To love or to pay: On consumption, health and health care

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People face heterogeneous health shocks and medical spending risks. Using a rich dynamic structural life-cycle model, this paper investigates how these shocks affect the savings behavior of retired single households. Consumers are allowed to respond to health shocks in two different ways: they can directly pay for their health care expenses (self-insure) or they can rely on health insurance contracts. There are two possible insurance options, one through formal contracts and another through informal health care provided by family. Formal insurance contracts may be affected by asymmetric information problems, while informal insurance depends on social ties (cohesion) and on the wealth available for bequeathing. I estimate the model on SHARE data, using the simulated method of moments for four levels of wealth and three European country groups: Mediterranean, Central European and Scandinavian. I find that the risks of living long and facing high medical expenses can provide an explanation for increasing precautionary savings (and consequently bequests) after retirement. Most important and novel, the estimates on family cohesion, by country and wealth level, confirm two relevant social literature findings on the strength of family ties: it generally rises with age and declines with wealth and it is higher in Mediterranean countries as opposed to Central European or Scandinavian countries. Finally, I find that high family cohesion is usually accompanied by a high life expectancy.

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1. INTRODUCTION

What are the main reasons why the elderly decumulate wealth so slowly? The economic literature has focused on explanations based on bequest motives and/or precautionary savings motives. As has long been recognized, these two motives for savings overlap and cannot generally be distinguished from one another. This is mainly due to an important consumption literature feature, namely allowing for uncertainty in life-cycle models. Moreover, while intergenerational transfers and availability of private and public health insurance appear to be of central importance in understanding patterns of wealth accumulation, relatively little is known about what motivates individuals to leave bequests.

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The novel feature of this paper is twofold. First, using a realistic simulation exercise, I analyze the effects of heterogeneous health shocks and medical spending risks on savings behavior in eleven European countries. Second, I consider intergenerational transfers to be actually used by the elderly to obtain health care in case of a health shock. More specifically, the elderly are allowed to respond to health shocks in two different ways, one involving direct payment for their health care expenses (self-insure) and another involving health insurance contracts. In the second case, I assume that health care can be provided formally by the market or informally by the family. Formal insurance contracts may be affected by asymmetric information problems, while informal insurance depends on social consensus (cohesion) and on bequeathable wealth. I estimate the model on SHARE data, using the simulated method of moments (SMM) for four levels of wealth and three country groups: Mediterranean, Central European and Scandinavian. I make the strong assumption that there are no country-specific shocks.

I find that the risks of longevity and facing high medical expenses can satisfactory provide an explanation for increasing precautionary savings (and consequently bequests) with age after retirement. Moreover, the estimates of family cohesion, by country and wealth level, succeed in proving two relevant social literature findings on the strength of family ties. First, family cohesion generally rises with age and declines with wealth. Second, it is higher in Mediterranean countries as opposed to Central European or Scandinavian ones. Finally, I find that high family cohesion is usually accompanied by a high life expectancy. More specifically, in Mediterranean countries the level of formal health insurance is low, health expenses being mainly covered by the family, while people tend to display rather high survival probabilities. On the contrary, in Scandinavian countries, individuals register short life expectancies, despite the high formal coverage available.

The remaining part of the paper is organized as follows: Section 2 develops the dynamic model and Section 3 describes the data. Section 4 presents the estimation method, using Gauss-Herman quadrature and SMM. Results are illustrated in Section 5, and Section 6 concludes.

2. THE MODEL

2.1. Utility function

For simplicity, I consider as the unit of analysis, the household consisting of one single individual who has just retired. This allows me to concentrate on consumption, health insurance and savings decisions, and not to consider labor supply and retirement choices. The first period of observation occurs when the individual is 65 years old and entering retirement. The retirement age is assumed to be exogenous and deterministic, with all individuals retiring at the age of 65. Consequently, the model consists of a series of one-year periods, starting at the age of retirement and ending at the year of death, which is finite and restricted to occur by maximum age 100. The maximum length of the retirement period therefore counts 36 periods ($T = 36$). Periods are indexed by t, the number of years in the retirement period, starting at 1 for age 65, so that overall $1 \leq t \leq T, t \in \mathbb{N}$. There is a stochastic survival probability $s_t \in [0, 1]$ in year t that evolves in a matter defined in the model's uncertainty section.

