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 55-64 than we observe in the data.

JEL classification: E24; J22; J26

Keywords: Life cycle; Retirement; Disability insurance; Health

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1 Introduction

While the employment rates of prime-aged males are very similar across OECD countries, the employment rates of older workers differ considerably. To illustrate, the employment rates of males aged 55-64 in France and Germany are only 58-72% of the U.S. level, whereas the employment rates of 55-64 year old men in New Zealand and Sweden are actually slightly above those in the United States. Interestingly, however, France and Germany 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 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, 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. 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, 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 U.K., 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 health insurance dampens the incentives for continued employment in all of the countries under study. While the addition of public health insurance brings the model predictions for the U.K., Canada, Australia and New Zealand more in line with the data, the model predicted employment rates for older workers in Canada, Australia and New Zealand are nevertheless too high relative to the data. Conversely, the model predicted employment rates for Spain and Sweden are much too low relative to the data. This is in large part due to over-predicted disability insurance incidence rates. The model predicted employment rates for France and Germany are more in line with the data, but the disability incidence rates – particularly for France – are over-predicted. 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 that something outside our model dampens the labor supply effects arising purely from the incentives built into institutions. Possible candidate explanations 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 the Sensitivity Analysis section we briefly discuss each of these potential explanations.

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 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

[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).

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 we observe significant differences in the labor supply behavior of these groups in the data. 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

[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.

on health. 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 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:

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

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 dependent on preference type (low or high disutility type) 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]

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

[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.

constraints given by:

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

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.[5] 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.

Figure 1 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 is very limited in scope at all ages, irrespective of whether part-time work is defined as working less than 1,750

[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.

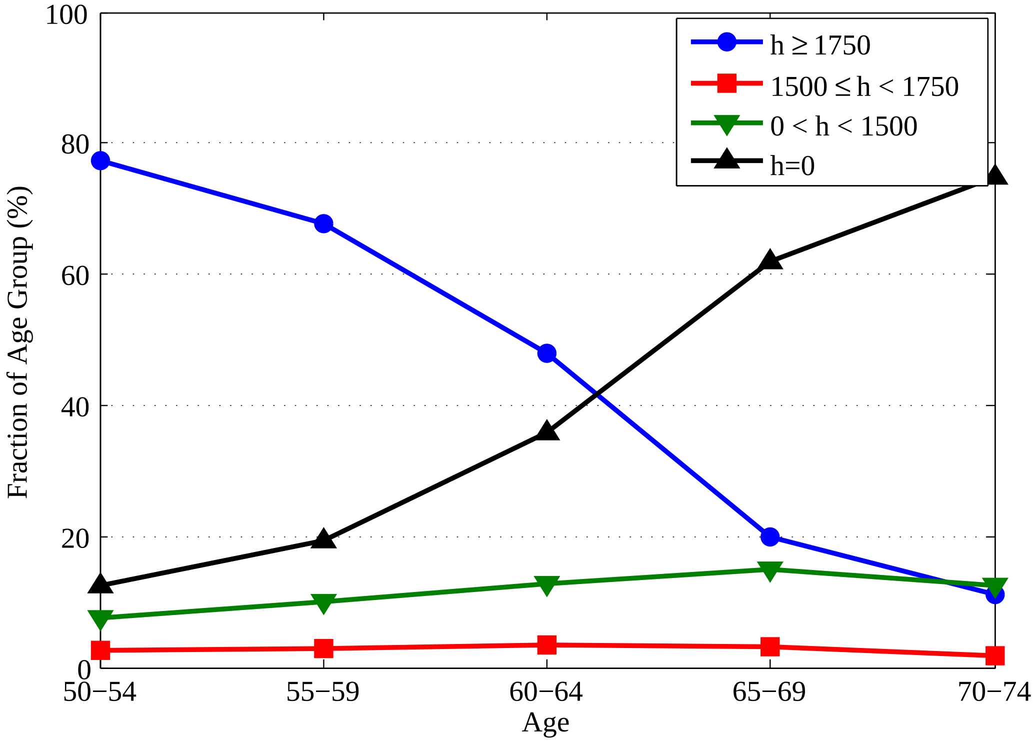

Figure 1: Distribution of Male Annual Hours by Age. Data source: CPS, 2004.

hours annually (35 hours per week) or as working less than 1,500 hours annually (30 hours per week). Our focus is on the labor supply decisions of older workers, particularly the retirement margin. 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. Motivated by these observations, we assume a discrete labor choice. In the model, the individual either works full-time or not at all, $l_{a,s} \in \{0, \bar{l}\}$.[6] Labor income is the product of the exogenous, age-dependent wage and labor supply.[7]

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

[6]We return to the issue of the prevalence of part-time work in other countries in Section 5.
[7]The price per efficiency unit of labor has been normalized to one.

