retirement in these countries arise in large part from the generous disability insurance schemes. In France, the old-age pension scheme creates strong incentives for early retirement. Conversely, less generous social security programs encourage older workers to remain employed in the U.K., Canada, Australia and Germany. In fact, the differences in social insurance across countries are so substantial that our model predicts even more variation in employment rates across countries than observed in the data. This suggests that something outside our model dampens these effects. The puzzle is not so much, why do Europeans work less than Americans, but rather, given the institutional incentives they face, why some Europeans work as much as they do. This result is similar in sprit to that of Ljungqvist and Sargent (2007), who find it hard to reconcile generous unemployment insurance benefits with the observed employment rates in Europe.

5.2 Discussion

In this section we discuss some of our modeling choices and how robust our results are to these assumptions. We also provide some intuition for our results.

Uses for Tax Revenue

Following Rogerson (2007) and Ragan (2013), we know that what the government does with the tax revenue matters for labor supply responses. Recall that we assume that the tax revenue left over after financing old-age pensions and disability insurance is thrown away. This is equivalent to assuming that the revenue is used to finance government consumption, which does not affect the marginal utility of private consumption. This is a reasonable assumption for at least a share of the remaining tax revenue. There are, however, tax and transfer programs in addition to the social insurance schemes modeled here that have potentially large effects for labor supply decisions. For example, Rogerson (2007) and Ragan (2013) stress that governmental subsidies to childcare and elderly care boost employment in the Scandinavian countries. These programs are, however, more likely to impact prime-aged workers than older workers. It is nevertheless potentially interesting to study alternative uses for the remaining tax revenue. Our approach can be thought of as a starting point for future analysis.

Discrete Labor Supply

Our model assumes a discrete labor supply choice, individuals either work full-time or not at all. Figure A1 in the Appendix illustrates that roughly 77% of 50-54 year old men in the U.S. are working 1,750 or more hours annually, whereas approximately 12% are not working at all. By age 70-74, only about 11% work in excess of 1,750 hours, while almost 75% report working zero hours. This implies that the prevalent transition in the data as people age is from full-time work to little or no work. Part-time work among men in the U.S. is very limited in scope at all ages, irrespective of whether part-time work is defined as working less than 1,750 hours annually (35 hours per week) or as working less than 1,500 hours annually (30 hours per week). By studying individual level panel data from the PSID, Rogerson and Wallenius (2013) demonstrate that the prominent transition from full-time work to no work is indeed an abrupt one.

The lack of a part-time work option could, however, contribute to the model's over-prediction of the variation in employment rates across countries. Table A8 in the Appendix reports the prevalence of part-time work among men by age across our sample of OECD countries.[19] The incidence of part-time work among men is very limited in scope in all of the countries under study, although it does appear to rise slightly with age in some countries. While abstracting from a part-time work option is not entirely innocuous, it seems unlikely to be driving our results.

A related issue is that our model includes a number of discrete variables. This can mean that small changes to parameter values result in either no changes or alternatively large changes in labor supply. We have conducted some sensitivity analysis with respect to the calibration. There are several similar parameterizations that give almost as good of a fit as our chosen specification. The labor supply responses across the various policy experiments are similar with the slightly perturbed parameter values that we have experimented with. Nevertheless, an inherent feature of a model with a discrete labor supply choice is that the labor supply responses to policy changes may be larger than with a continuous labor supply choice. We would, however, argue that given the limited scope

[19]The OECD classifies less than 30 hours per week as part-time work. Canada and Australia do not report values for 65-69 and 70-74 year olds separately, only for 65+.

of part-time work among men, the retirement decision appears well approximated by a discrete choice.

