Health Insurance

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Chapter 4

Health, Health Insurance and Retirement Behavior

4.1 Introduction

Social insurance programs often provide perverse incentives. Yelowitz (1995), for example, describes the *Medicaid notch*, where women with dependent children on welfare might lose entitlement to Medicaid when they start working. Rust and Phelan (1997) discuss that due to Medicare men without a retiree health insurance plan have a strong incentive to continue working until age 65. Additionally, social security creates incentives to retire at age 62 (early retirement) and 65 (retirement). These unintended *lock-in* effects of social insurances might increase costs and diminish public support

In this chapter, we investigate how the existing Medical Card scheme in Ireland affects labor force participation among couples around retirement. This scheme provides free health care to all individuals with earnings below some threshold. Other individuals have considerable copayments when using national health services. To reduce copayments, one can take private supplementary health insurance. For older individuals with deteriorating health and increasing health care costs, it might be beneficial to retire (earlier) and accept a lower income to become entitled to a Medical card. Our key research question is how the existing Medical Card scheme affects the age of retirement.

It is well known that health insurance decisions, health and labor supply behavior are strongly interrelated. Both the health insurance and labor supply decision depend on an individual's health status. However, health might be affected by work. Also, there might be heterogeneity in individual preferences, which jointly affect health, labor supply and the health insurance decision. Ideally, one would exploit exogenous variation in the entitlement rules for the Medical Card to investigate its impact on the age of retirement. However, during our observation period no relevant policy reforms occurred. Therefore, we structurally estimate a dynamic programming model for the retirement behavior of married males between age 50 and 75. An advantage of the latter approach is that the estimated model can be used to simulate the effect of policy changes, such as changing the eligibility rules for the Medical Card scheme and increasing the age at which individuals become eligible for collecting social security and pension benefits.

Our structural model starts following males, who are labor market participants at age 50. We only focus on couples where the woman is nonparticipant, which is the most common household situation of elderly in Ireland. While working, men can contribute to pension funds, but they can also lose their job. Working up to an older age can thus increase the level of pension benefits, but also may increase health deterioration. Households that are not eligible for a Medical Card might take supplementary private health insurance to deal with the costs of bad health or the risk of health shocks. In our model we allow for heterogeneity in preference and risk aversion parameters to capture that there are various types of individuals who make different choices.

In the empirical analyses we use data from Living in Ireland Survey. This survey follows households from 1994 to 2001. Each year individuals are surveyed about their labor market and health status. Furthermore, information is collected on health insurance choices and health care use. We use simulation techniques to estimate the structural parameters. In particular, we adopt the estimator proposed by Keane and Sauer (2009), which is a classification error approach.

Recently, for the US a number of papers have estimated structural models for retirement decisions (French, 2005; Rust and Phelan, 1997; French and Jones, 2004; Van der Klaauw and Wolpin, 2003, and Blau and Gillieskie, 2006). Most papers have mainly focussed on the effects of social security and/or Medicare. Exceptions are Blau (2004) who considered consumption patterns at older ages and Bound, Stinebrickner and Waidmann (2008) who focused on different exit routes such as disability insurance. Our work connects to the first group of papers, but uses a different institutional setting with different incentives. This mainly has consequences for the way health insurance choices are modeled. Within the European context health insurance is not so much connected to employers as in the US.

Our model relates to French (2005) and Blau (2007), who consider the retirement behavior of men without modeling the behavior of spouses explicitly. Gustman and Steinmeier (2004), Blau and Gilleskie (2006) and Van der Klaauw and Wolpin (2005) explicitly model the labor market behavior of spouses. It should, however, be noted that they consider a situation where most often both spouses work, which is not common for older couples in Ireland. We make three main contributions to this literature. First, we treat wealth more flexible. Whereas other papers considered wealth as a discrete variable, we allow it to be continuous. Second, we allow for unobserved heterogeneity in preference parameters. Heterogeneity in preference parameters might be important to explain health insurance choices. Bolhaar, Lindeboom and Van der Klaauw (2008) find evidence in favor of advantageous selection (also for older individuals), which can only be explained from heterogeneity in structural parameters (see Bolhaar, 2009).[1] Third, most structural analyses for retirement behavior and health insurance decisions consider the US. We provide evidence from another institutional environment, one that is much closer to that in most European countries.

Section 4.2 gives more detail about the Irish institutional context. The model is outlined in section 4.3, after which the data are discussed in section 4.4. Section 4.5 explains the method of estimation used, 4.6 presents the parameter estimates and the results from policy simulations. Finally, section 4.7 concludes.

4.2 Institutional background

4.2.1 Pensions

The Irish pension system is built on two pillars. The first pillar consists of social security, the second of occupational and private pensions. There are two main schemes for social security, which differ in generosity. Individuals are entitled to one of the social security schemes from age 65 or 66 onwards. Occupational and private pensions function as supplement to the social security benefits.

The first social security scheme is the Old Age Contributory Scheme, which is not means-tested. Only individuals who made sufficient social insurance contributions during their working life are entitled to benefits from this scheme. Most employees with a full-time job compulsory pay social insurance contributions. Earnings are taken into account for the level of the contribution made by the employee. Employers also pay their share. The benefit level from the Old Age Contributory Scheme *only* depends on household composition, not on earnings at retirement. Beneficiaries of this pension scheme are allowed to work without any reduction in the payment. Individuals with enough contributions can already retire at age 65 and receive a transition pension. The transition pension has the same benefit level as the Old Age Compulsory Scheme, but additional earnings are not allowed.

The second social security scheme is the Old Age Non-Contributory Scheme, which covers all individuals without (sufficient) social security contributions. This scheme is means-tested and its benefit level, therefore, depends on additional income and/or capital of the individual. Capital is only assessed above a threshold and benefits are lowered proportional to the additional income and capital. The full payment rates are somewhat lower than those of the Contributory scheme, but this gap is to be closed in the future.

Almost 90% of the elderly receive some social security pension (Hughes and Watson, 2005). The number of recipients of the Contributory scheme has been rising over the last

[1] See also Finkelstein and McGarry (2006), Fang, Keane and Silverman (2008) and Cutler, Finkelstein and McGarry (2008), who provide evidence for advantageous selection in health insurance markets for the elderly.

Table 4.1: Social welfare pension rates (in pounds per week)

	Nominal rates (in £)		Real rates (in 1994 £)	
Year	Contributory	Non-Contributory	Contributory	Non-Contributory
1994	71.00	61.00	71.00	61.00
1995	72.80	62.50	71.01	60.96
1996	75.00	64.50	71.92	61.85
1997	78.00	67.50	73.73	63.80
1998	83.00	72.50	76.65	66.96
1999	89.00	78.50	80.81	71.27
2000	96.00	85.50	82.60	73.56
2001	106.00	95.50	86.93	78.32

Source: Pension Board, 1998

twenty years, and at the same time the number of recipients of the Non-Contributory scheme has declined (Pensions Board, 1998).