(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 $c^{DI}_{a,s}$, 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. $I^{R}_{a,s}$ 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 levies proportional taxes on consumption (τ_c) and labor income (τ_h). 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. We assume a balanced budget in equilibrium.

We solve for the decision rules via backward induction and then simulate the model. 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. Note that all data is for males.

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 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. 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.[8]

The preference parameters that need to be assigned a value are the discount factor, β, and the parameters governing the disutility from working, $b(h,s)$. We assume an annual interest rate equal to 3% and set $\beta = 1/(1+r)$.[9] The parameters governing the disutility from working are critical for matching the retirement age distribution. We assume two

[8] 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.

[9] More generally, we could assume that the discount factor and interest rate are not perfectly offsetting, which would introduce life-cycle effects in the consumption profile. 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.

disutility from work types, low and high, and moreover allow the disutility from working to differ by health. Specifically, the disutility from working is greater the worse the health of the individual. 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: 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. The target distribution is shown in Table 1.[10]

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 2 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.

[10]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.

For the non-college educated worker, wages rise early on, but much less steeply than for the college educated worker, and similarly level off in the fifties. 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.

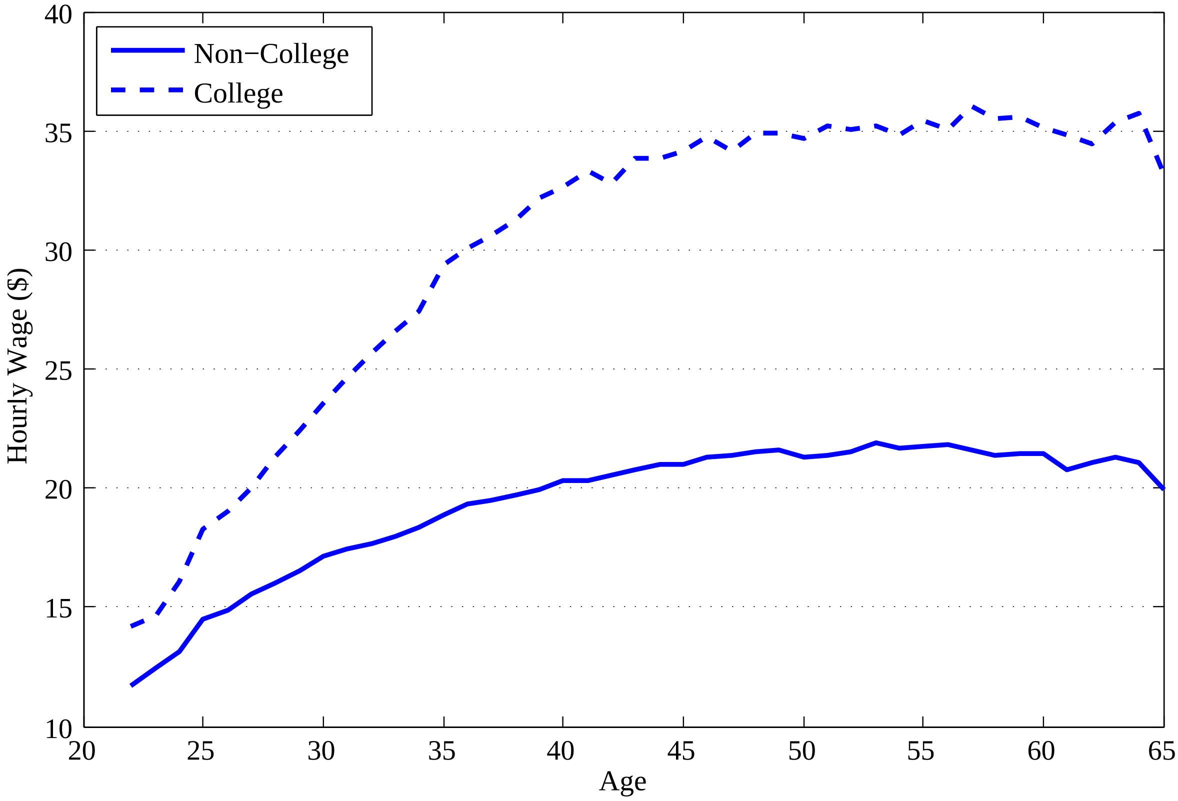

Figure 2: Hourly Wages for College and Non-College Men. Data source: CPS 1976-2006.