Income and Employment Risk

Given that the only source of uncertainty in the model is health risk, one might be concerned that health shocks play too large a role in driving retirement behavior. In the Calibration Section, we demonstrated that this is actually not the case. In our model, just over 9% of the transitions from employment to retirement are associated with a decline in health from good to bad, compared with roughly 13% in the data. A potential concern, however, is that our calibrated disutility parameters may be influenced by the fact that we are abstracting from income or employment risk. See, e.g., Low, Meghir, and Pistaferri (2010), French (2005) and Erosa, Fuster, and Kambourov (2012) for a discussion of the effect of income and employment risk on precautionary savings and retirement. On a related note, unemployment is a potential channel into early retirement that we abstract from. This could be one reason our model over-predicts employment in Germany, since unemployment is a prevalent channel into retirement in Germany.

Disability

As previously documented, we observe big cross-country differences in the prevalence of disability insurance claiming. This is not so surprising, considering how much the incentives for disability insurance claiming differ across countries. However, our model predicts even more variation in the disability incidence rates than we see in the data. In particular, the model predicts much higher disability insurance claiming rates for Spain and the Netherlands, and to a lesser extent also for France, than we observe in the data. Conversely the model predicts too low disability incidence in the U.K. and Australia. To gain intuition for this result, it is perhaps interesting to evaluate some of our model assumptions. Recall that our analysis assumed that the cost of applying for disability insurance benefits and the probability of being awarded benefits (conditional on health) are the same for all countries. Moreover, we also assumed that preferences and the process governing shocks to health are the same across countries. As an illustration, let us consider the European countries of Spain, the Netherlands and France for which our model over-predicts disability incidence. Potential explanations for why our model over-predicts disability insurance claiming in these countries include: (1) the application cost for disability insurance benefits is higher in Europe than in the U.S., (2) the probability of being granted disability insurance benefits is lower in Europe than in the U.S., (3) Europeans have a lower disutility for work than their American counterparts or (4) Europeans are healthier or live longer than their American counterparts. In what follows we explore these alternative explanations.

While a longer life span has qualitatively the correct effect on employment and disability incidence rates, this explanation does not seem quantitatively plausible. A deterministic increase in the length of life of as much as five years has only a negligible effect on both employment and disability insurance incidence.

The notion that Europeans would have a lower disutility for work than their American counterparts seems implausible, given other cross-country observations regarding labor supply patterns, namely vacation days, holidays, sick time and workweek length.

As one would expect, raising the application cost of disability insurance benefits lowers disability incidence. The application cost would need to be raised from 30% to close to 50% to bring model predicted disability incidence rates down to the levels observed in the Netherlands, and to around 44% to bring the rates down to the levels observed in Spain. Even a cost of 100% of income in the application period is, however, not quite enough to bring down the disability incidence rates to levels observed in France. Note that in the U.S. applicants for disability benefits are required to have a six-month period of no work before applying for benefits, while in Europe applicants are not. Our findings would therefore suggest that the non-monetary component of application costs (e.g., social stigma, bureaucracy etc.) would need to be much higher in Europe than in the United States in order for differences in application costs to rationalize the discrepancy between disability rates predicted by the model and those observed in the data. This is supported by Lindbeck (1995) and Lindbeck and Nyberg (2006) who argue that generous welfare policies are only possible with strong social norms favoring work. The authors do caution, however, that such norms erode over time as more and more people start collecting social assistance.

In the baseline model the probability of being awarded disability insurance benefits when in good health and age 50 or older is 5%. Lowering this probability to around 3.5% brings the model predicted disability incidence rates close to those observed in Spain and the Netherlands. However, to lower the disability incidence rates under the French regime to the levels observed in the data one needs to also lower the probability of being granted disability benefits when sick. This implies a substantially tighter screening of disability insurance applicants in the aforementioned European countries relative to the United States. It should also be noted that, at least in the Netherlands (and Sweden), disability insurance benefits have also been awarded for labor market reasons since the 1970s (see Aarts and de Jong (2014)), although some countries have implemented more stringent screening policies recently (see, e.g., Johansson, Laun, and Laun (2014)). All in all, it remains a bit of a puzzle why some Europeans work as much as they do, given the generous social insurance programs in place in the countries in question.