Consider an individual seeking to maximize her expected lifetime utility at time t, $t \in [1, T]$, with an exponential discounting factor $\beta > 0$, by choosing current and future level of consumption and insurance, both formal and informal. For each period, the individual's utility depends on her health status m_t, consumption C_t, and face value of insurance, formal $F_t(f_{t-1})$ and informal I_t. All the variables mentioned above are functions of time, so they will be indexed by t, while $F_t(f_{t-1})$ is at least of class C^1 (first class of differentiability). Consumption and insurance are additively separable, and the utility of being looked after (through formal and/or informal coverage) is a CES embedded in a constant-elastic function, with substitution parameter θ.

The within-period utility function is given by

$$\begin{aligned} u(m_t, C_t, F(f_t), I_t) &: \mathbb{R}_+ \rightarrow \mathbb{R}_+ \\ u(m_t, C_t, F(f_t), I_t) &= \delta(m_t)\frac{C_t^{1-\gamma} - 1}{1-\gamma} + \epsilon(m_t)\frac{\left[\alpha F_t(f_{t-1})^\theta + (1-\alpha) I_t^\theta\right]^{\frac{1-\sigma}{\theta}} - 1}{1-\sigma}, \end{aligned} \tag{1}$$

where $m_t \in [0,1]$ represents health status, and $\delta_t(m_t)$ and $\epsilon(m_t)$ describe the health status dependency of utility from consumption of non-durable goods and from being looked after respectively. C_t is consumption of non-durable goods in period t, $F_t(f_{t-1})$ is the face value of the formal insurance policy, purchased the previous period (i.e., health expenditures covered by insurance in period t) and I_t is the face value of the informal insurance policy, purchased in period t. The parameters $\gamma, \sigma > 0$ are the relative risk aversion parameters for consumption of non-durables and medical goods respectively; σ increases as individuals become less willing to substitute formal and informal insurance across time, i.e., it measures the non-separability between formal and informal insurance.

There are four health states modelled. State 1, $m_t(1)$ is death and state 2, $m_t(2)$ is a state in which long term care of some form is required (invalidity or poor health). In state 3, $m_t(3)$ the individual has medical problems but no need for long term care (fair health). State 4, $m_t(4)$ is the good health state.

$\delta_t(m_t)$ determines how a person's utility from consumption of non-durable goods depends on her health status, and is given by

$$\begin{cases} \delta_t(m_t) = 1 + m_t, & \text{for } 0 < m_t \leq 1, \\ \delta_t(m_t) = 0, & \text{for } m_t = 0, \end{cases} \tag{2}$$

so when dead ($m_t = 0$), health status does not affect utility from consumption, while when healthy ($m_t = 1$), it has a positive effect on utility (the individual enjoys the consumption of goods more when healthy).

On the other hand, $\epsilon(m_t)$ determines how a person's utility from insurance coverage depends on her health status, and is given by

$$\begin{cases} \epsilon_t(m_t) = 1 - m_t, & \text{for } 0 < m_t \leq 1, \\ \epsilon_t(m_t) = 0, & \text{for } m_t = 0, \end{cases} \tag{3}$$

so when sick ($0 < m_t \leq 1$), health status does affect utility from medical care, while when healthy ($m_t = 1$), it has no effect on utility (healthy individuals do not enjoy any consumption of medical care).