As previously noted, our focus is on the pathways into retirement. Rogerson and Wallenius (2013) document that the dominant transition from full time work to not working 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 (2013) 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).[11] 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 the 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

[11] 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.

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 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. For ease of exposition, we again group the three best health categories into 'good' and the two worst into 'bad'. 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.

Given our focus on the labor supply incentives built into social security systems, we strive to accurately capture the details of the 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:

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

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

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.[12] 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 take the consumption and labor tax rates from McDaniel (2007). The labor tax rate includes income taxes and social security taxes. 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,

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

as long as the government consumption does not affect the marginal utility of private consumption.

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 insurance implies that 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 the two worst health states is 0.55, whereas the probability in all other health states is 0.01 when younger than 50 and 0.053 otherwise. This results in an acceptance rate of 34.9%. Moreover, our model predicts that 6.3% of disability insurance claimants are not truly disabled (i.e., in very good, good or fair health), whereas 41.2% 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.

We assume that the probability of being hit by a small 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. In the calibration it rises from 0.12 to 0.6 for the non-college types and from 0.1 to 0.4 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 0.6 for the non-college educated worker and 0.4 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). The table reports the boundary values for the two health states.

Parameter	Value
Policy Parameters	
Effective tax on labor $(1+\tau_c)/(1-\tau_h)$	0.261
DI Parameters	
Cost of applying for DI (c^{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	0.053
Utility Parameters	
Discount factor	0.97
Interest rate	0.03
Disutility from work when health good and disutility type low	2.70
Disutility from work when health bad and disutility type low	2.85
Disutility from work when health good and disutility type high	4.00
Disutility from work when health bad and disutility type high	4.20
Health Parameters	
Decrease in health from low shock	1
Decrease in health from high shock	3
Probability of low shock (non-college)	$0.12 \to 0.6$
Probability of low shock (college)	$0.10 \to 0.4$
Probability of low shock when health very bad (non-college)	0.6
Probability of low shock when health very bad (college)	0.4
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 5: Calibrated Parameter Values

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 3 shows the employment rates of older men by age and education relative to the data. The calibration places equal weights on the low and high disutility from work types.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 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 decent.

There are substantial differences in retirement behavior based on health insurance coverage. Our model predicts that individuals with retiree health insurance stop working almost a year earlier than those with either tied health insurance or no health insurance. These patterns are in line with the findings of French and Jones (2011).