Both social security schemes take account of the household composition in determining the benefits level. In particular, supplements are added on top of the basic insurance level for a dependent spouse and children under age 18 (or age 22 when in full-time education). Table 4.1 gives for our observation period the basic level of both types of social security benefits. The benefits levels are increasing over time, not only in nominal terms but also in real terms. The increase is however lower than the average increase in (real) wages in this period. In Table 4.2 we provide the supplements for a dependent spouse and children, the spousal supplement depends on the income and age of the spouse. Social security benefits are relatively low. The replacement rate for a worker with average earnings is only 30.6%, which is the lowest in the OECD (OECD, 2005).

The second pillar of the pension system are the occupational and private pensions. Three main types can be distinguished. *Public service pensions* cover civil servants, teachers, health workers, local authority employees, etc. on a pay-as-you-go basis. The typical public service pension arrangement is to provide a total retirement income (including the social security benefits), which is 1/80th of the last year's wage for each working year (with a maximum of 40 years). *Occupational pensions* are set up by employers for their employees. These plans are most often defined benefits schemes, but can also be defined contribution. Total retirement pension income is usually 1/60th of the last wage for each working year. It is usually possible to start collecting public service pensions and occupational pensions from age 60 onwards. The third type are *personal pensions*, which are fully arranged by individuals. Especially self-employed individuals have to rely on this last type of pension provision. A survey from the Economic and Social Research Institute (ESRI) in 1995 found that about 38% of the employees in the private sector participated in a second pillar pension scheme, compared to 83% in the public sector, and 27% of the self-employed. Full-time workers and workers in large firms and high-income workers are most likely to participate in a second pillar pension scheme (Pensions Board, 1998).

Table 4.2: Rates of supplements for spouse and children for 1998

Contributory Pension		
full rate	£	83.00
max. supplement for spouse aged < 66	£	52.50
max. supplement for spouse aged ≥ 66	£	59.90
child supplement if no spouse or spouse that qualifies for supplement	£	15.20
child supplement if spouse does not qualify for supplement	£	7.60
Non-contributory Pension		
full rate	£	72.50
max. supplement for spouse aged < 66	£	41.20
spouse aged ≥ 66 can apply in own name for Non-Contrib. Pension	£	72.50
child supplement if no spouse or spouse that qualifies for supplement	£	13.20
child supplement if spouse does not qualify for supplement	£	6.60

Source: Department of Social, Community and Family Affairs

4.2.2 Health insurance

Below we give a brief description of the Irish public and private health insurance system. A more extensive discussion can be found in Bolhaar, Lindeboom and Van der Klaauw (2008).

Ireland has publicly funded national health insurance. However, there are (considerable) copayments for use of medical services. For example, in 2007 the copayment for a GP visit was €40. Low-income households are eligible for a Medical Card, which exempts them from copayments and provides them also with free optical, aural and dental care and prescribed drugs and medicines. The income threshold for eligibility depends on household composition and age of the head of the household. About one-third of the total Irish population is covered by such a card. Among the 65+ the coverage rate is twice as high, around two-third of them have a Medical Card.

Supplementary health insurance is available on the private market. These insurances offer partial reimbursement of copayments, but also provide access to privately provided health care (in both public and private hospitals). The latter mainly serves as a way to circumvent waiting lists. By law insurance companies can only use community rating in determining their premiums. Additionally they are obliged to accept everybody, irrespective of age or health status. For long there was only one, state-supported en non-profit, provider of private supplementary health insurance, Voluntary Health Insurance (VHI). European regulations forced opening of the market to other providers in 1996 and a year later a second player, British United Provident Association Ireland (BUPA Ireland), entered the market. VHI still dominates the market: in 2001 BUPA Ireland insured only 3.6% of the population, VHI the other 45%. Private supplementary health insurance coverage has not always been at this level. In 1960 coverage was only 4%, but it has been (and still is) rising ever since. Currently, more than 50% of the population is covered.

Obviously, private supplementary health insurance is more valuable to individuals without Medical Card. In our data close to 60% of the individuals without a Medical Card has private supplementary health insurance, while this is only 5% among Medical Card holders. The insurance premium for an adult was just below €50 per month in 2006.

4.3 Model

Our model describes the labor market participation and health insurance decisions of married males with a non-working partner, which is the most common household composition in Ireland. We focus on males around the age of retirement and assume that their objective is to optimize the present value of total household utility.

4.3.1 Outline

Each period t a household derives utility from the total consumption C_t and the health of both the male H_t and his spouse H_t^s. The spouse is always non-working, but the male can either be retired ($R_t = 1$) or when not being retired employed ($E_t = 1$) or unemployed ($E_t = 0$). Labor market status also directly generates (dis)utility, the level of which depends on the male's age. Furthermore, private supplementary health insurance (I_t) not only reduces the costs of health care, but may also be valued for the possibility to circumvent waiting lists and the free choice of care provider. Having private supplementary health insurance, therefore, also affects utility directly. The instantaneous utility function is

$$U_t = \left(\frac{C_t^{1-\nu}}{1-\nu}\right)^{\beta} u\left(H_t, H_t^s, R_t, E_t, A_t, I_t\right)^{1-\beta}$$

where β captures the relative preference for consumption and non-consumption attributes. A high value of β corresponds to a high relative preference for consumption. Parameter ν is the risk-preference parameter in a CRRA-type specification for the utility of consumption. Individuals are more risk-averse for higher values of ν.

Each period an individual can choose to retire $R_t = 1$. Retirement is, however, an absorbing state, implying that if $R_{t-1} = 1$, then also $R_t = 1$. If the individual is not retired, he can either be employed or unemployed. Being employed follows from a stochastic process, where the current employment probability depends on the previous labor market status. In particular, transition probabilities between unemployment and employed equal

$$\Pr\left[E_t = 1 | E_{t-1} = 0\right] = \zeta$$

and

$$\Pr\left[E_t = 1 | E_{t-1} = 1\right] = \xi$$

Obviously, if ξ is larger than ζ, there is state-dependence in labor market status.

When being employed an individual receives a predetermined wage $WAGE_t$ and unemployed workers receive a benefits level B_t. Retired individuals receive a pension P_t, the level of which depends on age A_t, the wage at retirement $WAGE_{ret}$ and employment history $E_{t-1}, E_{t-2}, \ldots$. Institutional details are used to create a pension profile for each individual (see subsection 4.2.1). The individual earnings in period t are, therefore,

$$Y_t = WAGE_t \cdot (1 - R_t) \cdot E_t + B_t \cdot (1 - R_t) \cdot (1 - E_t) + P_t(A_t, WAGE_{ret}, E_{t-1}, E_{t-2}, \ldots) \cdot R_t$$

Households can use their earnings for consumption, medical expenditures M_t and savings S_t

$$Y_t = C_t + S_t + M_t$$

Savings can both be positive and negative, but we do not allow for borrowing. This implies that individuals can never dissave more than their current wealth. Since our model describes the period around retirement, we think that for these individuals borrowing for consumptive purposes is almost impossible. Wealth W_t follows

$$W_t = (1 + \delta)W_{t-1} + S_t$$

where δ is the interest rate.

