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Social Insurance and Retirement: A Cross-Country Perspective

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Abstract

In this paper we study the role of social insurance, namely old-age pensions, disability insurance and healthcare, in accounting for the differing labor supply patterns of older individuals across OECD countries. To this end, we develop a life cycle model of labor supply and health with heterogeneous agents. The key features of the framework are: (1) people choose when to stop working, and when/if to apply for disability and pension benefits, (2) the awarding of disability insurance benefits is imperfectly correlated with health, and (3) people can partially insure against health shocks by investing in health, the cost of which is dependent on health insurance coverage. 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 55-64 than we observe in the data.

JEL classification: E24; J22; J26

Keywords: Life cycle; Retirement; Disability insurance; Health

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1 Introduction

The cross-country differences in aggregate hours of market work are striking. The U.S. is at the high end of the hours spectrum, along with Canada, Australia and New Zealand. France and Germany are at the opposite end of the spectrum, with hours worked at roughly 70% of the U.S. level. The differences in market work are particularly pronounced at older ages, with the employment rates of people aged 55-64 at 62-65% of the U.S. level in the continental European countries. Interestingly, however, the aforementioned European countries have low rates of disability insurance incidence, ranging between 4% and 6% of the population aged 50-64. Conversely, the U.S., the U.K. and Spain exhibit intermediate rates of between 7% and 10%, whereas Sweden has a high rate at close to 15%.

Simultaneously, we observe big cross-country differences in government programs, notably in old-age pension, 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, Australia and New Zealand, 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. These 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. The 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, France, Germany, New Zealand, Spain, Sweden, and the United Kingdom, in turn.

We find that older workers face very different incentives for continued employment in the various OECD countries under study. The generous early retirement and disability insurance programs create large incentives for early retirement –largely through disability insurance claiming – in France, Spain and Sweden, and to a lesser extent also Germany. Conversely, the less generous social security programs encourage older workers to remain employed in the UK, Canada, Australia and New Zealand. Based solely on differences in old-age pension and disability insurance programs, the model actually predicts even larger differences in the labor supply patterns of people aged 50-64 than we observe in the data. Public heath insurance dampens the incentives for continued employment in all of the countries. As a results, the model predictions for the UK, Canada, Australia and New Zealand line up quite well with the data. The model predicted employment rates for France, Spain and Sweden are much too low relative to the data. This is in large part due to over-predicted disability insurance incidence rates. In light of these 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, Europeans work as much as they do. It is worth noting that if one abstracts from disability insurance (or assumes it is exogenous), the results are quite different. Our results suggest one of four things: (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 the Sensitivity Analysis section we briefly discuss each of these potential explanations for the low model predicted employment rates of older workers in France, Spain and Sweden in turn.

Our paper 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 (2009), McDaniel (2011) and Erosa, Fuster, and Kambourov (2012). Relative to the literature, the novel features of our framework are the endogeneity of both health and disability insurance claiming. Individuals can influence their health, and thereby their likelihood of ending up on disability insurance, by investing in health. Individuals decide whether or not to apply for disability insurance benefits. Moreover, we allow for the possibility that non-disabled individuals might like to be on disability insurance, and could be granted benefits due to the imperfect nature of the screening process. 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 insurance coverage and their preference for leisure. We model two education groups, college and non-college. The motivation for this is that we observe significant differences in the labor supply behavior of these groups in the data. Whether this 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. We therefore model three health insurance categories: retiree health insurance, tied health insurance and no health insurance. We assume people differ in their preference for leisure. Specifically, individuals fall into one of three categories: low, medium or high disutility from working. All together, there are 18 combinations of education, health insurance coverage and preference for leisure, which we term types.

A model period is a year, and individuals live for 59 periods with certainty. We do not model educational attainment. Hence, model age zero corresponds to age 22 in the data.

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:

$$\sum_{a=0}^{58} \beta^{a} \left[\ln(c_{a,s}) - b(h_{a,s}, s) l_{a,s} + h_{a,s}\right], \tag{1}$$

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 health dependent, specifically that working is more unpleasant the worse ones health.[1] Furthermore, we allow the disutility from working to differ based on educational attainment (or type). The health of an individual also enters directly in the utility function.[2]

Each period there are markets for consumption, labor, capital and health investment. 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 $p(s,a)$ the cost of health investment as a function of health insurance status (or type). The individual faces a sequence of budget

[1] 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.

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

constraints given by:

$$c_{a,s} + k_{a+1,s} - (1+r)k_{a,s} + p(s,a)i^h_{a,s} = (1-\tau_s)w_{a,s}l_{a,s} + I^{DI}_{a,s}DI_{a,s} - c^{DI}_{a,s}I^{appDI}_{a,s} + I^R_{a,s}R_{a,s}. \tag{2}$$

The capital stock of an agent of type s at age a is denoted by $k_{a,s}$. 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.[3] We abstract from bequests.

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 are denoted by $i^h_{a,s}$, and take the value of zero or one. Health evolves 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.

Our focus is on the labor supply decisions of older workers, particularly the retirement margin. Motivated by the observation of Rogerson and Wallenius (2012) that the prominent transition from full-time work to no work is an abrupt one, we assume a discrete labor choice. In the model, the individual either works full-time or not at all, $l_{a,s} \in \{0, \bar{l}\}$. Labor income is the product of the exogenous, age-dependent wage and labor supply.[4] The government levies a proportional tax, τ_s, on labor income.