The face value of the formal insurance is given by

$$F_t(f_{t-1}) = \omega f_{t-1} + \overline{f}, \ \omega \geq 0, \ f_{t-1} \geq 0, \ \overline{f} > 0, \tag{4}$$

with f_{t-1} as insurance premia paid in period $t-1$, before period$-t$ health and medical spending shocks are realized. The total amount paid for the formal insurance f_{t-1} is equal at the limit, with no public insurance provision, to the health care expenditures covered through the health plan $F_t(f_{t-1})$ adjusted by ω, where ω is the inverse of the loading factor κ ($\kappa < 1$ allows for a tax subsidy for the insurance, while $\kappa > 1$ is the case of administrative costs or adverse selection). Almost all individuals who are 65 or older are eligible for some government-provided compulsory health coverage, which supplements any private insurance coverage (ωf_{t-1}); $\overline{f}$ can be considered to reflect the minimum level of formal insurance provided by government, given that individuals are opting for a combination of formal and informal insurance. Notice that from an optimization perspective, $\overline{f}$ represents the minimum health care consumption floor and has an impact on parameter estimates.

The face value of an informal insurance policy, I_t represents the money value of the time and/or financial transfers from the family on the individual's behalf. Informal insurance is considered to be function of three variables: the bequest that the elder individual will transfer to the extended family after her death B_t, the family cohesion coefficient towards the individual η_t, and individual's probability of survival at time $t+1$, given that she is alive at time t, s_t, namely

$$I_t = \eta_t(1 - s_t)B_t \ , \ \eta_t \in [0, 1], \tag{5}$$

with $B_t = a_{t+1}$ representing the wealth the individual will transfer to next period if alive or leave as bequest if dead. The parameter η_t is allowed to vary with the individual's age and from one group of countries to another, capturing the degree of family cohesion. As a result, I assume that η_t can be written as

$$\eta_t = \beta_0(1 + \beta_1 * t + \beta_2 * t^2 + \beta_3 * t^3 + \beta_4 * t^4), \tag{6}$$

where β_0 represents strictly family cohesion, while the fourth order polynomial in retirement years captures its age-structure. Assume that the market for informal insurance is perfect from the informational point of view: the premia paid for the informal insurance equals the face value of the insurance. The intuition is that, for each period, family is providing an amount of informal care that equals a fraction of the elder's wealth, weighted by the probability that the individual will die next period and so the bequest will actually be received; the per-period cost to insure informally equals the informal coverage, with benefits being received each period while the individual is alive, and costs being paid after her death. Note that the informal insurance provision scheme implies a complete lack of commitment of the retired individual to the family, with respect to the amount of bequest she will leave at her death in return for the care received. There is an extended literature (Bernheim et al. 1985, Venti and Wise 2004, Chiuri and Jappelli 2006) arguing that illiquid assets can be considered as instruments for commitment to leave a bequest. Instead of using this approach, I considered the more realistic scenario in which the informal care scheme is a function of the whole amount of wealth that can constitute a bequest (liquid and illiquid assets and the flow of interests, dividends and pension income), adjusted for the individual's probability of dying next period.

Finally, the distribution parameter α helps explain the influence of the relative formal/informal insurance share in health care costs, and it depends on the health status m_t, ($\alpha\left(m_t\right) = a * m_t$). I consider $\alpha\left(m_t\right)$ as the coefficient that assigns higher importance to the informal care rather than to the formal one, if in poor or fair health states. Notice that, since the individual prefers, in certain circumstances, informal to formal care, this element motivates the introduction of the strategic bequest through which the individual actually purchases informal insurance. Obviously, the individual can decide indirectly how much to informally insure through the amount she decides to leave as a bequest. She does that by directly choosing consumption and formal insurance premia, while the family provides the informal care according the cohesion measure η_t.

2.2. Uncertainty

The individual faces several sources of risk, treated as completely or partially exogenous. The reason is that the focus is on older people who have already shaped their health and lifestyle, but who also make choices in terms of their way to respond to medical care uncertainty through insurance. The individual's utility depends on three stochastic variables:

1) Health status uncertainty. I allow the transition probabilities matrix for health status to depend on previous health status, wealth and age, as follows:

$$\pi_{kj} = \Pr(m_t = j|\, m_{t-1} = k, wealth, age), \qquad k, j \in \{1, 2, 3, 4\}\,. \tag{7}$$

2) Survival uncertainty. Let $s_{m_t,age} = s_t$ denote the probability that an individual is alive at time $t+1$, conditional on being alive at time t, having time-t health status m_t, and a certain age. This means that the death probability $(1 - s_t)$ in the utility function can equivalently be computed as $(1 - s_t) = \pi_{k1} = \pi(m_t(1))$, where $k \in \{1, 2, 3, 4\}$.