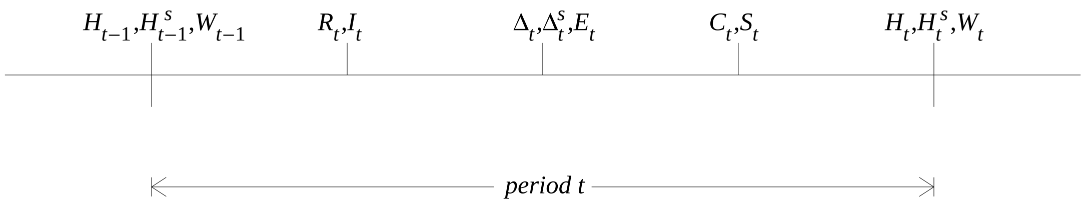
Medical expenditures depend on the amount of health care used by both spouses, their Medical Card status and insurance status. The health status of the individual and his spouse and wether or not they experience health shocks Δ_t, Δ_t^s determine the level of health care that is used. Health can only take two values, it can either be good ($H_t = 1$) or bad ($H_t = 0$). Bad health is an absorbing state, so if ($H_t = 0$) we know with probability one that $H_\tau = 0$ for all $\tau > t$. Thus, following De Nardi, French and Jones (2006) and Palumbo (1999), health care is modeled as a forced investment that has to be made and cannot be used to improve individual health. The price p_t associated with health care depends on whether or not an individual has a Medical Card $1(Y_t \leq \bar{Y})$ or private supplementary health insurance I_t. Eligibility to a Medical Card only depends on having earnings below the threshold $\bar{Y}$, but having private supplementary health insurance is a choice variable of the household. A Medical Card reduces the price of health care with fraction π_1 and private supplementary health insurance reduces the price with fraction π_2, where $\pi_1 > \pi_2$. The price level of health care is

$$p_t = 1 - \pi_1 \cdot 1(Y_t \leq \bar{Y}) - \pi_2 \cdot 1(Y_t > \bar{Y}) \cdot I_t$$

Medical Card holders only buy private supplementary health insurance if the direct utility they get from it is high. The costs of obtaining private supplementary health insurance are q. So total medical expenditures are

$$M_t = p_t \cdot \big(2\omega_0 + \omega_1 \cdot (\Delta_t + \Delta_t^s) + \omega_2 \cdot (2 - H_{t-1} - H_{t-1}^s)\big) + 2q \cdot I_t$$

Figure 4.1: Timing of events



This implies that a household has a higher level of medical costs if individuals in the household are in bad health or if they experience health shocks. The probability with which health shocks occur, depends on the health status of the individual,

$$Pr(\Delta_t = 1 | H_{t-1} = 0) = \phi$$

and

$$Pr(\Delta_t = 1 | H_{t-1} = 1) = \varphi$$

One might expect individuals in bad health to be more likely to experience a health shock, i.e. $\varphi > \phi$.

Whereas health shocks describe temporary health problems, the health indicator H_t describes permanent health conditions (recall that bad health is an absorbing state). The transition probability from good health to bad health depends on age A_t and the labor market status, so

$$\Pr(H_t = 0 | H_{t-1} = 1, A_t, R_t, E_t)$$

This implies that working, unemployment and retirement can have a direct impact on the health of an individual. For the non-working spouse the transition probability from good to bad health reduces to a function of only age.

Figure 4.1 shows the timing of events. At the start of period t, the state variables are health H_{t-1}, the health of the spouse H^s_{t-1}, household wealth W_{t-1} and previous period's labor market states R_{t-1} and E_{t-1}. Based on information on these state variables, the household has to decide about taking health insurance for period t and if $R_{t-1} = 0$ whether or not to retire this period. Next, the household experiences health shocks and employment shocks. After the household learned about the shocks the household has to decide about the level of consumption and savings. The chosen level of savings determines the new wealth level W_t, and a new health status H_t is drawn depending on age and the chosen labor market state, E_t and R_t.

We use the model to describe behavior between age 50 and 75. So, age $A_t = 50$ at $t = 0$ and in final period $T = 25$ the individual's age is 75. During this period, households optimize lifetime utility, which implies the Bellman equation

$$V_t(W_{t-1}, H_{t-1}, H^s_{t-1}, E_{t-1}, R_{t-1}) = \max_{I_t, R_t} \mathrm{E}_{E_t, \Delta_t, \Delta^s_t} \left[\max_{C_t} U_t + \rho \mathrm{E}_{H_t, H^s_t} \left[V_{t+1}(W_t, H_t, H^s_t, E_t, R_t) \right] \right]$$

where ρ is the rate at which future utility is discounted. Furthermore, we impose

$$V_{T+1} = (W_T)^{\kappa}$$

where κ is a parameter. Households thus derive utility from leaving wealth after the last observation period. If T is interpreted as the age of death, then V_{T+1} gives the utility from leaving bequest. However, V_{T+1} can also be interpreted as the present value of expected utility beyond T. This additional term avoids that the model predicts strong dissaving towards age 75.

4.3.2 Parametrization

The non-consumption contribution to the instantaneous utility function depends on health, labor market status and insurance status. In particular, we adopt a linear specification

$$\begin{aligned} u(H_t, &H^s_t, R_t, E_t, I_t) = \\ &\alpha_0 + \left(\alpha_1 + \alpha_2 A_t + \alpha_3 A_t^2\right) E_t + \alpha_4 R_t + \alpha_5 H_{t-1} + \alpha_6 R_t H_{t-1} + \alpha_7 I_t + \alpha_8 H^{sp}_{t-1} \end{aligned}$$

in which we allow the (dis)utility of working to depend on the individual's age. Furthermore, we include the possibility of an interaction effect between retirement and health to capture that (voluntary) leisure might generate more utility when being in good health.

Next, we have to parameterize the transition probability from good health to bad health. For the male in the household, this is

$$\begin{aligned} &\Pr(H_t = 0 | H_{t-1} = 1, A_t, R_t, E_t) = \\ &\quad \frac{\exp(\gamma_0 + \gamma_1 A_t + \gamma_2 A_t^2 + \gamma_3 E_t + \gamma_4 R_t + \gamma_5 A_t (1 - R_t) + \gamma_6 A_t^2 (1 - R_t))}{1 + \exp(\gamma_0 + \gamma_1 A_t + \gamma_2 A_t^2 + \gamma_3 E_t + \gamma_4 R_t + \gamma_5 A_t (1 - R_t) + \gamma_6 A_t^2 (1 - R_t))} \end{aligned}$$

The specification allows the transition probability of health to differ in the way it depends on age with participation in the labor force. For the non-working spouse, this transition probability simplifies to

$$\Pr(H^s_t = 0 | H^s_{t-1} = 1, A^s_t) = \frac{\exp(\gamma^s_0 + \gamma^s_1 A^s_t + \gamma^s_2 (A^s_t)^2)}{1 + \exp(\gamma^s_0 + \gamma^s_1 A^s_t + \gamma^s_2 (A^s_t)^2)}$$

Finally, in the model we allow for unobserved heterogeneity in the preference parameter β and risk-aversion ν. We use a discrete distribution with two points of support for both parameters. So

$$\begin{aligned} \Pr(\beta = \beta_1, \nu = \nu_1) &= q_1 \qquad & \Pr(\beta = \beta_2, \nu = \nu_1) &= q_3 \\ \Pr(\beta = \beta_1, \nu = \nu_2) &= q_2 \qquad & \Pr(\beta = \beta_2, \nu = \nu_2) &= q_4 \end{aligned}$$

with $q_1 + q_2 + q_3 + q_4 = 1$.