6 Conclusions

We observe large cross-country differences in employment rates; these differences are particularly pronounced at older ages. In this paper we develop a life cycle model of labor supply and health to study the role of social insurance, namely old-age pensions, disability insurance and health insurance, in accounting for these differences across OECD countries.

Our model features heterogenous agents, who differ with respect to educational attainment, health insurance coverage and their preference for leisure. Individuals choose when to stop working and when/if to apply for old-age pension and disability insurance benefits. The granting of disability insurance benefits (conditional on applying) is imperfectly correlated with health. This implies that, in equilibrium, some healthy individuals will be granted benefits, while some sick individuals will in fact be denied benefits. Agents can partially insure against health shocks by investing in health. Health expenditures differ by health insurance status. We calibrate the model to the U.S., and then modify the retirement and health insurance systems to reflect those in place in Australia, Canada, Denmark, France, Germany, the Netherlands, Spain, Sweden and the U.K. in turn.

Older workers face very different incentives for continued employment in the OECD countries under study. We find that generous social insurance programs create incentives for early retirement in France, Spain, Sweden, the Netherlands and Denmark. With the exception of France, this is to a substantial degree driven by generous disability insurance schemes. Conversely, the model predicts high employment rates of older workers for Australia, Canada, the U.K. and Germany. The existence of public health insurance depresses labor supply in all of the countries under study. Despite this dampening effect, the model predicted employment rates for older workers in Canada, the U.K. and Germany are somewhat too high relative to the data. On the contrary, the model predicts somewhat too low employment of older workers in Spain, Sweden, Denmark and the Netherlands. The model predicted employment rates for France and Australia are more in line with the data. Given our findings, the puzzle is not, why do Europeans work so much less than Americans, but why, given the incentives built into the social insurance programs in place, do some Europeans work as much as they do. Moreover, viewed through the same lens, it is equally puzzling why people in Canada and the U.K. do not work more than they do.

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Appendix A: Data

Age	Non-College	College
50-54	91.3	96.6
55-59	85.2	92.2
60-64	63.6	71.7
65-69	37.4	53.8
70-74	25.4	34.9

Table A1: Employment Rates of Men (%) by Age and Education. Data source: HRS, 2004.

	Non-College			College		
Country	*Age*	*Age*^{2}	*Const.*	*Age*	*Age*^{2}	*Const.*
Canada	1731.6	-17.7	-4669.5	2833.9	-28.8	-19582.0
Denmark	1482.2	-16.0	7627.7	3154.2	-32.7	-19988.4
Germany	1223.5	-10.2	5847.5	3575.6	-34.3	-32192.0
Netherlands	1931.8	-19.1	-6748.8	4406.7	-41.2	-52838.7
Spain	861.6	-8.3	4678.9	1961.5	-17.1	-11967.4
US	1858.8	-16.9	-6069.3	5840.7	-59.1	-67737.6

Table A2: Coefficients of Earnings Functions

Country	a_0	a_1	a_2	ϕ
Australia	0.134	0.106	0	-9.450
Canada	0.273	0.020	-0.053	-1.371
Denmark	15.297	0.052	-14.940	-0.006
France	0.240	0.050	-0.004	-4.325
Germany	10.180	-0.101	-9.655	-0.025
Netherlands	0.266	0.069	0	-14.347
Spain	0.188	0.044	-0.030	-1.820
Sweden	7.210	0.118	-7.002	0.003
UK	0.204	0.059	0	-11.787
US	7.467	0.031	-7.248	-0.008

Table A3: Coefficients of Tax Functions

Medicare	Retiree Working	Retiree Not Working	Tied Working	Tied Not Working	None
No	$3,391	$4,165	$3,603	$5,806	$6,448
Yes	$3,563	$3,950	$4,109	$4,539	$5,214

Table A4: Average Health Expenditures by Health Insurance Coverage and Work Status. Based on French and Jones (2011).