3) Medical expense uncertainty. Besides formal and informal insurance, there is a third possibility to finance the health spending, namely out-of-pocket.[2] Health costs out-of-pocket, hc_t, are defined as the residual of total health care costs considered exogenous h_t, after deducting the coverage (both formal and informal), and a shock ψ_t. I assume that out-of-pocket medical spending depends on health status and age, and is decreasing in formal/informal insurance coverage,

$$hc_t = h_t - \left(\omega f_{t-1} + \overline{f}\right) - \eta_t(1 - s_t)B_t + \sigma_{\varepsilon_t} * \psi_t. \tag{8}$$

In fact, h_t is not a sufficient statistic for health spending out-of-pocket; in order to maintain a certain health status, a continuous investment in health costs is needed. Consequently, the health costs of an individual who passes from poor to good health will exceed the costs of an individual persisting in a good health state. Moreover, each health status has associated with it a necessary and deterministic health cost, $h_t(m_t)$.[3] After the individuals purchase insurance coverage, the exogenous health care spending shock is realized and it persists according to an AR(1),

$$\ln(\psi_t) = (1 - \rho_\psi) \ln \overline{\psi} + \rho_\psi \ln(\psi_{t-1}) + \varepsilon_t \;, \varepsilon_t \backsim N(0, \sigma^2_{\varepsilon_t}). \tag{9}$$

The issue of health dynamics and death is crucial to the insurance motive, given the high expenses associated with poor health. The health state follows a Markov chain with an age-varying one-period state transition matrix $P(t)$ described below. In each year, this is a 4×4 matrix. Retirees reaching age 100 die with probability one in the following year. Together with the initial health state, the Markov transition matrices $P(t), t \in [1, T]$, enable the computation of future probabilities attached to all health states, including death. Given the initial health state m_1, the transition matrix is applied repeatedly to derive the probability $\pi(m_t)$ that a retiree is in one of the four health states at time $t > 1$. Following the calibration used by Ameriks et al. (2005), I consider the same structure of age-dependent adjustment matrices, but I estimate the health status shifting parameters. More precisely, the 1-period ahead transition matrix at age $65 + t$ is given by

$$P(t) = \begin{bmatrix} 1 & 0 & 0 & 0 \\ \pi_{21} & \pi_{22} & \pi_{23} & 1 - \pi_{21} - \pi_{22} - \pi_{23} \\ \pi_{31} & \pi_{32} & \pi_{33} & 1 - \pi_{31} - \pi_{32} - \pi_{33} \\ \pi_{41} & \pi_{42} & \pi_{43} & 1 - \pi_{41} - \pi_{42} - \pi_{43} \end{bmatrix} * A_t,$$

[2] Health costs out-of-pocket were not considered in the utility function since I assumed that if no insurance coverage was available, the individual will have to incurr the health costs entirely out-of-pocket; however, if prudent, she will have an additional utility from being covered.

[3] Death expenses, $h_t(m_t(1))$, are also deterministic and are subtracted from the bequest.

with

$$A_t = \begin{bmatrix} 1 & 0 & 0 & 0 \\ c_1 t^e & 1 - c_1 t^e & 0 & 0 \\ c_1 t^e \frac{1}{1+c_2} & c_1 t^e \frac{c_2}{1+c_2} & 1 - c_1 t^e & 0 \\ c_1 t^e \frac{1}{1+c_2+c_2 c_3} & c_1 t^e \frac{c_2}{1+c_2+c_2 c_3} & c_1 t^e \frac{c_2 c_3}{1+c_2+c_2 c_3} & 1 - c_1 t^e \end{bmatrix}. \tag{10}$$