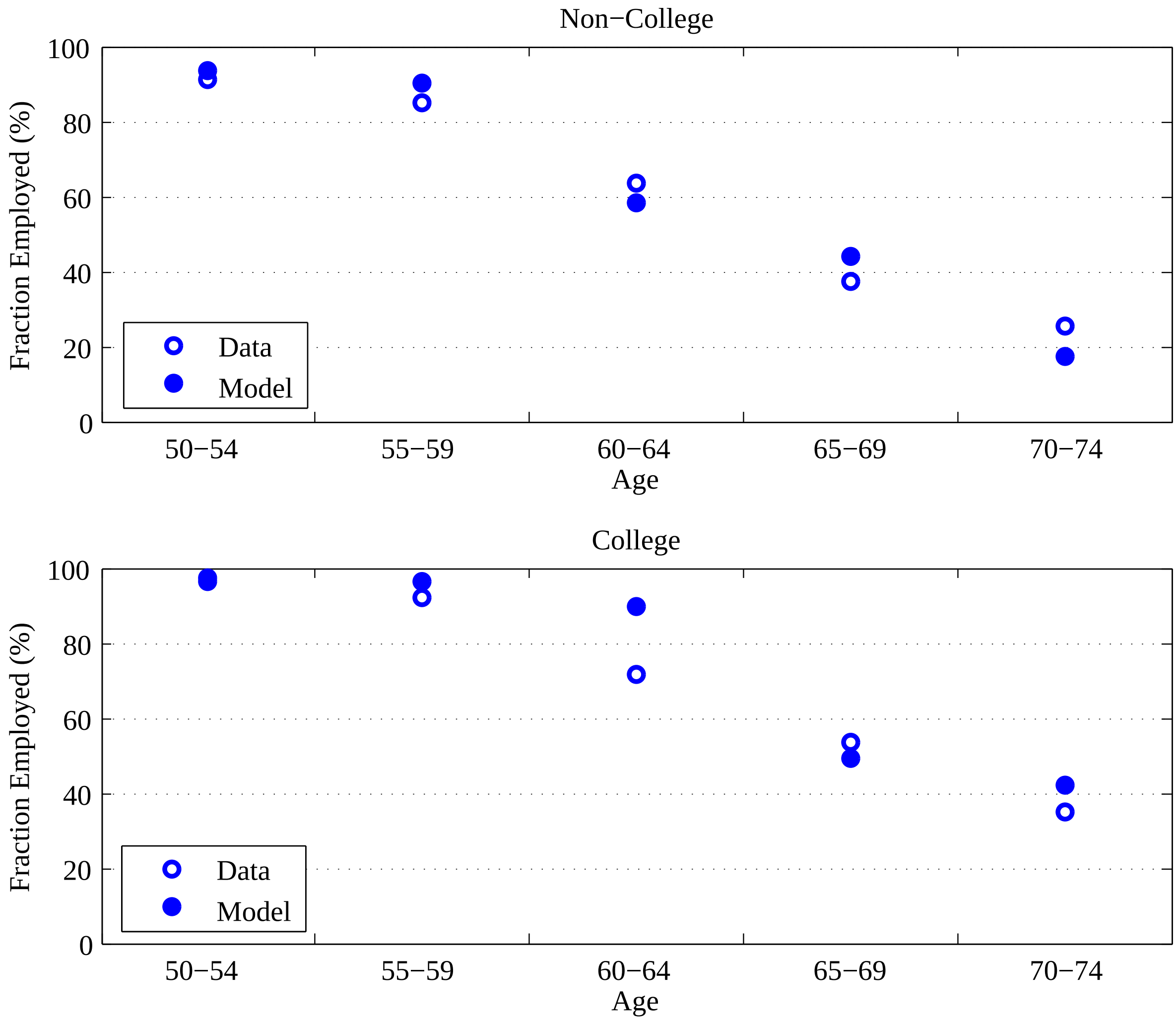

Figure 3: Employment Rates by Age and Education: Model vs. Data

Table 6 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 both the non-college and 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.

Non-College		
Age	Model	Data
50-54	6.57	8.70
55-59	9.74	10.00
60-64	12.83	11.20
College		
Age	Model	Data
50-54	2.55	3.40
55-59	3.71	4.60
60-64	4.84	4.60

Table 6: Disability Insurance Incidence (%) by Age and Education: Model vs. Data.

One dimension along which the model struggles a little bit is in matching the health distribution at older ages. As is evident from Table 7, 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. There is some tension in matching the data on disability insurance incidence, health and the moments pertaining to the granting of disability benefits. One reason for this may well be that in the self-reported health surveys people adjust their expectations of health with age – thinking that they feel good for, say, age 60. This creates divergence from the health metric in our model.

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, 7.2% of the transitions from employment to retirement are associated with a decline in health from good to bad and 79.5% 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.[13]

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	67.5
70-74	Bad	35.2	32.5
College			
Age	Health	Data	Model
60-64	Good	89.1	93.7
60-64	Bad	10.9	6.3
70-74	Good	85.4	86.6
70-74	Bad	14.6	13.4

Table 7: 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 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, France,

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

	Sweden	France	Spain	Germany
Old-Age				
Eligibility Age	61	60	60	63
Full Retirement	65	40 yrs of work	65	65
Must Stop Work	no	yes	yes	yes
Flat-rate	$6 300	no	no	no
Earnings Dependent	60% of ave. inc.> $6 600 (15 best yrs)	50% of ave. inc. (25 best yrs)	depends on yrs of work	accrue 1.5% of ave. inc. per year
Early Claiming Reduction	0.5% per month	5% per year	depends on yrs of work	0.3% per month
DI				
Flat-rate	same as regular	no	no	no
Earnings Dependent	same as regular (as if work to 65)	50% of ave. inc. (10 best yrs)	similar to regular (depends on age)	same as regular (as if work to 60)

	UK	Canada	New Zealand	Australia
Old-Age				
Eligibility Age	65	60 earn. dep. 65 flat-rate	65	65
Full Retirement	65	65	65	65
Must Stop Work	no	yes, if collect earn. dep. before 65	no	no
Flat-rate	$6 100	$6 800	$10 400	$11 400
Earnings Dependent	25% of ave. inc. (25 best yrs)	25% of ave. inc. (drop lowest 15%)	no	no
Early Claiming Reduction	n/a	0.5% per month	n/a	n/a
DI				
Flat-rate	$5 900	$4 500	$8 400	$11 400
Earnings Dependent	no	75% of regular earn. dep. portion	no	no

Table 8: Program Rules

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.