Age	Non-College	College
50-54	8.7	3.4
55-59	10.0	4.6
60-64	11.2	4.6

Table A5: Disability Insurance Incidence of Older Men (%) by Educational Attainment. Data source: HRS, 2004.

	Non-College	
Age	Good	Bad
50-54	68.8	31.2
55-59	70.6	29.4
60-64	69.2	30.8
65-69	68.5	31.5
70-74	64.8	35.2
	College	
Age	Good	Bad
50-54	90.3	9.7
55-59	89.0	11.0
60-64	89.1	10.9
65-69	84.1	15.9
70-74	85.4	14.6

Table A6: Self-Assessed Health of Older Men (%) by Educational Attainment. Data source: HRS, 2004.

Country	Per Capita Health Expenditure ($)	Public Share of Health Expenditure (%)
Australia	3 231	67.9
Canada	3 691	70.5
Denmark	3 475	84.7
France	3 313	77.3
Germany	3 621	76.4
Netherlands	4188	74.7
Spain	2 509	73.0
Sweden	3 165	81.5
UK	3 007	81.4

Table A7: Health Expenditure Around the World. Data source: OECD, 2008.

Country/Age	50-54	55-59	60-64	65-69	70-74	65+
Australia	5.7	7.3	10.5	.	.	5.0
Canada	3.8	5.7	8.1	.	.	4.6
Denmark	4.9	4.4	6.5	7.6	6.1	.
France	3.7	3.7	2.2	1.3	0.7	.
Germany	4.1	4.7	5.6	4.8	2.8	.
Netherlands	6.4	10.1	13.0	10.6	6.6	.
Spain	1.3	1.3	2.5	1.2	0.8	.
Sweden	4.4	5.9	11.0	10.0	7.2	.
UK	4.0	6.9	10.3	10.1	5.0	.

Table A8: Prevalence of Male Part-time Work (%) Across Countries by Age. Data source: OECD, 2007.

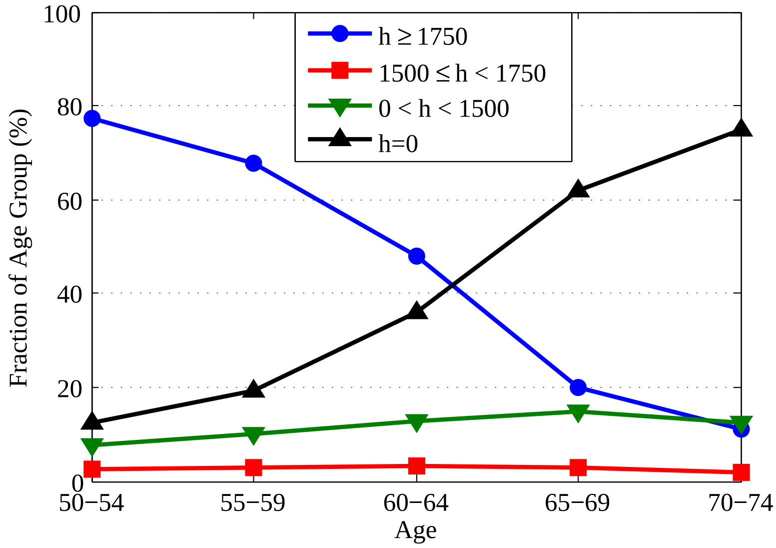

Figure A1: Distribution of Male Annual Hours by Age. Data source: CPS, 2004.

Appendix B: Details of Social Security Programs

Below we summarize the salient features of the social security programs in place in the countries under study. There have been changes to the systems over time; the programs outlined here are those in place in year 2004 (all amounts are in 2004 USD, PPP adjusted).