The collection of disability insurance benefits is contingent on both applying for ben-

[3]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.

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

efits and being awarded them. $I_{a,s}^{appDI}$ is an indicator function, which takes the value one if the individual applies for disability benefits and zero otherwise. Similarly, $I_{a,s}^{DI}$ is an indicator function, which takes the value one if the individual receives disability benefits (contingent on applying for them) and zero otherwise. 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 $c_{a,s}^{DI}$, and incurred irrespective of whether the individual is granted disability insurance benefits or not. This cost is intended to capture lost earnings associated with applying for disability insurance, as well as any potential social stigma associated with applying for disability insurance benefits. The cost is proportional to earnings prior to applying for disability insurance. $I_{a,s}^{R}$ is an indicator function, which takes the value one if the individual applies for retirement benefits and zero otherwise. $DI_{a,s}$ denotes the disability benefits and $R_{a,s}$ the retirement benefits. Both benefits depend on the age and past earnings of the claimant. The benefits will be discussed in more detail in the calibration section.

The government uses the proceeds from the proportional tax levied on labor income, τ_s, to finance the retirement and disability insurance benefits, as well as government consumption. We assume that individuals value government consumption, but that it does not affect the marginal utility of private consumption. An example of this nature is defense spending. We assume a balanced budget in equilibrium.

2.1 Solving the Model

Each period agents choose: how much to consume, how much to invest in physical capital, whether or not to invest in health, whether or not to work, whether or not to apply for disability insurance and whether or not to apply for pension benefits. The large number of combinations implies a large state space. Coupled with a large number of types, this yields a computationally intensive problem.

Labor supply and health investment are discrete choices by construction. Hence, we only need to discretize physical capital. We assume a capital grid with 31 grid points, ranging from 0 to \$150 000.

The decision rules are solved for via backward induction. Assuming zero utility when dead, we know the value function at age 81. This enables us to solve the agent's problem at age 80 for each possible employment history (including disability and pension claiming decisions as well as the decision of when to stop working) and for each state of health and physical capital. Given this, we know the value function at age 80, which in turn allows us to solve the agent's problem at age 79. Working iteratively backwards we are able to solve the full decision problem.

Once we have solved for the decision rules, we simulate the model 59 000 times. For aggregation purposes we assume that at any given point in time, the economy consists of 10 000 22 year olds, 10 000 23 year olds, 10 000 24 year olds, and so on.

3 Calibration

In this section we discuss the process of assigning values for the model parameters. We calibrate the model to the United States. The policy parameters are chosen to match the details of the U.S. social security and health insurance systems and the remaining parameters are chosen to match moments of the U.S. data.

Recall that the length of a period is calibrated to a year, and that model age zero corresponds to age 22 in the data. All agents enter the model in very good health and with zero assets. 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 three disutility from work categories, low, medium and high. This yields 18 types. The weights for the education and health insurance categories are taken from the data. The weights for the disutility from work categories are chosen to help match the retirement age distribution. Slightly less than a third of men in the U.S. have a college degree. Less than 10% of college educated men 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.[5]

The preference parameters that need to be assigned a value are the discount factor, β, and the parameter governing the disutility from working, $b(h,s)$. We assume an annual interest rate of 3%. For simplicity, we abstract from any life cycle effects and assume that $\beta = 1/(1+r)$.[6] The parameters governing the disutility from working are critical for matching the retirement age distribution. We allow the disutility from working to differ by health and educational attainment. We assume that the non-college educated worker derives greater disutility from working than his/her college educated counterpart. We further assume that there are three disutility types within each educational category, low, medium and high. For each of these six disutility types, the disutility from working is greater the worse the health of the individual. For each type we assume a linear relationship between the disutility levels associated with each of the five health states. As previously noted, the

[5]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.

[6]While there is some empirical evidence of life cycle effects, they are not of first-order importance for the questions addressed in this paper. We therefore abstract from them here.

parameters governing the disutility from work are chosen to match the employment rates of older men. The target distribution is shown in Table 1.[7]

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

The data used to construct the wage profiles is from the CPS. We construct a synthetic panel based on data for years 1976-2006. This is done separately for the two education groups. We calculate the hourly wage for an individual by dividing annual wage and salary income by annual hours. The data gives partial life cycle profiles for a large number of cohorts. To illustrate, one example of a cohort is 22 year olds in 1976, 23 year olds in 1977, 24 year olds in 1978 and so forth. We average over all the cohorts in the data to construct life cycle profiles for what we term an average cohort. It should be noted that this is not intended as an aggregation technique, but rather a way of constructing a typical profile for a typical individual. Wage and salary incomes are made comparable across time by adjusting for increases in the price level using the Consumer Price Index. Figure 1 plots the average wages for the college and non-college educated individual. For the college educated worker, wages rise steeply early on, and level off in the fifties. For the non-college educated worker, wages rise early on, but less steeply than for the college educated worker, and level off already in the forties. 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 the wage rate above age 65 fixed at the age 65 level.

As previously noted, our focus is on the pathways into retirement. Rogerson and Wallenius (2012) document that the dominant transition from full time work to not working

[7]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.