Table 8 summarizes the key features of the old-age pension and disability insurance programs in place in the countries under study.[14] A more detailed description of the programs can be found in the Appendix. At one end of the spectrum lie France, Germany, Spain and Sweden, 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 France, Germany and Spain, one is essentially required to stop working.[15] In Sweden, however, one is not required to stop working to collect old-age pension benefits. The disability insurance benefits are quite generous in France, Spain and Sweden, but somewhat less so

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

[15] 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.

in Germany. 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.

To see how the country specific program rules in Table 8 are mapped to the model, consider, for example, the case of Sweden. To compute the old-age retirement benefit for Sweden, one must adjust the AIME formula for the U.S. to reflect the fact that retirement benefits in Sweden are based on income from the 15 highest years (not 35 as in the U.S.):

$$AIME_{a+1,s} = AIME_{a,s} + \frac{w_{a,s} l_{a,s}}{15} \quad \text{if} \quad a < 15. \tag{7}$$

$$AIME_{a+1,s} = AIME_{a,s} + \max\left\{0, \frac{w_{a,s} l_{a,s} - AIME_{a,s}}{15}\right\} \quad \text{if} \quad a \geq 15. \tag{8}$$

The PIA formula on the other hand must be adjusted to reflect the fact that in Sweden there is a flat-rate component to the benefit:

$$PIA = \$6,300 + 0.6(AIME - \$6,600). \tag{9}$$

For the Swedish case we set the first age at which the benefit can be claimed to 61 and modify the penalty for early claiming to reflect the reduction of 0.5% per month. The disability benefit formula for Sweden is identical to the old-age retirement benefit formula, with the exception that the benefit is computed as if the individual had worked up to age 65.

We use a similar approach for all of the countries under study. 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 and restrictions associated with work when collecting benefits. 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.

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 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.

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).

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

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.[16]

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 relatively 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 the model predicts too low employment rates for older workers in Spain and Sweden and much too high disability insurance claiming for the French, Spanish and Swedish economies relative to actual observations. Despite the fact that the model slightly over-predicts disability insur-

[16] 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	83.0%	85.3%	87.7%	95.6%	81.1%	91.6%	96.7%	94.4%
55-59	70.7%	79.3%	82.2%	67.9%	63.5%	77.5%	92.8%	78.3%
60-64	45.2%	59.9%	19.1%	16.2%	13.4%	49.9%	63.0%	34.8%
65-69	16.5%	16.4%	0.0%	4.3%	0.0%	6.0%	3.7%	8.2%
70-74	0.0%	12.2%	0.0%	1.5%	0.0%	1.6%	0.0%	4.5%
Ret. Age	60.48		59.00		57.68		62.77	
DI 50-64	26.2%	14.7%	16.4%	4.4%	31.5%	8.4%	6.9%	5.5%

	UK		Canada		New Zealand		Australia	
Age	Model	Data	Model	Data	Model	Data	Model	Data
50-54	98.5%	89.7%	97.8%	94.3%	98.8%	93.6%	98.2%	89.2%
55-59	97.2%	79.0%	95.9%	80.0%	97.4%	87.2%	96.8%	76.2%
60-64	71.9%	57.0%	87.6%	55.0%	94.5%	67.1%	93.9%	51.9%
65-69	48.0%	18.7%	60.7%	22.9%	63.7%	30.6%	60.6%	21.4%
70-74	23.0%	7.0%	46.2%	11.3%	46.2%	14.4%	45.7%	
Ret. Age	66.91		69.88		70.62		70.18	
DI 50-64	2.7%	10.3%	4.0%	5.7%	2.6%	6.4%	3.2%	10.8%

Table 11: Employment and Disability Insurance Incidence Rates Across Countries: Model vs. Data. Data source: OECD, 2003.

ance incidence in Germany, the model predicted employment rate for people aged 60-64 is somewhat higher than in the data. Overall, the model predictions for France and Germany line up somewhat more closely with the data than the predictions for Spain and Sweden.