Australia

In Australia, the old-age pension benefit is comprised of two components, a flat-rate benefit and a mandatory occupational pension. The flat-rate benefit equals \$8 810 per year, and it is awarded at age 65. One is not required to stop working to collect the flat-rate benefit. Occupational pension accrual is 9% of earnings per year (paid out as annuity). The occupational pension can be claimed starting at age 55. However, if one claims before age 65, one is required to stop working. Disability insurance benefits are flat-rate and equal in size to the old-age pension benefit. There is no provision for disability in the occupational pension. Flat-rate benefits are not taxed, as long as the individual does not earn income in excess of \$16 705 per year. Occupational pensions are taxable income.

Canada

In Canada, the old-age pension benefit is comprised of two components, a universal pension (flat-rate) and an earnings related pension. The universal pension is awarded at age 65 and equals roughly \$4 653 annually. One is not required to stop working in order to collect the universal pension. The earnings related pension can be claimed starting at age 60. However, if one claims before age 65, one is required to stop working. The earnings related pension equals 25% of average lifetime earnings (with 15% of the lowest years of earnings dropped). The pension is reduced by 0.5% per month for each month in which benefits are received prior to reaching the full-retirement age of 65. Similarly, there is an increase of 0.5% per month for deferred claiming up to age 70. The maximum earnings dependent benefit is roughly \$8 085 annually. The disability benefit equals \$3 792 per year plus 75% of the earnings related pension. Benefits are taxable income.

Denmark

In Denmark, the old-age pension benefit is comprised of two components, a universal pension (flat-rate) and a mandatory occupational pension. The universal pension is awarded at age 67 and equals roughly \$13 086. The universal pension is reduced if the individual works. The occupational pension depends solely on hours and years worked, not on earnings. The maximum annual occupational pension for someone with a full contribution history (40 years working full-time) is \$2 619. The occupational pension is awarded at age 65. The disability benefit equals roughly \$19 850. Benefits are taxable income.

France

The French pension system has two tiers: an earnings related public pension and a mandatory occupational pension. The maximum public pension benefit is awarded with 40 years of contributions, but before 2003 it was granted with 37.5 years of contributions. We assume that a non-college individual can receive a full pension at age 60, while a college individual can receive a full pension at age 63. The full benefit equals 50% of average income from the 25 best years. The first age at which the benefit can be claimed is 60. However, the benefit is reduced by 5% per year for each missing year of contributions. One is required to stop working to collect benefits. Disability insurance can be claimed up to age 60. The disability benefit equals 50% of the average wage from the best 10 years. The occupational pension scheme that we model applies to workers in the private sector (this is also what Erosa, Fuster, and Kambourov (2012) model). The normal retirement age is 65 and there is a quasi-actuarial adjustment for early retirement (full retirement pension is possible with 37.5 years of contributions). The pension is calculated based on a point system. The contribution rate is 6% of average earnings on earnings below the economy's average earnings, and 16% above the average (up to three times the economy's average). The number of points earned in a particular year are computed by dividing the contributions by the cost of the pension point that year ($14.33). The total accumulated points are multiplied by the point value ($1.24) to compute the occupational pension benefit. Benefits are taxable income.

Germany

In Germany, the full-retirement age is 65, but it is possible to start claiming old-age pension benefits at age 63 (if the worker has 35 years of contributions). Benefits are tied to average lifetime earnings, as well as the relative earnings position of the individual. So called total earnings points are computed by taking individual annual earnings in each year, dividing them by average earnings in the economy in that year and then summing up over all years. To compute the benefit, one then multiplies total earnings points by the pension value. The pension value in 2004 was roughly $350. Benefits are reduced by 0.3% per month for every month that pension benefits are collected prior to reaching the full-retirement age of 65. The increase in benefits from deferred retirement is 0.5% for every month after age 65. One can only earn a small amount, approximately $385 per month, while collecting pension benefits. The disability insurance benefit is computed in the same manner as the old-age pension benefit, with the exception that if disability occurs before age 60, the period from the beginning of the reduction in earning capacity up to age 60 is taken fully into account for the purpose of calculating the pension. The benefit is reduced by 0.3% for every month a pension is drawn before age 63. Benefits are not taxed (after 2005, taxes phased in).