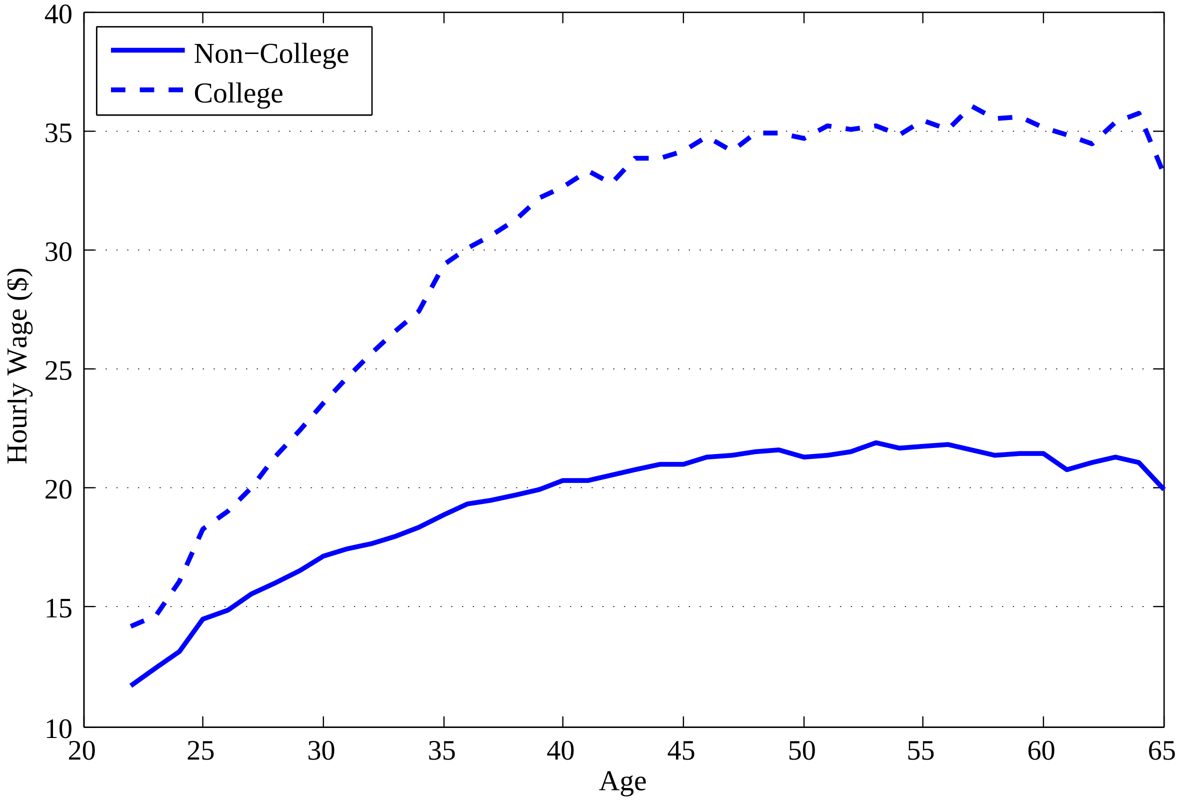

Figure 1: Hourly Wages for College and Non-College Men. Data source: CPS 1976-2006.

is an abrupt one. In other words, most people do not reduce hours of work prior to retirement, but rather retire directly from full-time work. Moreover, according to Rogerson and Wallenius (2012) employed people in their sixties work on average roughly 2000 hours annually. Motivated by these observations we have chosen to model the labor supply decision as a discrete choice between working full-time, 2000 hours annually, and not working.

There are three objects pertaining to health that must be parameterized: the cost of health investment, the effectiveness of health investment and the shocks to health. 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 2 reports average health expenditures by health insurance type and work status.

These numbers are based on those reported by French and Jones (2011).[8] 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.

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

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 persistence of health shocks. We also allow the shock probabilities 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. Iyen-

[8] 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.

gar 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 as well as stigma 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 3 summarizes the prevalence of disability insurance claiming among older men by educational attainment. The values reported are as a percentage of the referenced age group. Disability insurance claiming is much more prevalent among non-college educated workers than among college educated workers; slightly more than 11% of non-college educated workers go on disability insurance sometime during their life, whereas less than 5% of college educated workers go on disability insurance during their lifetime.

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

Table 3: Disability Insurance Incidence of Older Men (%) by Educational Attainment. Data source: HRS, 2004.

Table 4 reports the self-assessed health of older men for college and non-college educated workers respectively. The values are expressed as a percentage of the referenced age group. Unsurprisingly, college educated worker's report being in better health than their non-college educated counterparts.

			Non-College		
Age	Very Good	Good	Fair	Bad	Very Bad
50-54	13.6	24.6	32.0	21.9	11.1
55-59	10.7	29.0	32.1	20.5	9.9
60-64	10.3	26.8	33.3	21.5	10.0
65-69	8.9	25.2	35.7	22.5	9.2
70-74	7.4	25.4	33.0	23.3	12.6
75-79	8.5	20.1	35.3	27.0	11.9
			College		
Age	Very Good	Good	Fair	Bad	Very Bad
50-54	32.6	33.0	25.7	8.8	2.0
55-59	30.2	40.5	24.4	10.4	3.0
60-64	20.2	43.4	28.4	10.4	4.0
65-69	20.6	34.8	29.9	13.8	5.1
70-74	18.1	36.8	34.4	13.8	7.8
75-79	16.0	38.7	36.9	17.1	7.2

Table 4: Self-Assessed Health of Older Men (%) by Educational Attainment. Data source: HRS, 2004.