4.4 The data

The data are from the Living in Ireland Survey (LIIS), the Irish contribution to the European Community Household Panel (ECHP) with eight waves of data covering the years 1994-2001. In 1994 a representative sample was drawn from electoral registers. Until 2001, individuals in this sample and all their household members over age 16 were each year asked to complete a questionnaire. In total 4048 households participated in the first wave in 1994, which was 57% of the originally sampled households. In the year 2000 new individuals and their households were added to the panel, as the size of the panel had diminished over time due to attrition. The main cause for attrition after the first wave was the difficulty to trace households that had moved. This problem occurred most often with single young adults, and, therefore, is less of a problem for our purposes (see Watson (2004) and Bolhaar, Lindeboom and Van der Klaauw (2008) for more details on the attrition pattern).

4.4.1 Sample selection and descriptives

From the Living in Ireland Survey all households are selected with a man between age 50 and 75. This reduces the data from 5902 to 2453 households. Furthermore, we select only men, who were married (and whose marital status did not change), which reduces the sample to 1981 couples. Next, we remove men who already left the labor force before age 50, which leaves us with 1739 couples. Since in the model, we consider single-income households, we only keep 1130 couples with a non-working female spouse. The data contain 454 self-employed men and farmers. These types of employment differ from regular employment in the way a pension is provided. Both farmers and the self-employed do not make social security contributions and do not have occupational pensions to supplement the Non-Contributory social security pension. For most farmers and self-employed their business is their 'pension fund': the revenue of selling the business should provide enough capital to live off their own means (Hughes and Watson, 2004). Because this would be difficult to fit in our model, we exclude them from the data. This results in a reduction of the sample to 676 households. Next, we have to exclude households with missing information in relevant variables. This results in a sample of 608 households with 2406 couple-year observations.

The questionnaires cover a wide range of topics, such as (sources of) income, labor market status, health, etc. Table 4.3 gives some descriptives of our sample. The descriptives in the first column are averages over individuals and waves. The descriptives in the second column are taken from the first available observation of the individual in our sample. In this way individuals that have more observations do not have a larger weight in the descriptives than those who entered later or left the survey before the official end in 2001. Of course this will give a low average age and better average health than in the complete sample used.

Men are on average 58.6 years old when first observed. At the initial observation, slightly one-third has already retired and 60% is still employed. On average they have been in the labor force over 40 years and have been retired for over 2 years when first observed. Most households are either covered by a Medical Card (23%) or supplementary private health insurance (55%).

A relatively large fraction of the retired in the sample receives some second pillar pension. When first observed, 23.8% of the retirees receives a public service pension and 39.9% an occupational pension. Only 10% of the retirees receives a private pension. Of those without a second pillar pension, 52.9% receives a Contributory Pension and 12.9% a Non-Contributory Pension. Most of the people who receive neither a Contributory nor a Non-Contributory Pension do so because they have not yet reached age 65 or 66 to qualify for these schemes.

The (female) spouses are somewhat younger than their husband. They are slightly less often having a health problem, but more often have a high score on the mental health scale, meaning they have worse mental health. On self-assessed health the male and female spouse score (on average) the same.

4.4.2 Variable construction

In our model bad health is an absorbing state. To construct the health variable we use the survey question *Do you have any chronic, physical or mental health problem, illness or disability?* A positive answer to the question above is followed by the request to specify the nature of the health problem. Up to three health problems can be specified. Individuals are also asked since when they have had this health problem. However, this can only be specified for the first health problem that is listed. As a result, the indicated starting age of the health problem increases with age. This can be explained if people with more than one health problem list the most recent health problem they suffer from first. This could either be because this is the health problem they suffer from most at the moment they fill in the questionnaire or because this problem is most fresh in memory. Unfortunately, this question therefore cannot be used to define the health status at age 50, H_0, an initial condition in our model. We will therefore simulate for every individual both situations ($H_0 = 0$ and $H_0 = 1$) and give them weights in the likelihood function according to the average percentage of 50 year-olds with and without a health problem.

For health shocks we use admittance to hospitals. In particular, we directly estimate the parameters describing the risks of health shocks from the fraction of individuals in good and bad health which is admitted to hospital. Table 4.4 shows these probabilities. When being in bad health the probability of experiencing a health shock is 0.27, and this is 0.09 when being in good health. These probabilities are the same for males and females.

The health care costs are represented by the parameters ω_0, ω_1 and ω_2. The value

Table 4.3: Descriptive statistics

	all obs (1)	firstyearonly (2)
age	60.7	58.6
retired	0.412	0.335
employed ≥ 15hrs per week	0.528	0.607
years of life † in labor force	41.3	40.1
years of life † retired	2.7	2.1
years education	9.177	8.910
net weekly income in £ 's of 1994	259.40	250.86
savings increased	0.322	0.267
savings fell	0.150	0.156
savings stayed same	0.527	0.577
supplementary private health insurance	0.549	0.550
Medical Card	0.281	0.233
GP visits last 12 months	3.692	3.817
specialist visits last 12 months	0.730	0.703
optician visits last 12 months	0.404	0.394
dentist visits last 12 months	0.571	0.679
hospital stay last 12 months	0.134	0.138
health problem	0.286	0.254
self-assessed health = (very) good	0.760	0.770
GHQ-score ≥ 4 (bad mental health)	0.099	0.113
only those already retired		
years of life † in labor force	44.4	44.8
receives no second pillar pension	0.299	0.365
receives public service pension	0.302	0.238
receives occupational pension	0.400	0.399
receives private pension	0.063	0.102
only those already retired and without a second pillar pension		
receives Contributory Pension	0.618	0.529
receives Non-Contributory Pension	0.098	0.129
age spouse	58.0	56.0
GP visits spouse last 12 months	3.878	3.874
specialist visits spouse last 12 months	0.703	0.585
optician visits spouse last 12 months	0.411	0.375
dentist visits spouse last 12 months	0.613	0.635
hospital stay spouse last 12 months	0.115	0.103
health problem spouse	0.263	0.220
self-assessed health = (very) good	0.760	0.779
GHQ-score ≥ 4 (bad mental health) spouse	0.123	0.155