The A_t matrix is the so-called age-adjustment matrix. It shifts probability mass from the left (worse health states and death) towards the right (better health states), relative to the transition matrix at age 65, $P(1)$. The three parameters c_1, c_2, and c_3 control how fast this shifting occurs. Loosely speaking, parameter c_1 controls the transition from invalidity to death as age increases; c_2 determines how much more likely death is, relative to invalidity, when in a fair or good health state, and c_3 determines how much more likely a good health state will be when an individual is in good health. Basically, as the agent becomes older, the exponent c_1 allows for faster than linear shifting. Because the system is non-linear, there is no unique solution to the system of twelve equation and twelve parameters. Consequently, I estimate the parameters that control for the speed at which the shifting occurs, together with the persistence and standard deviation of the Markov process characterizing the health spending uncertainty.

2.3. Budget constraint

Households enter retirement with wealth $a_1 \geq 0$, and wealth at the beginning of time t is denoted as a_t. Assuming there is one composite riskless asset in which a household can invest, that yields a constant rate of interest r. Next period's wealth is given by

$$a_{t+1} = a_t + (y + ra_t) - f_t - C_t - hc_t, \tag{11}$$

where $(y + ra_t)$ represents the income flow, which includes constant pension payment as well as wealth interests and dividends. Associated with this budget rule there is the borrowing constraint

$$a_{t+1} = (1 + r)a_t + y - f_t - C_t - hc_t \geq 0, \forall t. \tag{12}$$

Note that I include in the borrowing constraint the medical expenses out-of-pocket, assumed to be realized at the beginning of the period, after health and medical spending shocks are realized. I consider this assumption as more reasonable than the alternative, namely that time-t medical expenses are fully unknown when individuals decide whether to hold on to their formal or informal health insurance. Under this borrowing constraint, given the timing of medical expenses, an individual with extremely high medical expenses this year could have zero net worth next year.

2.4. Timing of the model

The timing of events is the following: The individual enters period t with health state m_t, wealth state a_t and formal insurance $F_t(f_{t-1})$, bought the previous period. At the beginning of the period, she receives pension income and pays the formal insurance premia for the next period. Then the health shock is realized and, if she is still alive, medical costs are realized, she consumes and saves; if she doesn't survive the next period, funeral costs $h_t(m_t(1))$ are paid and the bequest B_t equals the remaining net resources after accounting for the formal insurance purchased previously, down to a minimum of zero,

$$B_t = \max\left[a_{t+1}, 0\right] \geq 0, \forall t. \tag{13}$$

One remark on the timing of insurance provision and payment: While in the formal market, the two moments are successive (coverage through the insurance becomes active from the next period with respect to the one in which the payment was made); in the informal market, the moments have a considerable lag between them (individual benefits of medical services provided by the extended family in the current period, but she will get to pay at the end of her life). Assuming that there is a bequest involved (and so the elderly individual is not consuming all the wealth by the time of her death), which the data will relate to country specific features, there is a higher incentive for the elderly to insure informally rather than exclusively through formal markets. On the other hand, medical goods provided in an institutionalized framework are less substitutable than the ones provided by the family or, in the case of the family actually paying for the professional medical care, less expensive due to the risk-pooling of the formal insurance market (it is more profitable to pay them through the formal insurance purchased previously, and consequently consume more in the current period). Moreover, for the family, any optimal allocation involving informal care provision does not involve leisure, since its opportunity cost is certainly higher than the informal care's provision. Note that h_t represents the annual health care costs and will be covered through informal insurance up to a maximum amount which accounts for the yearly labor time.

2.5. Recursive framework

Assuming the existence of a maximum, and given the functions continuity on the compact space of wealth and formal insurance premia, the recursive form is

$$\begin{aligned}
\underset{C_t, f_t}{Max} V_t(m_t, C_t, F(f_{t-1}), I_t) &= \underset{C_t, f_t}{Max} \left\{ (1+m_t) \frac{C_t^{1-\gamma} - 1}{1-\gamma} + \right. \\
&+ (1-m_t) \frac{\left[\alpha(\omega f_{t-1} + \overline{f})^{\theta} + (1-\alpha)\left(\eta_t(1-s_t)B_t\right)^{\theta}\right]^{\frac{1-\sigma}{\theta}} - 1}{1-\sigma} + \\
&\left. + \beta s_t E_t \left[V_t(m_{t+1}, C_{t+1}, F(f_t), I_{t+1})\right] \right\}, \qquad (14)
\end{aligned}$$