Given our focus on the labor supply incentives built into social security systems, we have striven to capture the details of said social insurance systems. In the U.S., 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. When mapping the retirement system to the model, AIME is the state variable. 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 66, 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.[9] One does not have to stop working to collect benefits. 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. 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 retirement at the age of 65. Benefits are unaffected by this transition.

We set the tax rates to match the average labor tax burden in the U.S. for college and non-college educated individuals, respectively. The tax rate is 25.6% for non-college educated individuals and 28.8% for college educated individuals. These tax rates include income taxes, social security taxes and consumption taxes.[10] The government uses the tax revenue to finance the social insurance programs as well as government consumption. The government balances its budget in equilibrium.

Table 5 summarizes the calibrated parameter values for the benchmark U.S. economy. A few of the parameters are worth commenting on. The cost of applying for disability

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

[10]The tax rates are from McDaniel (2007) and The College Board, Education Pays 2010 (http://trends.collegeboard.org/education_pays).

insurance implies that roughly 30% of labor earnings are lost in the period in which the individual applies for disability benefits, irrespective of whether or not the individual is awarded 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. The probability of being awarded disability insurance benefits when in bad or very bad health is 0.4, whereas the probability in all other health states is 0.01 when younger than 50 and 0.053 otherwise. This results in an acceptance rate of 52.8%. Moreover, our model predicts that roughly 8% of disability insurance claimants are not truly disabled (i.e., in very good, good or fair health), whereas around 51% of those denied benefits are in fact disabled. These values are in line with the estimates from Low and Pistaferri (2010) and Benitez-Silva, Buchinsky, and Rust (2004).

Recall that the probability of a health shock is dependent on age, health and educational attainment. Specifically, we assume that the probability of being hit by the small health shock increases linearly with age, from 0.12 to 0.6 for the non-college types and from 0.1 to 0.4 for the college types. However, if the individual is in the worst health state, the probability of being hit by the small shock is 0.6 for the non-college educated worker and 0.4 for the college educated worker, regardless of age. The probability of the big health shock is constant over age at 0.006 for the non-college types and 0.004 for the college types, unless the individual is in the worst health state, in which case the probability is 0.1 regardless of age or educational attainment. 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. The table reports the boundary values for each of the five health states.

Recall that the non-college educated worker derives greater disutility from working than his/her college educated counterpart, and furthermore that there are three disutility

Parameter	Value	Explanation
Policy Parameters		
τ_n	0.2558	Tax on labor income (non-college)
τ_c	0.2884	Tax on labor income (college)
DI Parameters		
τ_d	0.29	Cost of applying for DI
ph_1	0.40	Probability of getting DI if health=1-2
ph_2	0.01	Probability of getting DI if health=3-5 and younger than 50
ph_2	0.053	Probability of getting DI if health=3-5 and older than 49
Utility Parameters		
β	0.97	Discount factor
r	0.03	Interest rate
Health Parameters		
e^l	1	Decrease in health from low shock
e^h	3	Decrease in health from high shock
p_n^l	$0.12 \to 0.6$	Probability of low shock (non-college)
p_c^l	$0.10 \to 0.4$	Probability of low shock (college)
p_{1n}^l	0.6	Probability of low shock when health very bad (non-college)
p_{1c}^l	0.4	Probability of low shock when health very bad (college)
p_n^h	0.006	Probability of high shock (non-college)
p_c^h	0.004	Probability of high shock (college)
p_1^h	0.1	Probability of high shock when health very bad
q_5	$1.0 \to 0.5$	Probability health investment effective when health very good
q_4	$0.9 \to 0.5$	Probability health investment effective when health good
q_3	$0.8 \to 0.5$	Probability health investment effective when health fair
q_2	$0.4 \to 0.1$	Probability health investment effective when health bad
q_1	$0.2 \to 0.1$	Probability health investment effective when health very bad

Table 5: Calibrated Parameter Values

types within each educational category, low, medium and high. For each of these six disutility types, the disutility from working is greater the worse the health of the individual. We assume a linear relationship. For clarity, the disutility profiles are reported separately in Table 6.

The calibration of the model is an involved process, as there are many moments from the data that we are attempting to match. We are particularly interested in how well we are able to replicate the labor supply behavior of older workers. Figure 2 shows the employment rates of older men by age and education relative to the data. The results assume

Non-College					
Disutility	Very Good	Good	Fair	Bad	Very Bad
Low	3.0	3.05	3.1	3.15	3.2
Medium	3.7	3.75	3.8	3.85	3.9
High	4.4	4.45	4.5	4.55	4.6
College					
Type	Very Good	Good	Fair	Bad	Very Bad
Low	3.2	3.25	3.3	3.35	3.4
Medium	3.6	3.65	3.7	3.75	3.8
High	4.8	4.85	4.9	4.95	5.0

Table 6: Disutility of Working Parameters by Health and Educational Attainment

equal weights on the three disutility from working types for the college educated workers and weights of 26.67%, 26.67% and 46.67% for the low, medium and high disutility types for the non-college educated workers. The fit of the model is quite 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 does, however, predict slightly too low employment in the late 60s and early 70s. The model fit for the college types is not as good as for the non-college types, but still decent. In particular, the model predicts somewhat too high employment in the early 60s and a steeper decline in employment thereafter relative to the data.