† = years of life since the age of 10

Table 4.4: Parameter values of parameters not estimated in Step 2

PARAMETERS TAKEN FROM THE DATA		
Employment opportunities		
$\Pr[E_t = 1 \mid E_{t-1} = 0]$	ζ	0.480
$\Pr[E_t = 1 \mid E_{t-1} = 1]$	ξ	0.955
Health shocks		
$\Pr[\Delta_t = 1 \mid H_t = 0]$	ϕ	0.274
$\Pr[\Delta_t = 1 \mid H_t = 1]$	φ	0.094
Health care costs (in 1000's of £)		
regular costs / health maintainance	ω_0	0.125
costs due to health shock	ω_1	0.900
costs due to bad health	ω_2	0.300
Cost of health insurance (in 1000's of £)		
health insurance premium	q	0.250
PARAMETERS ESTIMATED IN STEP 1		
Transition probability from good to bad health		
constant	γ_0^s	−14.052
age of spouse	γ_1^s	0.265
(age of spouse)^2	γ_2^s	−0.00156
OTHER PARAMETERS		
interest rate	δ	0.01

of all three parameters is estimated by the reported number of visits to a GP, medical specialist, optician or dentist and the number of nights in hospital in the past 12 months. We combine this information with the calculations of Layte and Nolan (2003) of the per unit cost of different types of health care in Ireland.[2] For households with a private supplementary health insurance, we observe their monthly insurance premium. Rates are converted to £ś of 1994 and the median rate is used as an approximation of q. This per person premium for private supplementary health insurance is about £ 250 per year.

The threshold $\bar{Y}$ for getting a Medical Card depends on the household composition and the age of both spouses. As the Medical card income guidelines are increased in accordance with the Consumer Price Index each year, the threshold in real terms stays the same over time. Like the different sources of income, we also use 1994 £ś for the Medical Card threshold. A couple where the man's age is below 66 faces a threshold of £ 118.25 per week. For a couple aged 66 or above, this increases to £ 132.90 per week. For each dependant child below the age of 16 another £ 14.50 is added, for each dependant child above 16 £ 15.00.

For savings our data only contains a measure on a five-point scale: *Increased a lot/Increased a little/Remained the same/Fell a little/Fell a lot.* As might be expected,

[2]The unit costs in Layte and Nolan are in euro's for 1999/2000. We convert the unit costs to 1994 Irish pounds

in the data the most mass is in the category *Remained the same*. Therefore, we reduce the number of categories to 3: *Increased*, *Remained the same* and *Fell*. For 57% of the couples savings stayed the same, 26% said they increased and 17% indicated that savings decreased in the year they entered the sample. If we look at all observations we see a lower percentage for whom savings stayed the same or fell and a higher percentage for whom savings increased. This could indicate that people do not dissave when they get older, but save even more.

Wealth in our model serves two purposes: self-insurance against health care costs and accumulating means to supplement retirement income or retire early on private means. Unfortunately, the data do not contain any information on wealth. Furthermore, even more general information on wealth levels in Ireland is very scarce. We will use the individual's annual wage at age 50 to set an initial wealth level, $W_0 = \varpi \cdot WAGE_0$. We set ϖ to 0.5, as a sensitivity check a change in ϖ can be investigated.

We use observed transitions between employment and unemployment to estimate transition probabilities. In particular, the probability of staying in employment, when being employed (ξ) equals 0.955. The probability of finding work while being unemployed (ζ) is 0.48. Unemployed individuals receive a benefit B_t. The level of the unemployment benefit is equal to that of the Non-Contributory Pension benefits listed in Table 4.1. Finally we set the interest rate at 0.01 (in accordance with French, 2005). Table 4.4 summarizes the values of the structural parameters which we estimated on the raw data.

Recall that in our model wages are predetermined. This implies that we have to impose wage profiles. To approximate the wage an individual receives for employment, the following equation is estimated:

$$WAGE_{i,\tau} = \vartheta_0 + \vartheta_1 X_{i,\tau} + \vartheta_2 J_{i,\tau} + \varepsilon_{i,\tau} \qquad \varepsilon_{i,\tau} \sim N(0, \sigma_\varepsilon) \tag{4.1}$$

where $WAGE_{i,\tau}$ is the wage of individual i observed in wave τ (corrected for inflation). The vector X_τ contains individual characteristics, such as age, gender, years of education, labor market history, etc., while the vector J_τ includes job characteristics, such as hours of work, sector, occupation, etc.

Next, we use that between age 50 and 75, individual wages are very well approximated by

$$\ln\left(WAGE_{i,t}\right) = WAGE_{i,0}\left(1 + \iota_{wage}\right)^t \tag{4.2}$$

where the annual wage growth is estimated to equal 0.0316. Using this approximation we only need to predict the *baseline wage* $WAGE_{i,0}$ of individual i at age 50. For individuals for whom wage is observed in one or more waves, the baseline wage $WAGE_{i,0}$ can be deducted from the observed wage using equation (4.2). Individuals who were already retired when first included in the data, do not have any wage observations. However, the data contain the characteristics of their last job before retirement and we can use equation

(4.1) to get an estimate of the baseline wage.[3] It should be noted that almost 90% of the individuals in our data do not switch employer anymore after age 50. To take into account that the estimated wage approximates the true wage up to the error term $\varepsilon_{i,\tau}$ (equation 4.1), n draws from $N(0, \sigma_\varepsilon)$ are taken to create n reconstructed wages. Each of these n reconstructed wage profiles will have a weight of $\frac{1}{n}$ in the likelihood function.

The pension P_t received at retirement is the sum of social security FP_t (first pillar pensions) and public service, occupational and private pensions SP_t (second pillar pensions). Recall from subsection 4.2.1 that it is common for public service and occupational pensions to take into account the level of social security benefits. Adopting the most common arrangement for each of the pension types, this implies a quite simple rule for calculating the pension profile of individuals with a second pillar pensions. The data provide information on second pillar pensions for retired individuals. For individuals in the labor force we observe if they are eligible for second pillar pensions other than a private pension. We also observe if an individual works in the private or public sector, and more precisely in which occupation. We can thus deduct eligibility for either a public service or an occupational pension. The pension profile for those with a public service pension is

$$P_t = SP_t^{pub}\left(yw_t, WAGE_{A^r-1}, A^r\right) = \frac{1}{80} \cdot \max\left\{yw_t, 40\right\} \cdot WAGE_{A^r-1} \cdot \left(\iota_{sp}\right)^{A_t - A^r}$$

where yw_t is the number of years the individual has been in the labor force. The profile for occupational pension members is

$$P_t = SP_t^{occ}\left(yw_t, WAGE_{A^r-1}, A^r\right) = \frac{1}{60} \cdot \max\left\{yw_t, 40\right\} \cdot WAGE_{A^r-1} \cdot \left(\iota_{sp}\right)^{A_t - A^r}$$

Private pensions are not very common and do not follow a specified rule. We will use the same rule as for occupational pensions for private pensions.

For individuals that are only entitled to collecting first pillar pensions (social security), the pension profile depends on whether the individual has made (enough) social security contributions. If no contributions are made wealth has to be taken into account as well (recall that the Non-Contributory Pension is means-tested). First, we estimate the probability that an individual has made social security contributions ($SSC = 1$) on individual and job characteristics. In particular, we use a logit model,

$$\Pr[SSC = 1] = \Lambda\left(X_t, J_t\right)$$

This estimation is based on a sample of retired workers. We use the estimated parameters to approximate the likelihood of making social security contributions for non-retired workers.