To gain insight into the relative importance of pension and disability insurance programs in accounting for the model predicted retirement patterns, we conduct an exercise where only one of the programs is modified at a time. We discuss the results for one representative low employment/high disability incidence country, France, and one high employment/low disability incidence country, Canada. First consider the French case. The model predicted a low employment rate for 60-64 year olds, 19.1%, and a rather high disability insurance incidence rate for 50-64 year olds, 16.4%, with the full French pension and disability programs. In an economy with the French pension system and the U.S. disability insurance system (as well as U.S. tax rates), the model predicts a relatively low employment rate for 60-64 year olds, 36.2%, but a modest disability insurance incidence rate for 50-64 year olds, 7.1%. Conversely, in an economy with the French disability insurance program and the U.S. pension program (as well as U.S. tax rates) the model predicts a high employment rate for 60-64 year olds, 61.8%, but a relatively high disability insurance incidence rate among 50-64 year olds, 17.2%. This exercise implies that the design of the French pension program is largely responsible for the relatively low model predicted employment rates of older workers, while the design of the French disability insurance program (together with higher taxes) is responsible for the high disability insurance incidence.

Now consider the case of Canada. Recall that with the full Canadian pension and disability insurance programs the model predicted a high employment rate for 60-64 year olds, 87.6%, and a low disability insurance incidence rate for 50-64 year olds, 4.0%. In an economy with the Canadian pension system and the U.S. disability insurance system the model predicted employment rate for 60-64 year olds is high, 86.6%, and the disability insurance claiming among 50-64 year olds is low, 5.7%. In an economy with the Canadian disability insurance scheme and the U.S. pension scheme the employment rate among 60-64 olds is lower, although still relatively high at 71.1%. Note, however, that the average retirement age is only 66.78, compared with 69.65 in the economy with the Canadian pension scheme and the U.S. disability scheme and 69.88 with the full Canadian pension and disability schemes. The model predicted disability incidence rate for 50-64 year olds under the Canadian disability program and the U.S. pension program is low, 4.8%. This exercise suggests that the design of the pension scheme in Canada is responsible for the high model predicted employment rates of older workers.

The analysis thus far assumed the health expenditure structure of the U.S. benchmark economy. We now conduct the same exercise of modifying the old-age pension and disability insurance schemes (and labor taxes) to match those in various OECD countries, 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

	Sweden		France		Spain		Germany	
Age	Model	Data	Model	Data	Model	Data	Model	Data
50-54	81.3%	85.3%	84.1%	95.6%	81.1%	91.6%	96.6%	94.4%
55-59	38.1%	79.3%	75.6%	67.9%	50.5%	77.5%	83.9%	78.3%
60-64	21.5%	59.9%	8.0%	16.2%	11.8%	49.9%	27.2%	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	56.79		58.04		56.96		60.33	
DI 50-64	28.2%	14.7%	21.9%	4.4%	31.3%	8.4%	6.6%	5.5%

	UK		Canada		New Zealand		Australia	
Age	Model	Data	Model	Data	Model	Data	Model	Data
50-54	98.0%	89.7%	97.3%	94.3%	98.4%	93.6%	97.4%	89.2%
55-59	66.0%	79.0%	95.3%	80.0%	89.4%	87.2%	95.8%	76.2%
60-64	52.8%	57.0%	49.2%	55.0%	66.0%	67.1%	65.1%	51.9%
65-69	18.5%	18.7%	48.0%	22.9%	47.9%	30.6%	48.3%	21.4%
70-74	0.0%	7.0%	21.0%	11.3%	16.7%	14.4%	21.2%	
Ret. Age	61.72		65.54		66.01		66.41	
DI 50-64	2.8%	10.3%	4.4%	5.7%	3.0%	6.4%	4.1%	10.8%

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

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. After the addition of public health insurance, the model predicted employment rates for the U.K., Canada, Australia and New Zealand become more in line with the data. Nevertheless, the model predicted employment rates for older workers in Canada, Australia and New Zealand are still too high relative to the data. The model predictions for the U.K. line up quite well with the data. The same is true of Germany. Conversely, the model predictions for France, Spain and Sweden diverge even more from the data after the introduction of the country-specific health insurance structure, with the model predicting much too low employment and much too high disability calming among older workers.