There are sizable differences in retirement behavior based on health insurance coverage. Our model predicts that individuals with retiree health insurance stop working earlier than those with tied health insurance, while individuals with no health insurance coverage work the longest. The differences are more pronounced for the non-college educated workers than for the college educated workers. The non-college educated workers with tied health insurance coverage retire on average almost one year later than the non-college educated workers with retiree health insurance; for the college educated workers this difference is only roughly 4 months. The non-college educated workers with no health insurance work on average more than 17 months longer than the non-college educated workers with tied health insurance coverage; for the college educated workers this difference is just over 8 months. These patterns are in line with the findings of French and Jones (2011).

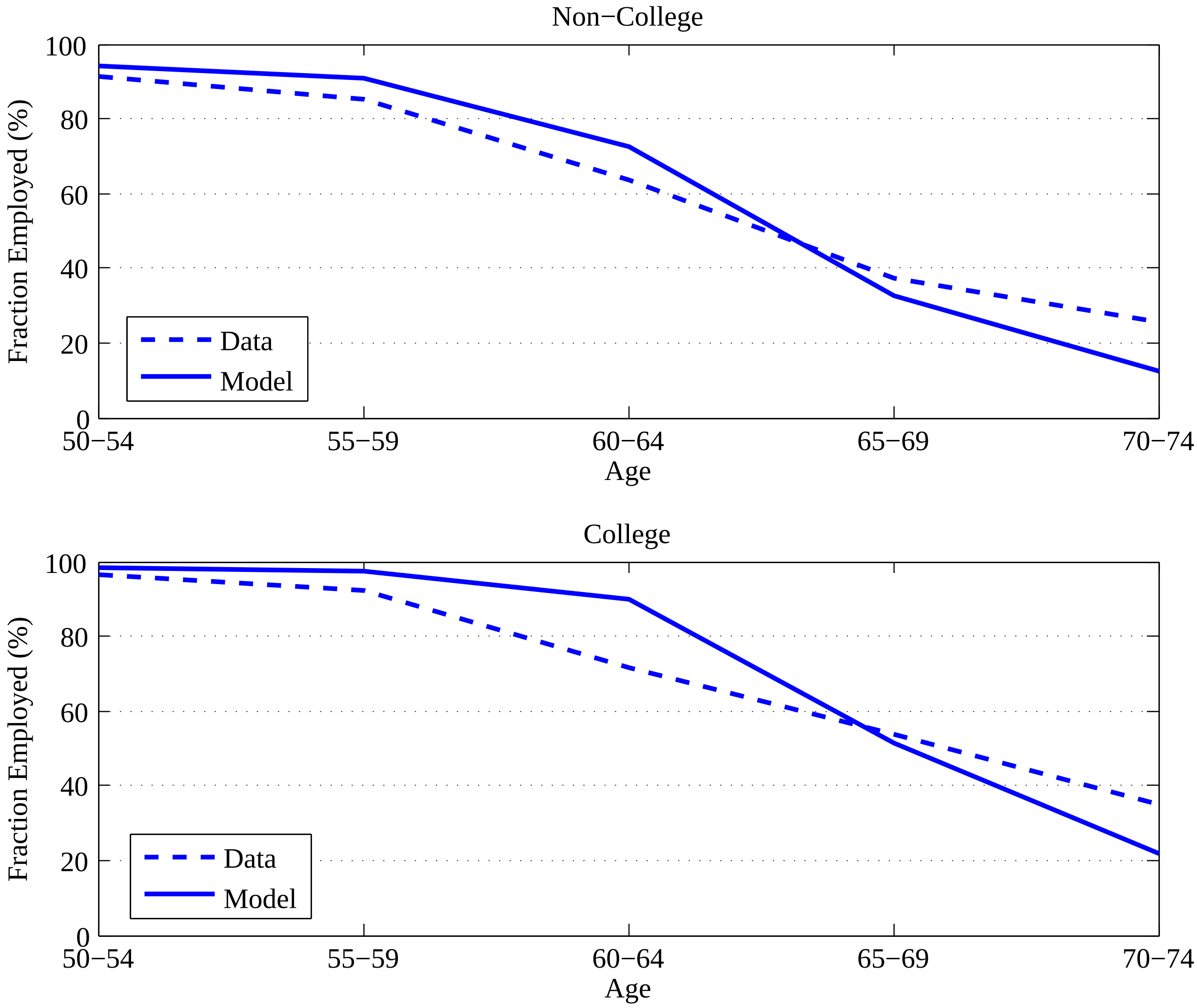

Figure 2: Employment Rates by Age and Education: Model vs. Data

Table 7 reports disability insurance claiming by age and educational attainment. The model slightly over-predicts the incidence of disability insurance in the 60-64 age group for the non-college educated workers and slightly under-predicts the incidence of disability insurance throughout for the college educated workers. All in all, however, the model does a relatively good job of matching both the timing and incidence of disability insurance claiming.

One dimension along which the model struggles a little bit is in matching the health

Non-College		
Age	Model	Data
50-54	5.94	8.70
55-59	9.07	10.00
60-64	12.35	11.20
College		
Age	Model	Data
50-54	1.64	3.40
55-59	2.77	4.60
60-64	3.71	4.60

Table 7: Disability Insurance Incidence (%) by Age and Education: Model vs. Data.

distribution at older ages. In particular, the model predicts too much mass at the extremes and not enough at the intermediate health states. However, if we group the five health states into two categories, 'good' and 'bad', where good health corresponds to the three best health states and bad health to the two worst, the fit of the model to the data on self-assessed health is quite good. As is evident from Table 8, in the age group 60-64 the model somewhat over predicts the share of healthy individuals. By age 70-74, this corrects itself and the fit to the data is good.