[3]Some individuals have missing observations in the characteristics of the last job before retirement. For them we use a second approximation rule, based on the pension rule for second pillar pensions. Using the number of years worked and the pension received, the wage before retirement can be reconstructed. Comparing the reconstructed wage using this approximation method and approximation using equation (4.1) for individuals for whom characteristics of the last job before retirement are available, indicates that the two methods produce wages that are reasonably close.

If sufficient social security contributions are made, an individual is entitled to the Contributory rate. If an individual is not eligible for the Contributory pension, a means test will determine the pension income. Conditional on receiving the Non-Contributory pension, we estimate the amount of the payment that is received by regressing the payment on the level of other possible sources of income and individual characteristics. The estimates are used to predict the amount of Non-Contributory pension payable to those still at work if they would retire without having made (enough) social security contributions. The social security pension that is payable is given by

$$FP_t(A_t, A_t^s, SSC, Y_t^{other}, X_t) =$$
$$\Pr[SSC = 1] \cdot FP_t^{ssc=1}(A_t, A_t^s) + (1 - \Pr[SSC = 1]) \cdot FP_t^{ssc=0}(A_t, A_t^s, Y_t^{other}, X_t)$$

4.5 Estimation

The first step in our procedure to estimate the parameters from the dynamic programming model specified above is to solve the model backwards using a vector of starting values θ_0 for the parameters we want to estimate θ. For n different values of W_{T-1} and for every possible retirement age $A^r, A^r \in \{50, \ldots, 50+T\}$, last period's value function $V_T = U_T + \rho V_{T+1} = U_T + \rho (W_T)^\kappa$ is optimized over C_T for all relevant (combinations of) values of the state variables at time T, $Q_T = \{W_{T-1}, H_{T-1}, H_{T-1}^s, E_T, R_T, I_T, \Delta_T, \Delta_T^s\}$.

Stepping back one period to period $t = T-1$, the expectation of period T's value function V_T over E_T, Δ_T and Δ_T^s is calculated using the shock and transition probabilities ζ, ξ, ϕ and φ, given H_{T-1}, H_{T-1}^s, E_{T-1} and R_{T-1}. This gives $\mathrm{E}_{E_t,\Delta_t,\Delta_t^s}[\max_{C_t} U_t + \rho V_{t+1}(\ )]$ for the n values of W_{T-1} and for all retirement ages A^r. Given H_{T-1}, H_{T-1}^s, E_{T-1} and R_{T-1}, the optimal insurance decision for period T, I_T can be determined. Buying insurance is optimal if the expected value of doing so is larger than the expected value of not doing so, conditional on H_{T-1}, H_{T-1}^s, E_{T-1}, R_{T-1}, W_{T-1} and A^r. The resulting vector contains the maximum value for V_T given H_{T-1}, H_{T-1}^s, E_{T-1}, R_{T-1} and A^r for n different values of W_{T-1}. A x^{th}-order polynomial in W_T can now be fitted to this vector to approximate V_T (given H_{T-1}, H_{T-1}^s, E_{T-1} and R_{T-1}) by a function in W_T (as proposed by Keane and Wolpin, 1994). This reduces the optimization problem from

$$V_t(\ ) = \max_{I_t,R_t} \mathrm{E}_{E_t,\Delta_t,\Delta_t^s}\left[\max_{C_t} U_t + \rho \mathrm{E}_{H_t,H_t^s}[V_{t+1}(\ )]\right]$$

to

$$V_t(\ ) = \max_{I_t,R_t} \mathrm{E}_{E_t,\Delta_t,\Delta_t^s}\left[\max_{C_t} U_t + \rho \mathrm{E}_{H_t,H_t^s}\left[\psi_0 + \psi_1 W_{T-1} + \psi_2 W_{T-1}^2 + \psi_3 W_{T-1}^3\right]\right]$$

The advantage is that it makes evaluation of all combinations of the state variables *of all time periods* no longer necessary. Given H_{T-1}, H_{T-1}^s, E_{T-1}, R_{T-1} and A^r, the ψ's summarize the utility of optimal choices in the future and reduce the first-order conditions for optimization to an expression that can be solved. The estimated parameter values of the ψ's are stored for later use.

For $H_{T-1} = 0$, with probability 1 $H_T = 0$. For $H_{T-1} = 1$, the probability with which $H_T = 0$ depends on A_{T-1}, E_{T-1} and R_{T-1}. For the spouse this probability only depends on age. For all relevant combinations of E_{T-1} and R_{T-1} the probability that good health will deteriorate to the bad state in period $T-1$ (where $A_{T-1} = 50 + T - 1$) can be computed. Using the obtained transition probabilities for the male and the earlier estimated transition probabilities for the spouse, $\mathrm{E}_{H_t,H_t^s}[V_{t+1}(\ )]$ (given E_{T-1} and R_{T-1}) can be computed. With the obtained expected value of future utility the routine described above can be repeated for $t = T-1, T-2, \cdots$ down to $t = 0$.

After having solved the model, we use simulation methods to estimate the parameters. In particular, we adopt the estimation methods of Keane and Sauer (2009). This methods is based on using classification errors. So we simulate the model for a set of parameters and obtain predictions for retirement status, health status, health insurance choice and saving.[4] Estimating the parameters simply yields maximizing the number of correct predictions over the parameters. The criterium function is, however, non-continuous. Therefore, we use the simplex algorithm proposed by Nelder and Mead (1971) to estimate the parameters.[5]

The second step uses the stored values of the ψ's estimated in the first step to solve for optimal choices in each period. Starting at $t = 0$, where initial health of the individual and his spouse H_0, H_0^s and wealth W_0 are known, the ϕ's for each of the retirement ages for period 1 are used to solve the optimization problem and chose the optimal value for R_1 and I_1. For a set of draws for E_1, Δ_1 and Δ_1^s the optimal consumption level C_1 is determined. Subsequently, W_0 can be updated to W_1 as the level of savings S_1 directly follows from the optimal consumption. In addition, a new value for the health variables is drawn using the transition probability resulting from the chosen labor market choices and age. Proceeding in this way, the model can be solved for all period until $t = T$.

The third step of the procedure involves comparing the simulated choices with the observed choices for retirement status, health, health insurance and savings. For each of these outcome variables the fraction of classification errors is calculated. The classification error rates are used to construct the likelihood function as proposed by Keane and Sauer (2009). As savings is a continuous variable in our model, but only a categorized variable in the data, the simulated savings histories have to be categorized in a similar manner as the data to determine the error classification rates. We tried different threshold values to categorize the simulated savings, and a fraction of 0.025 of wealth fitted the data best.

[4]In the data we only observe whether or not household saved or dissaved. In our model savings is continuous. We impose that a household saves if savings were more than 2.5% of the wealth level. We have tried different threshold values.

[5]Also Keane and Wolpin (2001) and French (2005) use this methods to estimate structural models.