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. Potential explanations for why our model over-predicts disability insurance claiming in several European countries therefore 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 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

Our model assumes that individuals work full-time or not at all; we do not allow for a part-time work option. The lack of a part-time option could be one reason for the model's over-prediction of the variation in the employment data. Table 13 reports the prevalence of part-time work among men by age across our sample of OECD countries.[17] The incidence of part-time work among men is not very high in the any of the countries under study, although it does appear to rise with age in Australia, Canada, New Zealand, Sweden and the United Kingdom. Conversely, the incidence of part-time work is not rising with age in France, Germany or Spain. The lack of a part-time work option in our model could, therefore, modestly contribute to the over-prediction of employment in Canada, Australia and New Zealand, but it is unlikely to be the reason for the low model predicted employment in the European countries.

Country/Age	50-54	55-59	60-64	65-69	70-74	65+
Australia	5.68	7.27	10.49	.	.	5.04
Canada	3.76	5.66	8.09	.	.	4.59
France	3.74	3.69	2.23	1.31	0.66	.
Germany	4.05	4.70	5.62	4.79	2.82	.
New Zealand	4.55	7.50	8.25	.	.	7.02
Spain	1.31	1.31	2.47	1.18	0.79	.
Sweden	4.42	5.94	10.97	10.00	7.23	.
UK	3.99	6.85	10.34	10.12	4.97	.

Table 13: Prevalence of Male Part-time Work (%) Across Countries by Age. Data source: OECD, 2007.

The very high disability insurance incidence rates under the continental European pension and disability insurance programs are among the more striking predictions of the model. To gain intuition for this result, it is helpful to note that disability insurance programs differ along two key dimensions: (1) the generosity of disability insurance benefits and (2) the generosity of disability insurance benefits relative to old-age pension benefits. To disentangle these two effects, we conduct 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 each of the European countries in turn, keeping total social security payments constant at the benchmark

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

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. For France and Sweden, 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 almost a third of the predicted difference in disability insurance claiming rates between the U.S. and Sweden and as much as 70% of the predicted difference between the U.S. and France. In other words, the Swedish and French 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. Conversely, in Spain the high disability incidence is driven exclusively by the high generosity of disability insurance benefits.

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, possible reasons for this include: (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. To bring model predicted disability insurance incidence rates down to the levels observed in Spain and Sweden, the application cost would need to be raised from 30% to slightly above 50%. Even a cost of close to 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 5.3%. Lowering this probability to 3-4% brings the model predicted disability incidence rates close to those observed in Spain and Sweden. 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 Sweden, disability insurance benefits were also awarded for labor market reasons through the 1990s. The screening of disability insurance applicants in Sweden has, however, gotten much stricter subsequently (see, e.g., Johansson, Laun, and Laun (2014)). 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 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, 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 in all of the countries under study. Despite this dampening effect, the model predicted employment rates for older workers in Canada, Australia and New Zealand are nevertheless too high relative to the data. On the contrary, the model largely under-predicts the employment rates of older workers and over-predicts the incidence of disability insurance in France, Spain and Sweden, and to a lesser extent also in 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. Moreover, viewed through the same lens, it is equally puzzling why people in Canada, Australia, New Zealand and the U.K. do not work more than they do.

References

BENITEZ-SILVA, H., M. BUCHINSKY, AND J. RUST (2004): "How Large Are the Classification Errors in the Social Security Disability Award Process?," Working Paper 10219, National Bureau of Economic Research, Cambridge, MA.

BERKOVEC, J., AND S. STERN (1991): "Job Exit Behavior of Older Men," *Econometrica*, 59, 189–210.

BLAU, D., AND T. SHVYDKO (2011): "Labor Market Rigidities and Employment Behavior of Older Workers," *Industrial and Labor Relations Review*, 64, Article 3.

COILE, C., AND J. GRUBER (2007): "Future Social Security Entitlements and the Retirement Decision," *The Review of Economics and Statistics*, 89, 234–246.

COILE, C., AND P. LEVINE (2007): "Labor Market Shocks and Retirement: Do Government Programs Matter?," *Journal of Public Economics*, 91, 1902–1919.

EROSA, A., L. FUSTER, AND G. KAMBOUROV (2012): "Labor Supply and Government Programs: A Cross-Country Analysis," *Journal of Monetary Economics*, 59, 84–107.

FRENCH, E. (2005): "The Effects of Health, Wealth, and Wages on Labor Supply and Retirement Behavior," *The Review of Economic Studies*, 72, 395–427.

FRENCH, E., AND J. JONES (2011): "The Effects of Health Insurance and Self-Insurance on Retirement Behavior," *Econometrica*, 79, 693–732.

FRENCH, E., AND J. SONG (2009): "The Effect of Disability Insurance Receipt on Labor Supply," Working Paper 2009-05, Federal Reserve Bank of Chicago.