subject to equation (12). An individual's decision thus depends on her state variables, $X_t = (a_t, f_{t-1}, m_t, \psi_t) \in \mathbb{R}^4_+$, and her overall set of parameters,

$$\phi = (\beta, \rho_{m_t}, \sigma_{m_t}\omega, r, e, \sigma, \gamma, \theta, a, \rho_{\psi}, \sigma_{\varepsilon_t}, c_1, c_2, c_3, \eta_t(\beta_0, \beta_1, \beta_2, \beta_3, \beta_4)) \in \mathbb{R}^{20}.$$

From the discrete dynamic optimization principle it follows that the solution to the individual's problem is found in two steps: the first one consists of finding the set of consumption $\{C_t(X_t, \phi)\}$, formal insurance benefits $\{f_t(X_t, \phi)\}$, and, using these rules, the set of informal insurance benefits $\{\eta_t(1-s_t)a_{t+1}(X_t, \phi)\}$, rules that solve the system (14). Inserting these decision rules into the wealth accumulation equation yields next period's wealth, $a_{t+1}(X_t, \phi)$, for all the values that compose the grid for formal insurance purchased in the previous period. Using the optimal values for wealth in the second step, the value function is maximized and the optimal value for the formal insurance is found.

I used backward induction to compute value functions and policy functions. The optimization problem is solved by a grid search, and the state-space for wealth, formal insurance and stochastic processes are made discrete. Given that $t \in [1, T]$, the solution of the problem is obtained in a finite number of periods. In the last period, the decision is trivial, with the agent consuming whatever is left, since at time T she has no probability to survive the next period. Once the policy function is solved, the corresponding value function in the last period can be obtained and used in computing policy rules for the previous period. This iteration is continued until $t = 1$.[4]

3. DATA

I estimate the dynamic model using data from the first wave of the SHARE dataset, a cross-national microeconomic database, containing household level information regarding health, socioeconomic status and social and family networks of individuals aged 50 or over. SHARE was conducted in 2004 in eleven countries covering the representative regions of Europe: Scandinavia (Denmark and Sweden), Central Europe (Austria, France, Germany, Switzerland, Belgium, and the Netherlands) and the Mediterranean (Spain, Italy and Greece). Notice that, since the model refers only to single individuals, observations regarding married people or those who have a registered partner were dropped. Mainly, the dataset used to estimate the model in Section 2 is formed by the annual values of voluntary (supplementary) private insurance (formal insurance henceforth), expenditures on non-durables (consumption henceforth) and total wealth as a overall measure of financial and real assets, as well as yearly income flow.[5] The dataset selected included only observations on individuals age 65 and over, who are divorced, widewers or do not have a registered partner. Also excluded are individuals with missing net worth, net worth less than consumption of food at home, outside home or telephone bills or missing information for the variables used in the estimation. I also exclude individuals with negative or zero wealth, according to the borrowing constraint of the model.

Based on the observations of formal insurance, consumption, total wealth and individual observable characteristics, a linear model was used to obtain the predicted values of formal insurance for all individuals that reported wealth. Consumption, on the other hand, considers the amount spent on food at home, on food outside and on telephone bills, all weighted according to coefficients extrapolated from national datasets of SHARE countries, through an ordinary least square procedure. Using only information contained in the first wave of SHARE made it impossible to obtain a temporal dimension of the variables that could latter be used to match the simulated series. To overcome this problem, data was further detailed by age and three total wealth percentile: 25th, 50th and 75th wealth percentile. For the representative agent, an additional profile was created to match the aggregate median value accross the data. By selecting wealth-specific groups of individuals, I recreated life-profiles of identical individuals from the wealth point of view, with ages between 65 and 100. The missing values within each profile were obtained by linear interpolation. For ages beyond the last year of age reported by the median individual, extrapolation proved much less reliable than interpolation, especially since decision rules were non-linear. Each profile was then smoothed by taking five year moving averages, and extrapolated to age 100 (the assumed maximum age) based on average relative rate of growth of the variables in the last 15 years. Finally, the procedure was repeated for all three groups of countries. To model the medical costs associated with each health state, I identified the mean annual funeral, long-term care and curative and rehabilitation costs for the seniors using data provided by the OECD statistics.