In the fourth step, the obtained likelihood is used to update parameter vector θ. With the new parameters θ we go back to step 1. This iterative process continues until the vector of parameters is found that best fits the data. Because of the highly discontinuous nature of the likelihood function, we used the Simplex algorithm proposed by Nelder and Mead (1971) to choose new parameter values.[6] Though computationally intensive, our strategy has two advantages. First, we don't restrict the choice variables by discretizing them (contrary to, for example, French and Jones, 2004). And second, it automatically incorporates a way to address measurement error in the choice variables. Standard errors are obtained with the BHHH-method, or outer product of gradients, using numerical derivatives (in line with Sauer, 2004, and Keane and Wolpin, 2001).

4.6 Results

4.6.1 Parameter estimates

In Table 4.5 the results for the estimated parameters are presented. We find that couples derive positive utility from both employment and retirement of the man, compared to unemployment. The direct effect of health on utility is very small (1.651). The effect of health interacted with retirement is for both spouses much larger. We find that couples derive more utility from retirement if the man is in good health (8.337) and/or his spouse is in good health (15.763). One way to interpret these positive coefficients is that retirement is enjoyed more in good health. The positive coefficients can also be interpreted differently: couples derive more utility from retirement if they are in good health than if they are in bad health because when they are in bad health the lower income that comes with retirement is a larger burden. The couples in our sample also derive some utility of having health insurance beyond the reduction in copayments. Harmon and Nolan (2001) report a survey by the Economic and Social Research Institute (ESRI) in which people were questioned on reasons to buy health insurance. Besides financial reasons also waiting lists were mentioned as an important reason. The positive effect of health insurance, therefore, most likely reflects the utility of health insurance as a way to circumvent waiting lists. In the transition from good to bad health age, as expected, plays an important role. The positive coefficients of γ_1 and γ_5 imply that the probability to move from good to bad health increases with age. This effect is stronger if individuals have not yet retired, suggesting a negative impact on health of being in the labor force at advanced ages. Both γ_2 and γ_6, the effect of age squared, are negative, so the positive effect of age on the probability to transition from good to bad health is diminishing with age. We allowed for heterogeneity in both risk aversion and preferences in our model. The estimated

[6] This is a common choice for this type of models, see for example Keane and Wolpin (2001) and French (2005).

Table 4.5: Estimation results

Utility function			
constant	α_0	79.575**	(35.674)
employment	α_1	85.049***	(3.502)
employment∗age	α_2	0.804***	(0.019)
employment∗age squared	α_3	−0.044***	(0.002)
retirement	α_4	19.806***	(1.433)
health	α_5	1.651	(1.719)
retirement∗health	α_6	8.337	(5.957)
retirement∗health of spouse	α_7	15.763	(13.145)
health insurance	α_8	0.959***	(0.131)
Health transition function			
constant	γ_0	−14.037	(65.197)
age	γ_1	0.247	(0.782)
age squared	γ_2	−0.002	(0.002)
employment	γ_3	−0.003	(1.339)
retirement	γ_4	−0.002	(1.186)
age∗(not retired)	γ_5	−0.00001	(0.013)
age squared∗(not retired)	γ_6	−0.00001	(0.0003)
Behavioural and preference parameters			
value of bequest	κ	0.995***	(0.031)
valuation of future utility	ρ	0.975***	(0.105)
preference for consumption	β_1	0.770	(0.632)
	β_2	0.889	(0.944)
risk aversion	ν_1	0.183***	(0.006)
	ν_2	0.198***	(0.003)
$\Pr(\beta = \beta_1)$		0.127	(0.081)
$\Pr(\nu = \nu_1 \mid \beta = \beta_1)$		0.412***	(0.035)
$\Pr(\nu = \nu_1 \mid \beta = \beta_2)$		0.944***	(0.086)

*** = significant at 1% level,**= significant at 5% level,*=significant at 10% level

parameters indicate a little heterogeneity in risk aversion (0.183 and 0.198), and more heterogeneity in preferences (0.769 and 0.889). However, the group of individuals that has $\beta = \beta_1$ is quite small, only 12.7% of the population. The by far largest group of individuals has $\beta = \beta_2$ and $\nu = \nu_1$. These results indicate that it is not superfluous to allow for heterogeneity in risk aversion and preferences.

Figure 4.2 shows how the simulated data fit the true data we observe. All panels show the fraction of individuals for which some variable (retirement, health insurance, health, etc.) equals one, ordered by age.[7] The simulated profile for retirement is steeper than in the observed data. In the simulated data most individuals retire at age 60. In reality however, this goes more gradually between 57 and 67. The simulated profiles of having a Medical Card and for health insurance purchase fit the original data better. At lower ages the simulated model predicts lower levels of health insurance purchase, where in the data

[7] As we observe individuals only for a maximum of 8 years, the observations at age 70 are not from the same individuals as the observations at age 55, for example. Hence the irregularities in the profiles, especially for the observed data.

health insurance purchase is quite constant over age. The simulated profile for health fits the data fairly well at lower ages, but health does not decline as much at higher ages as in the true data. The simulated profile for spousal health fits the data quite well. Savings are increasing at lower ages for the majority of the population in the simulations. After age 60, the fraction of the population that has increased savings declines rapidly. The figure for the fraction of the population for whom savings stayed the same is the mirror image of that for increased savings. The simulations show a fraction for whom savings stayed the same that is too low at lower ages, and that increases rapidly after age 60. The fraction for whom savings decreased is low in both the observed and the simulated data. The increased savings at lower ages in the simulated data are thus not used to be dissaved after retirement; after having accumulated wealth, the level of savings stays the same and does not decrease. The discrepancy between the observed and the simulated data for retirement can therefore not (only) be explained by simulated individuals accumulating large amounts of wealth to retire early. A more probable explanation is that some of the assumptions that were made in the construction of the variables are too strong. It was assumed that all the years an individual has been working, count in determining the level of second pillar pensions. If, for example, an individual had employment for some years that did not have a second pillar pension scheme, this will influence the level of his pension. This effect can be especially strong because of the cap on the number of years in employment in the pensionrule (recall from subsection 4.4.2 that years in employment in the pension rule is 40 at maximum). Assuming for all individuals that the full number of years they have been working counts in determining the level of the second pillar pension, implies for most individuals that working beyond age 60 will not increase the level of their pension as they have already worked for 40 years at that age.