Non-College			
Age	Health	Data	Model
60-64	Good	69.2	86.2
60-64	Bad	30.8	13.8
70-74	Good	64.8	67.2
70-74	Bad	35.2	32.8
College			
Age	Health	Data	Model
60-64	Good	89.1	95.1
60-64	Bad	10.9	4.9
70-74	Good	85.4	88.4
70-74	Bad	14.6	11.6

Table 8: Health Distribution (%) by Age and Education: Model vs. Data

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 in the Introduction, 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, France, Germany, New Zealand, Spain, Sweden and the U.K., are similar to the United States. However, by age 60-64, the differences grow very large. The employment rates of people aged 60-64 in France and Germany are 26% and 56% of the U.S. level, respectively. The employment rates in Australia, Canada and Spain are noticeably higher at 88%, 89% and 83% of the U.S. level, respectively. New Zealand, Sweden and the U.K. report the highest employment rates at 115%, 110%, and 98% of the U.S. level, respectively.

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 between 4% and 6% of the population aged 50-64 claiming disability benefits. Conversely, the U.S., the U.K., Spain, New Zealand and Australia exhibit intermediate rates of disability insurance incidence with between 6% and 11% the population aged 50-64 claiming benefits. Sweden has a high rate of disability insurance incidence with close to 15% of the population aged 50-64 claiming disability benefits.

In our policy analysis, we modify the old-age pension benefits, the disability insurance benefits and healthcare to reflect the social insurance programs in place in various European countries and in Canada, Australia and New Zealand in turn. The tax rate on labor is set equal to the effective tax burden on labor in the country in question.

We now briefly highlight some of the key features of the old-age pension and disability insurance programs in place in the countries under study. The details for each country can be found in the Appendix. At one end of the spectrum lie France, Germany and Spain, where one can claim old-age pension benefits at a rather young age, and where the level of benefits is quite generous. In order to claim benefits in these countries, one is essentially required to stop working.[11] The disability insurance benefits are very generous in Spain. Conversely, they are not very generous in France or Germany. Old-age pension and disability insurance benefits are both quite generous in Sweden. However, contrary to the continental European countries, in Sweden one is not required to stop working to claim old-age pension benefits. Australia and New Zealand are at the opposite end of the spectrum. Both have a flat-rate benefit scheme, where old-age pension benefits and disability insurance benefits are independent of earnings. Benefit claiming starts at age 65 and one is not required to stop working to claim benefits. The level of benefits is quite modest in both countries. The U.K. and Canada are intermediate cases in terms of the generosity of benefits.

We take great care in modeling the institutional features of old-age pension benefits across countries, both in terms of the accrual of benefits and the eligibility rules associated with collecting benefits. We set the generosity of disability insurance benefits according to the country specific regulations. 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.

All the European countries, as well as Canada, Australia and New Zealand 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

[11] One can earn a small amount while collecting social security in Germany ($420 per month), 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.

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 9 reports average per capita health expenditures as well as the public share of all health expenditures. Per capita health expenditures range from roughly $3 000 in New Zealand, Spain and the U.K. to roughly $4 000 in Canada. The public share of health expenditures is large in all of the European countries as well as in Australia, Canada, and New Zealand. It ranges from roughly 68% in Australia to approximately 83% in New Zealand.

Country	Per Capita Health Expenditure ($)	Public Share of Health Expenditure (%)
Australia	3 353	67.5
Canada	4 079	70.2
France	3 696	77.8
Germany	3 737	76.8
New Zealand	2 983	83.2
Spain	2 902	72.5
Sweden	3 407	81.9
UK	3 129	82.6

Table 9: Health Expenditure Around the World. Data source: OECD, 2008.

The effective tax rate on labor income varies considerably across countries. The average effective tax rates on labor income are summarized Table 10 for the countries under study. Canada, Australia and New Zealand have tax rates similar to the U.S., ranging from 27.2% to 33.6%. The U.K. and Spain have slightly higher tax rates at 38.8% and 42.3%, respectively. France, Germany and Sweden have considerably higher tax rates, in excess of 50%. The tax rates are from McDaniel (2007) and include income taxes, social security taxes and consumption taxes.

All other parameters, including the parameters governing the disutility of working and the health process, are kept at the benchmark U.S. level.

Country	Tax on Labor (%)
Australia	27.2
Canada	33.6
France	53.9
Germany	50.4
New Zealand	32.0
Spain	42.3
Sweden	57.3
UK	38.8

Table 10: Effective Labor Tax Rates Across Countries, 2004. Data source: McDaniel (2007).