There are two econometric issues related to the use of cross-section data. First, in a cross-section, because wages have increased over time (with productivity), older individuals are poorer at every age, and the measured saving profile will overstate wealth decumulation over the life cycle. By not accounting for this effect, the model

[4] For further details, see Appendix B.

[5] Details on variables definitions and motivation for their selection are in Appendix C.

will generate simulated data for which the degree to which elderly people run down their wealth is overstated. Second, rich people tend to live longer: the average survivor at each age has higher lifetime income than the average individual who has become deceased at that same age. This "mortality bias" tends to overstate asset growth. More than that, as time passes, the surviving people will be, relative to the deceased ones, healthier and knowing that they will live longer, will tend to save more than their deceased counterparts, displaying a slower wealth decumulation during the retirement years. By not accounting for mortality bias, the model will simulate data that understate the wealth decumulation process. The solution to both biases is offered by the chosen estimation procedure: using a structural approach, these biases can be accounted for directly, by recreating them with the data generating process. Basically, each simulated individual is endowed with a certain age, total wealth and initial health status. If older people have lower lifetime wealth in the data, they will have lower total wealth in the simulated data as well. Similarly, the estimated decision rules and the simulated profiles incorporate mortality effects, by different wealth percentile, as in the data.

4. CALIBRATIONS AND ESTIMATION METHODOLOGY

This section describes the parameters estimation procedure and provides a quantitative analysis of its predictions. I am conscious of literature uncertainty regarding the values of many of the model parameters. Due to this reason, I estimate most of the parameters involved in the model and use literature values for those ones that I did not focus on, but used just as instruments for the dynamic programming model. The approach is similar to the two-step strategy used by Gourinchas and Parker (2002), Cagetti (2003), and French and Jones (2004): In the first step calibrate those parameters that can be cleanly identified without explicitly using the model $(\rho_{m_t}, \sigma_{m_t}\omega, r, e)$; in the second step estimate the interest parameters $\Delta = (\sigma, \gamma, \theta, a, \beta, \rho_\psi, \sigma_{\varepsilon_t}, c_1, c_2, c_3, \eta_t(\beta_0, \beta_1, \beta_2, \beta_3, \beta_4))$ with the two-stage SMM, taking as given the parameters estimated in the first step. The estimation will generate the parameter vector, yielding the simulated life-cycle decision profiles that "best match" the data ones.

Because the underlying motivation aims to explain why the elderly retain so much wealth and why they insure formally and informally, I match total wealth, consumption and formal insurance profiles, conditional on age and wealth percentiles; in practice, I consider four samples corresponding to three wealth percentiles (25, 50 and 75) and the median one, and for each of them I generate the time series of wealth, consumption and formal insurance for an individual aged between 65 and 100. I used a real risk-free asset return of $(1+r) = 1.02$, and for the health status shock, persistence coefficient, ρ_{m_t}, was set to 0.5, volatility, σ_{m_t}, was set to 0.214, while the age-adjustment matrix elements were estimated based on the data. The grid and simulation starting point for wealth, consumption and formal insurance were set to match the data; for the bequest, I use the same grid of values as for wealth. For the adjustment heath status-transition matrix, I consider the parameter e to be held fixed at $e = 1.5$ as in Ameriks et al. (2005). Finally, I set the loading factor κ to its average value within each group of countries, considering $\kappa > 1$ (administrative costs case).[6]

Assume the retirees at age 65 in good health $(m_1(4) = 1)$, following the health distribution of the sample selected. I realize that the sample is affected by mortality bias in the sense discussed at the end of the data section. However, since I actually estimate the health-transition matrix based on a sample of 100 simulated individuals that face a cross-section of mortality rates in a given year, the model manages to recreate