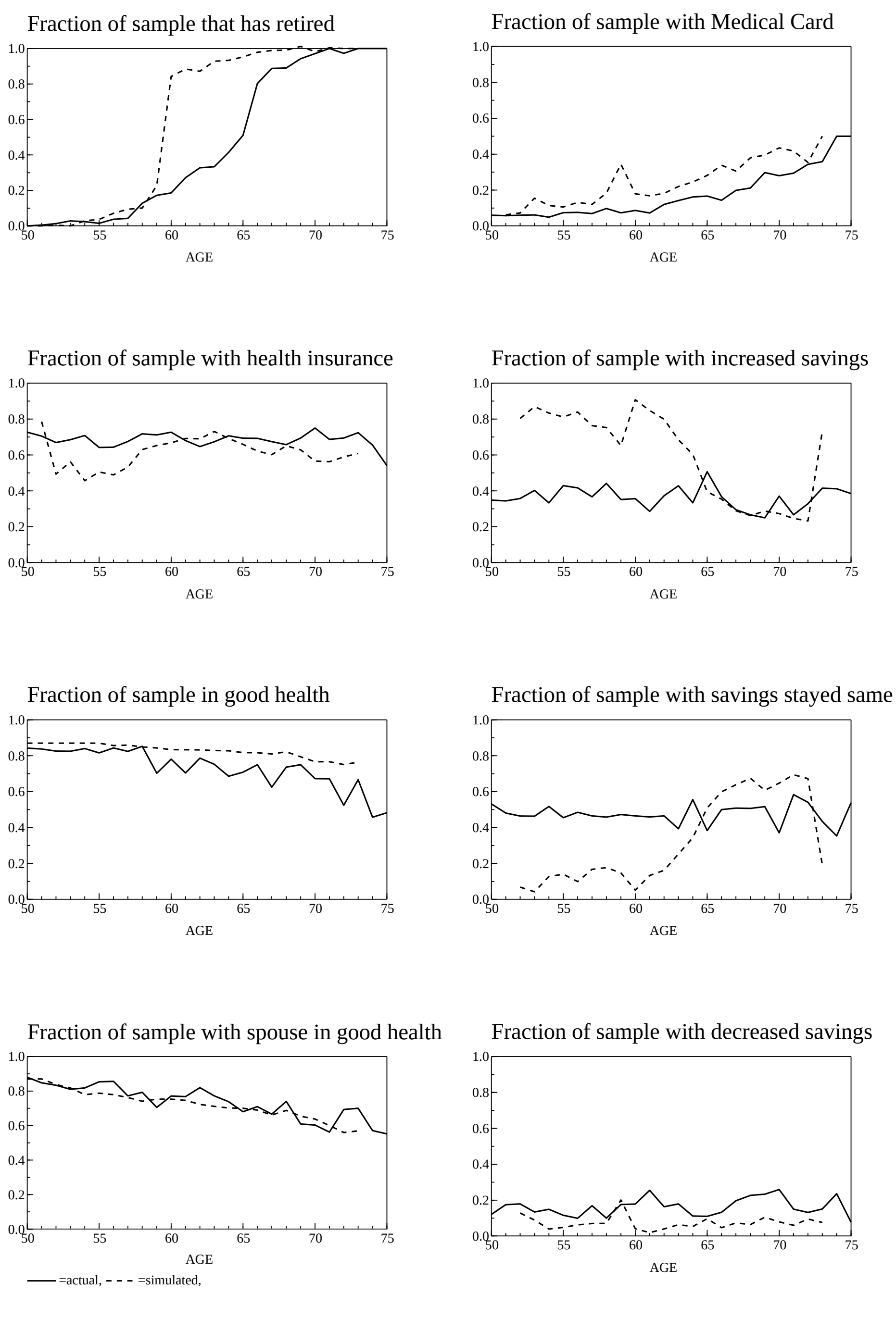
4.6.2 Policy simulations

We use the estimated model to simulate the effects of a number of policy changes.

First, we focus on the Medical Card and simulate the consequences of lowering the income threshold for eligibility for the Medical Card. We lower the income threshold with 20%. In Figure 4.3 we show the effect of lowering the Medical Card threshold on retirement behavior. There is only a very small change in the age of retirement. It seems that some people retire slightly earlier with the lower threshold.

Next, we consider the rising health care costs. Technological advancement results in treatments becoming available for diseases that could not (or not that good) be treated before. These new technologies are often very expensive. Furthermore, they enable people with fragile health to live longer, but with increased health care costs. It is likely that if health care costs rise, the premium of supplementary private health insurance will also increase. This experiment increases both health care costs and the insurance premium by 10%. Figure 4.4 shows that there is no effect on retirement behavior of these changes.

Figure 4.2: Fit of simulated data for retirement, private supplementary health insurance purchase, health, spousal health, Medical Card ownership and savings



Finally, we consider the increase in age at which people become eligible for state pensions. Many countries face an ageing population, which causes financial problems because of a declining ratio of active over inactive individuals. Many countries either recently increased the eligibility age for state pensions or are considering such a policy. Therefore, we simulate the effect of increasing the age for eligibility of the state pension from 65 to 67 and the second pillar pension from 60 to 62. The results are shown in Figure 4.5. We see a shift towards later retirement, but this shift is somewhat smaller than 2 years.

Figure 4.3: Retirement profile lower threshold for Medical Card

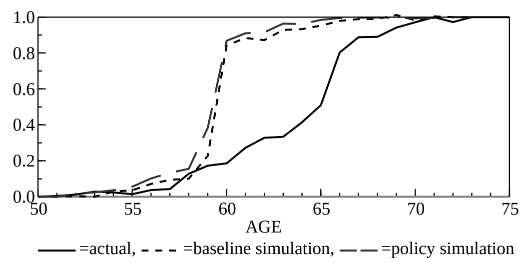


Figure 4.4: Retirement profile increased health care and health insurance costs

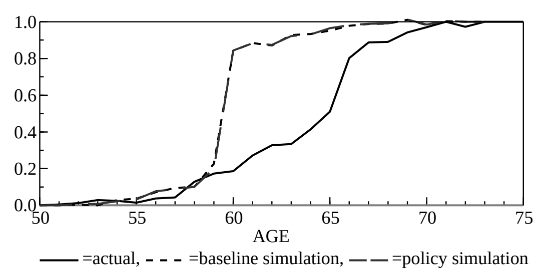
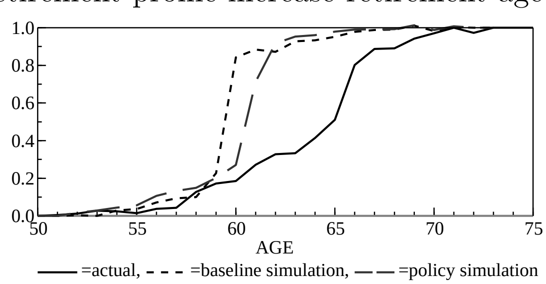


Figure 4.5: Retirement profile increase retirement age with 2 years



4.7 Discussion and conclusion

We developed an estimated a structural model for the behavior around retirement of couples. In particular, we focused on health, health insurance choices and labor market decisions. To estimate the model we used a sample of Irish couples with a single earner in the age between 50 and 75. We have used the estimated model to simulate a number of policy changes.

The key conclusion is that changes in the eligibility for a Medical Card only have a very minor effect on retirement behavior. The same is found for changing health care costs. This might suggest that when deciding to retire, the consequences of individual health risk do not play a very important role. On the other hand, varying the eligibility age for social security and pension affect retirement behavior. In particular, increasing the age of becoming eligible for social security increases the average age of retirement.

Our model allowed for heterogeneity in risk aversion and preferences. The parameter estimates indicate that this is not superfluous: although we find that about 82% individuals belongs to one group with the same preferences and risk aversion, still 18% belongs to one of three smaller groups with different preferences and risk aversion.