Netherlands

In the Netherlands, the old-age pension benefit is comprised of two components, a flat-rate benefit and a mandatory occupational pension. The flat-rate benefit equals $12 162 per year, and it is awarded at age 65. Occupational pensions are based on the lifetime average earnings of the individual. The replacement rate is 70% and benefits are reduced by a franchise amount which varies with the pension fund. We follow Erosa, Fuster, and Kambourov (2012) and assume a franchise of 40% of average earnings, which is the value that applies for most workers. The franchise serves as a threshold in the calculation of the occupational pension benefits. Individuals only build occupational pension if their earnings exceeds the franchise. In this way pension funds take into account the flat-rate pension that individuals receive. Early retirement schemes allow individuals to retire before age 65. The replacement rate determining the early retirement pension depends on the age of the individual at retirement and equals 0.7 for ages 61-64, 0.55 for age 60, 0.45 for age 59, 0.38 for age 58, 0.32 for age 57, 0.28 for age 56, and 0.25 for age 55. One must stop working to collect occupational pension. Disability benefits replace 70% of lost earnings. Benefits are taxable income.

Spain

The Spanish public pension system is organized in three regimes: the General Regime, the Special Regimes (for a few occupations), and the Regime for Civil Servants. We follow Erosa, Fuster, and Kambourov (2012) and model the General Regime, which applies to more than 70% of workers. The full-retirement age is 65, but the first age at which one can claim benefits is 60. The old-age pension benefit is based on average income from the last 15 years (called the benefit base). Contributions to the pension system are capped at 1.64 times the average earnings in the economy. Pension accrual is as follows: 50% of the benefit base for the first 15 years of contributions, plus 3% for each year between 16 and 25 years of contributions, and 2% for each year beginning with the 26th year, up to a maximum of 100%. Early pensions are reduced by 8% for each year less than age 65 for persons who have 30 years of contributions, by 7.5% if 31 to 34 years of contributions, by 7% if 35 to 37 years of contributions, by 6.5% if 38 to 39 years of contributions, by 6% if 40 years or more of contributions. One is required to stop working in order to collect benefits. The occupational disability award is 55% of the benefit base, plus 20% if the individual is 55 years old or more. Pension benefits are taxable income, but disability benefits are not.

Sweden

In Sweden, the old-age pension benefit is comprised of a public pension and a mandatory occupational pension. The public pension has two parts, a basic allowance and an earnings dependent supplement. Both are tied to the so-called basic amount (BA), which equals roughly \$4 319. The basic allowance is the same for everyone and equal to 0.96BA. The earnings dependent supplement is given by:

$$0.6AP_a \min(a/30, 1)\text{BA}, \tag{10}$$

where AP_a is average pension points at age a. One accrues pension points from earned income in the 15 highest years of earnings. They are computed by taking income in excess of the BA up to 7.5BA and dividing by the BA. Furthermore, there is an adjustment when there are less than 30 years of work. The first age at which the pension benefit can be claimed is 61. The full retirement age is 65. The actuarial adjustment for early claiming is 0.5%-points for every month up to age 65. The actuarial adjustment for delayed claiming is 0.7% for every month up to age 70. The disability insurance benefit is computed similarly to the old-age pension benefit with the exceptions that there is no actuarial reduction for early claiming, and assumed pension points are computed up to age 65 based on average income from the last three years prior to disability. Individuals can claim disability up to age 65. There are two occupational pension programs in the private sector: one for blue-collar workers and one for white-collar workers. We assume that the blue-collar scheme applies to non-college workers and the white-collar scheme to college workers. The size of the blue-collar occupational pension is based on average pension points from the three best income years between the ages of 55 and 59. The benefit is then computed by multiplying the average pension points plus 1 (to compensate for the base-amount deducted when calculating average pension points) by the base-amount and a factor of 0.1. A full occupational pension is granted with 30 years of work; the benefit is reduced proportionally for missing years. Similar to regular pension, only income up to 7.5 base-amounts counts toward the blue-collar occupational pension benefit. The white-collar occupational pension is based on income at the time of retirement. The white-collar occupational pension benefit equals 10% of the wage up to 7.5 base-amounts, 65% of the wage in excess of 7.5 and up to 20 base-amounts and 32.5% of the wage in excess of 20 and up to 30 base-amounts. No benefit is accumulated on income above 30 base-amounts. Again, a full occupational pension is granted with 30 years of work, and the benefit is reduced proportionally for missing years. The regular age for claiming both white-collar and blue-collar occupational pensions is 65. Early claiming of the white-collar occupational pension (from age 55 and up) is possible only if one stops working. Moreover, there is a reduction of 0.6%- points for every month up to age 65 for the early claiming of white-collar occupational pension. Benefits are taxable income.

United Kingdom

The claiming of old-age pension benefits in the United Kingdom starts at age 65. Benefits are comprised of two parts, a flat-rate portion and an earnings dependent portion. The flat-rate component equals roughly $6 372 per year. The earnings dependent component replaces 25% of average earnings from the best 20 years. The disability insurance benefit is a flat-rate benefit of approximately $5 936 per year. Benefits above a threshold of $15 800 are taxable.

Appendix C: Computation

The state x of an individual is given by age (a), assets (k), health (h), average income from best 35 years ($AIME$), pension status ($page$, age at which started claiming pension benefits, if claiming), disability status ($dage$, age at which started claiming disability benefits, if claiming) and work status ($rage$, age at which stopped working, if no longer working). Health is discretized into five states: very good, good, fair, bad and very bad, based on the OECD self-assessed health survey. We discretize assets and pick 472 evenly spaced grid points in $k = [0, k^{max}]$, where $k^{max} =$ \$800 000. $AIME$ is a continuous state variable. Individuals know x at the start of the period and decide how much to consume (c), how much to save (k'), whether or not to invest in health (i^h), weather or not to work (l), and, if applicable, whether or not to apply for pension/disability benefits (app^R and app^{DI}, respectively). Consumption is a continuous choice variable and solved for as the residual. The other choice variables are discrete by construction.

We solve the model by backward induction. We know the value function at age 81. For all possible states, we can then compute optimal policy and value functions at age 80, and so forth. The decision problem of the agent in a given period will depend on the age and past choices of the agent. Specifically, we assume that benefit claiming is an absorbing state and subject to eligibility. To illustrate, consider an individual aged 62, who is not currently claiming benefits and is still working. Given possible combinations of assets, health and $AIME$, this individual faces five possible choice combinations between working and claiming of benefits: keep working, keep working and apply for pension benefits, stop working, stop working and apply for pension benefits, apply for disability benefits. The choice space then consists of these five alternatives, the choice of whether or not to invest in health and the savings decision. We compute the consumption choice associated with each of these combinations and update $AIME$. We then pick the utility maximizing option from this set.

Having solved for the policy functions, we simulate the model. For aggregation purposes we assume that at any given point in time, the economy consists of 1 000 25 year olds, 1 000 26 year olds, 1 000 27 year olds, and so on.

To map the country-specific pension and disability rules to the model, we modify the formulas for $AIME$ and PIA. Specifically, the $AIME$ formula is adjusted to reflect the number of years on which the benefit is based. The PIA formula in turn is adjusted to incorporate a possible flat-rate component and to reflect the differing replacement rates on average earnings. We incorporate the country specific eligibility rules and adjustments for early and delayed claiming in the computation of the actual benefit.