GRUBER, J., AND D. WISE (2004): *Social Security Programs and Retirement Around the World: Micro Estimation*. University of Chicago Press.

——— (2009): *Social Security Programs and Retirement Around the World: The Relationship to Youth Employment*. University of Chicago Press.

GUSTMAN, A., AND T. STEINMEIER (1986): "A Structural Retirement Model," *Econometrica*, 54, 555–584.

IAMS, H., J. PHILLIPS, K. ROBINSON, L. DEANG, AND I. DUSHI (2008): "Cohort Changes in the Retirement Resources of Older Women," *Social Security Bulletin*, 68 (4).

IYENGAR, R., AND G. MASTROBUONI (2007): "The Political Economy of the Disability Insurance. Theory and Evidence of Gubernatorial Learning from Social Security Administration Monitoring," CeRP Working Paper 70/07.

JOHANSSON, P., L. LAUN, AND T. LAUN (2014): "Screening Stringency in the Disability Insurance Program," *The B.E. Journal of Economic Analysis and Policy (Contributions)*, forthcoming.

JOHNSON, R., AND S. CRYSTAL (1997): "Health Insurance Coverage at Midlife: Characteristics, Costs and Dynamics," *Health Care Financing Review*, 18, 123–148.

KEMPTNER, D. (2013): "Health-Related Life Cycle Risks and Public Insurance," DIW Discussion Paper 1320, DIW, Berlin.

LINDBECK, A. (1995): "Welfare-State Disincentives with Endogenous Habits and Norms," *Scandinavian Journal of Economics*, 97, 477–494.

LINDBECK, A., AND S. NYBERG (2006): "Raising Children to Work Hard: Altruism, Work Norms and Social Insurance," *The Quarterly Journal of Economics*, 121, 1473–1503.

LJUNGQVIST, L., AND T. SARGENT (2007): "Do Taxes Explain European Employment? Indivisible Labor, Human Capital, Lotteries, and Savings," in *NBER Macroeconomics Annual 2006*, vol. 21, pp. 181–246. National Bureau of Economic Research, Inc.

LOW, H., C. MEGHIR, AND L. PISTAFERRI (2010): "Wage Risk and Employment Risk over the Life Cycle," *American Economic Review*, 100, 1432–1467.

LOW, H., AND L. PISTAFERRI (2010): "Disability Risk, Disability Insurance and Life Cycle Behavior," Working Paper 15962, National Bureau of Economic Research, Cambridge, MA.

MCDANIEL, C. (2007): "Average Tax Rates on Consumption, Investment, Labor and Capital in the OECD 1950-2003," Mimeo.

——— (2011): "Forces Shaping Hours Worked in the OECD, 1960-2004," *American Economic Journal: Macroeconomics*, 3, 27–52.

OHANIAN, L., A. RAFFO, AND R. ROGERSON (2008): "Long-Term Changes in Labor Supply and Taxes: Evidence from OECD Countries, 1956-2004," *Journal of Monetary Economics*, 55, 1353–1362.

POZZEBON, S., AND O. MITCHELL (1989): "Married Women's Retirement Behavior," *Journal of Population Economics*, 2, 39–53.

PRESCOTT, E. (2004): "Why Do Americans Work So Much More than Europeans?," *Quarterly Review of the Federal Reserve Bank of Minneapolis*, pp. 2–13.

RAGAN, K. (2013): "Taxes, Transfers and Time Use: Fiscal Policy in a Household Production Model," *American Economic Journal: Macroeconomics*, 5, 168–192.

ROGERSON, R. (2007): "Taxation and Market Work: Is Scandinavia an Outlier?," *Economic Theory*, 32, 59–85.

ROGERSON, R., AND J. WALLENIUS (2013): "Nonconvexities, Retirement and the Elasticity of Labor Supply," *American Economic Review*, 103, 1445–1462.

RUST, J., AND C. PHELAN (1997): "How Social Security and Medicare Affect Retirement Behavior in a World of Incomplete Markets," *Econometrica*, 65, 781–832.

STOCK, J., AND D. WISE (1990): "Pensions, the Option Value of Work and Retirement," *Econometrica*, 58, 1151–1180.

WALLENIUS, J. (2013): "Social Security and Cross-Country Differences in Hours: A General Equilibrium Analysis," *Journal of Economic Dynamics and Control*, 37, 2466–2482.

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:

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

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.

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.