5 Cross-Country Analysis

5.1 Results

In this section we present the results from our quantitative exercise. We begin by modifying the old-age pension and disability insurance programs to reflect those in place in Australia, Canada, France, Germany, New Zealand, Spain, Sweden and the U.K. in turn. The effective labor tax rate is also set to the country specific level to capture the fact that the funding of more (less) generous government programs requires a higher (lower) payroll tax. As noted previously, all other parameters are kept at the benchmark U.S. values. In essence, we are asking what would happen if the U.S. were to implement the social insurance programs in place in, for example, Germany, 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. The results from this exercise are presented in Table 11, which reports the model predicted employment rates by age and the model predicted disability insurance incidence rates among 50-64 year olds, and contrasts both with the data for the country in question. The table also reports the model predicted average retirement age for each country.[12]

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

	Sweden		France		Spain		Germany	
Age	Model	Data	Model	Data	Model	Data	Model	Data
50-54	79.3%	85.3%	81.7%	95.6%	81.7%	91.6%	96.6%	94.4%
55-59	63.5%	79.3%	72.4%	67.9%	62.3%	77.5%	93.6%	78.3%
60-64	27.7%	59.9%	10.5%	16.2%	13.6%	49.9%	55.3%	34.8%
65-69	0.0%	16.4%	0.0%	4.3%	0.0%	6.0%	0.0%	8.2%
70-74	0.0%	12.2%	0.0%	1.5%	0.0%	1.6%	0.0%	4.5%
Ret. Age	57.94		57.73		57.70		62.22	
DI 50-64	32.1%	14.7%	24.9%	4.4%	32.5%	8.4%	6.3%	5.5%

	UK		Canada		New Zealand		Australia	
Age	Model	Data	Model	Data	Model	Data	Model	Data
50-54	98.8%	89.7%	97.4%	94.3%	98.7%	93.6%	97.8%	89.2%
55-59	96.8%	79.0%	95.5%	80.0%	97.0%	87.2%	96.1%	76.2%
60-64	74.0%	57.0%	78.1%	55.0%	94.8%	67.1%	93.8%	51.9%
65-69	35.4%	18.7%	49.0%	22.9%	54.3%	30.6%	51.8%	21.4%
70-74	9.7%	7.0%	40.7%	11.3%	40.5%	14.4%	39.8%	
Ret. Age	65.42		68.32		69.60		69.18	
DI 50-64	2.9%	10.3%	4.4%	5.7%	2.9%	6.4%	3.8%	10.8%

Table 11: Employment and Disability Insurance Incidence Rates Across Countries: Model vs. Data

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, the U.K., Australia and New Zealand. Specifically, the model predicted employment rates for people aged 65-69 in the U.K. are similar to those for the benchmark U.S. economy, whereas the corresponding model predicted values for Canada, Australia and New Zealand are even higher. The model also predicts low disability insurance claiming rates for the four aforementioned countries. Comparing this to the actual data, we see that the model predicts higher employment rates and lower disability insurance incidence rates for older workers than we observe in actuality in Canada, the U.K., Australia and New Zealand.

Conversely, the model predicts low employment rates for older workers under the French, German, Spanish and Swedish pension and disability insurance programs. The model also predicts high disability insurance claiming rates for France, Spain and Sweden. Comparing the model predictions to the data, we see that differences in pension and disability insurance programs go a long way toward accounting for the labor supply differences between the U.S. and Germany. Namely, the model predictions for Germany match up quite well with the data. The model predicted employment distribution under the French system is also quite similar to the actual data on France, although disability insurance incidence is largely over-predicted by the model. The model predicts too low employment and much too high disability insurance claiming among older workers relative to actual observations for the Spanish and Swedish economies.

The previous exercise assumed the health expenditure structure of the U.S. benchmark economy. We now conduct the same exercise but with the addition of public health insurance, captured through country specific subsidy rates on health expenditures. 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. 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. However, as is apparent from Table 12, this effect is larger for the countries where, in the absence of public health insurance, the model predicted high employment rates for older workers than in the countries where it predicted lower rates. This implies that after the addition of public health insurance, the model predictions are quite good for the UK, Canada, Australia and New Zealand. Moreover, it indicates that public health insurance is important for understanding the labor supply patterns of older workers in the aforementioned countries.

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. The fact the our model over-predicts disability insurance claiming in several European countries would, therefore, suggest one of four things: (1) the application cost for disability insurance benefits is higher in Europe

	Sweden		France		Spain		Germany	
Age	Model	Data	Model	Data	Model	Data	Model	Data
50-54	81.7%	85.3%	81.6%	95.6%	81.7%	91.6%	90.9%	94.4%
55-59	55.2%	79.3%	66.9%	67.9%	61.2%	77.5%	86.0%	78.3%
60-64	12.8%	59.9%	3.6%	16.2%	9.1%	49.9%	46.6%	34.8%
65-69	0.0%	16.4%	0.0%	4.3%	0.0%	6.0%	0.0%	8.2%
70-74	0.0%	12.2%	0.0%	1.5%	0.0%	1.6%	0.0%	4.5%
Ret. Age	57.25		57.33		57.41		61.12	
DI 50-64	31.9%	14.7%	28.6%	4.4%	33.6%	8.4%	13.2%	5.5%

	UK		Canada		New Zealand		Australia	
Age	Model	Data	Model	Data	Model	Data	Model	Data
50-54	98.1%	89.7%	97.0%	94.3%	98.1%	93.6%	97.3%	89.2%
55-59	73.3%	79.0%	95.0%	80.0%	96.1%	87.2%	95.4%	76.2%
60-64	43.1%	57.0%	57.7%	55.0%	66.6%	67.1%	71.8%	51.9%
65-69	20.5%	18.7%	39.4%	22.9%	39.9%	30.6%	39.7%	21.4%
70-74	0.0%	7.0%	35.7%	11.3%	30.6%	14.4%	32.7%	
Ret. Age	61.72		66.19		66.58		66.79	
DI 50-64	3.4%	10.3%	4.9%	5.7%	3.8%	6.4%	4.6%	10.8%

Table 12: Effect of Public Healthcare on Employment and Disability Insurance Incidence Rates Across Countries

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 the following sub-section we explore these alternative explanations. One should note, however, that despite modeling a large share of governmental programs, there are some programs that we abstract from that could potentially affect the results. As pointed out by Rogerson (2007) and Ragan (2013), 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.