Policy and Value Functions

Below are some plots of the policy and value functions. To conserve space we only show the plots for one type (high school, retiree health insurance, high disutility); the plots are similar across types. We plot the policy functions for consumption and savings as functions of current capital, assuming the individual is in average health and stops working/takes out pension at the average age for that particular type. These plots are for age 55. As one would expect, consumption and savings are increasing in current assets. The jaggedness in the graphs is due to the grid choice. Choosing an even finer grid smooths out the lines, but increases the computation time significantly. Our robustness checks indicate that our key outcomes are not affected by making the grid even finer. Thus it seems that our grid choice is appropriate. We also plot the age at which the individual stops working and the age at which the individual takes out pension benefits as a function of assets. For the former, we assume the agent is in average health and takes out pension benefits at the average age. For the latter, we assume the agent is in average health and stops working at the average age. The stop working age is decreasing in assets and the take out pension age is weakly increasing in assets. Health investment is weakly increasing in assets, although it appears to be driven more by health and age than assets (plot omitted here to conserve space).

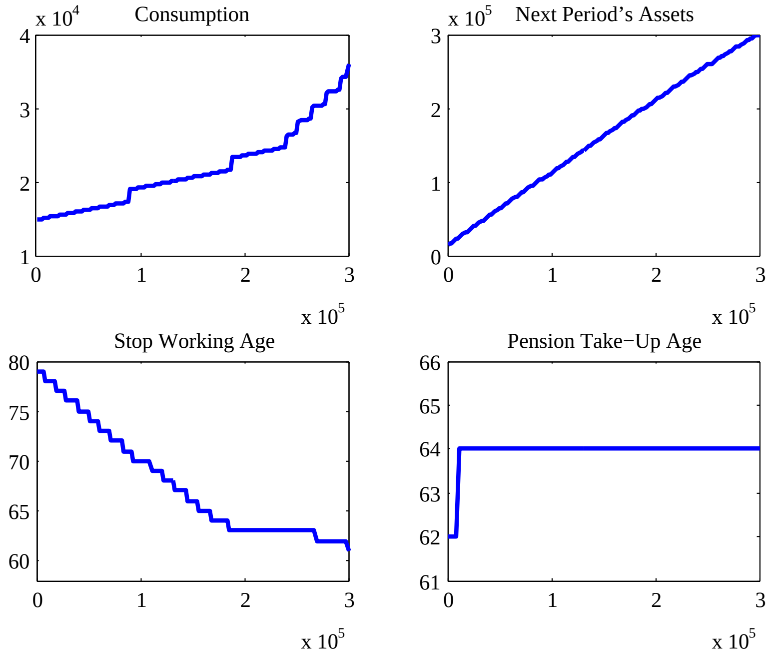

Figure A2: Policy Functions as a Function of Current Assets

Similarly, we plot the value function for one type as a function of assets, assuming average health and average age for stopping work/taking out pension. This plot is at age 55. As one would expect, the value functions are increasing in assets.

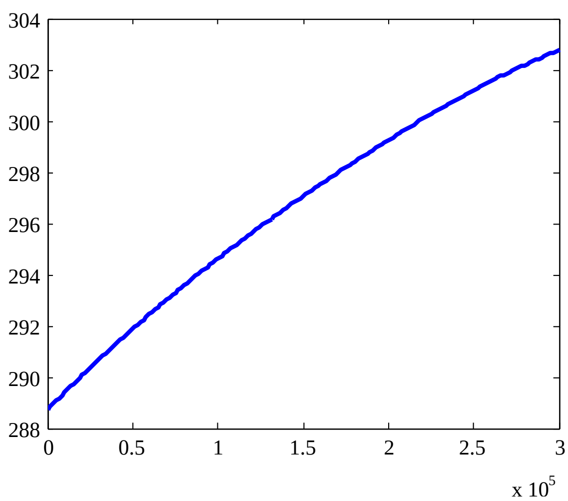

Figure A3: Value Function as a Function of Current Assets