To summarize, our results suggest that older workers face very different incentives for continued employment in the different OECD countries. In fact, feeding in the differences in institutional features 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 do they 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

The very high disability insurance incidence rates (which contribute to the low employment rates of older workers) under the French, Spanish and Swedish pension and disability insurance programs are among the more striking predictions of the model. When comparing the French, Spanish and Swedish disability insurance programs to the program in place in the U.S., two things stand out: (1) disability insurance benefits in Europe and more generous, and (2) the generosity of disability insurance benefits relative to the generosity of old-age pension benefits is higher in Europe than in the United States. Both of these features make disability insurance claiming more attractive under the French, Spanish and Swedish systems than under the U.S. system. To disentangle these two effects, we conducted the following exercise. Alter the U.S. old-age pension and disability insurance benefits so that the relative generosity of pension benefits (for someone claiming benefits at age 65) and disability insurance benefits (for someone going on disability insurance at age 50) is the same as in France, Spain and Sweden in turn, keeping total social security payments constant at the benchmark U.S. level. All other aspects, including the cost of applying for disability insurance benefits and the probability of being awarded benefits, are kept at the benchmark level. This entails scaling up disability insurance benefits and scaling down pension benefits relative to the baseline U.S. framework. We find that simply altering the relative generosity of pension and disability insurance benefits, keeping total social security payments fixed, accounts for roughly a third of the predicted difference in disability insurance claiming rates between the U.S. and the European countries in question. In other words, the European systems create large incentives for disability insurance claiming not only through generous benefits, but also by not rewarding continued employment to as large a degree as in the United States.

That said, the model predicts much higher disability insurance claiming rates for France, Spain and Sweden than we observe in the data. As we concluded in the previous section, there are four possible reasons for this: (1) Europeans are healthier or live longer than their American counterparts, (2) the disutility from work is lower in Europe than in the U.S., (3) the cost of applying for disability insurance benefits is higher in Europe than in the U.S. and (4) the probability of being granted disability insurance benefits is lower in Europe than in the United States. In this section we evaluate the plausibility of each of these explanations in turn.

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. However, in order to bring down disability insurance incidence rates to the levels observed in France, Spain and Sweden, the application cost would need to be more than doubled. This seems implausibly large, particularly since 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. This would imply 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 the baseline model the probability of being awarded disability insurance benefits when in good health and age 50 or older is 5.3%. Lowering this probability to 2.0%, 3.0% and 2.9% in France, Sweden and Spain, respectively, brings the model predicted disability incidence rates close to those observed in the data. This implies a substantially tighter screening of disability insurance applicants in the aforementioned European countries relative to the United States. The fact that in Sweden disability insurance benefits were also awarded for labor market reasons through the 1990s casts some doubt over the plausibility of this explanation. It should, however, be noted that the screening of disability insurance applicants in Sweden has gotten much stricter since then (see, e.g., Johansson, Laun, and Laun (2013)). All in all, it remains a bit of a puzzle why 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 aggregate hours of market work; 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, France, Germany, New Zealand, 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 early retirement benefits create strong incentives for early retirement, in large part thorough disability insurance, in France, Spain, Sweden and, to a lesser extent, also Germany. Conversely, the model predicts high employment rates of older workers for Australia, Canada, New Zealand and the United Kingdom. The existence of public health insurance depresses labor supply somewhat in all of the countries under study. All in all, the model predictions for Australia, Canada, New Zealand, the U.K. line up quite well with the data. On the contrary, the model largely under-predicts the employment rates of older workers in Spain and Sweden and, to a slightly lesser degree, also in France and Germany. 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 they work as much as they do.

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Appendix

This Appendix summarizes 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.

Australia In Australia, old-age pension is a flat-rate benefit of roughly \$11 440 per year. Claiming of benefits starts at age 65, and one is not required to stop working to collect benefits. Disability insurance benefits are also flat-rate and equal in size to the old-age pension benefit.

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 \$6 800 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 \$9 800 annually. The disability benefit equals \$4 500 per year plus 75% of the earnings related pension.

France In France, the maximum pension benefit is awarded with 40 years of contributions. The 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 to reach 40 years. 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.

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. The average individual accrues 1.5% of average lifetime earnings for every year of work. 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 $420 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.

New Zealand In New Zealand, old-age pension is a flat-rate benefit of roughly $10 400 per year. Claiming of benefits starts at age 65, and one is not required to stop working to collect benefits. Disability insurance benefits are also flat-rate and roughly equal to $8 400 annually.

Spain In Spain, 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.

Sweden In Sweden, the old-age pension benefit is comprised of two parts, a basic allowance and an earnings dependent supplement. Both are tied to the so-called basic amount (BA), which equals roughly \$6 600. The basic allowance is the same for everyone and equal to 0.96BA. The earnings dependent supplement is given by:

$$0.6AP_a \min(a/30,1)\text{BA}, \tag{7}$$

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.

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 \$6 100 per year. The earnings dependent component replaces 25% of average earnings from the best 25 years. The disability insurance benefit is a flat-rate benefit of approximately \$5 900 per year.

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