[6] The country level of the loading factor was considered to match the administrative costs as percentage of premia in 1999 (since no other data was available). See Comino (2003).

the health distribution of the real data. The construction of the transition matrix for the health care stochastic process is described in Appendix D. To compute optimal strategies, I first discretize the state space using the Gauss - Hermite quadrature method. The model is then solved by backwards induction, from the age of 65 to 100. For each wealth group, I compute the life-cycle history for 100 artificial individuals, using random draws for the two stochastic variables. To each of these individuals, I assign a value of the state vector $X_t = (a_t, f_{t-1}, m_t, \psi_t)$ which endows them with a value of wealth, health coverage, health status and health costs consistent with the stochastic processes described in Section 2.2.

The SMM technique used for this work is the standard one. Solving the model numerically and considering the stochastic structure of the solutions, allowed the simulation of each individual's wealth, consumption, formal insurance and mortality. I then compute profiles from the artificial histories and take moments of each simulated profile. Comparing the mean of the artificial moments vectors to the ones computed from the real data, parameters were adjusted until the difference between the data and simulated moments was minimized.[7] The goodness of fit between the two series is assessed by a χ^2-test statistic or corresponding $p - value$; the associated interpretation is whether or not the true data moments (m_T) are equal to the realized data moments, given the stochastic processes for which the true time series is just one realization ($m_n(\widetilde{\Delta})$) and perfectly fits the set of parameters to be estimated. Analytically, as $T \rightarrow \infty$, keeping the number of random sequences fixed, if the weighting matrix W is chosen optimally, then

$$T[m_T - \frac{1}{N}\sum_{n=1}^{N} m_n(\widetilde{\Delta})]'\widehat{W}[m_T - \frac{1}{N}\sum_{n=1}^{N} m_n(\widetilde{\Delta})] \rightarrow \chi^2(j-k),$$

where j is the number of moments, k is the number of estimated parameters and $\Delta \in R^k$ unknown parameter vector. As a reasonable compromise between speed and efficiency, I set $N = 100$ (number of simulated individuals). In practice, minimization of the SMM estimator is done by a grid search where each parameter takes on different values. Note that the SMM requires a large number of simulations to compute the standard errors of the estimator, even if the estimator is consistent for a fixed number of simulations.

The choice of SMM moments is still an open issue in the literature. In order to ease the interpretation and restrain the set of moments that would potentially be too large, the model limited itself to considering measures of variability, instantaneous correlation coefficients and persistence. In particular, I restrict the estimation to a set of three variables, namely wealth, consumption and formal insurance, and estimate the model using a set of fifteen true and simulated moments (m_T/m_N), shown in Table 1.

5. RESULTS AND MODEL FIT

This section reports the estimation results and discusses the model's implications in behavioral terms. Tables 2 - 4 report the structural parameters estimates, while Tables 5 - 8[8] present results on the set of fifteen moments match, as well as model fit for the aggregated and disaggregated models.

[7] The first stage takes place under the condition that the weighting matrix $W_T = I_T$. Obtaining the estimates from this stage will allow us to repeat the procedure and use, at the second stage, the weighting matrix W_T consistently estimated using the estimator proposed by Newey and West (1994), to obtain the final estimates. This matrix, heuristically, gives more weight to moments that are precisely estimated in the data.

[8] See Appendix A.

TABLE 1
Choice of Moments

$$\left\{\begin{array}{lll} \sigma_{\ln(a_t)}, & \sigma_{\ln(C_t)}, & \sigma_{\ln(C_t/a_t)}, \\ corr(a_t, C_t), & corr(a_t, F_t), & corr(a_t, C_t/a_t), \\ corr(C_t, F_t), & corr(C_t, C_t/a_t), & corr(a_t, a_{t-1}), \\ corr(a_t, a_{t-2}), & corr(C_t, C_{t-1}), & corr(C_t, C_{t-2}), \\ corr(F_t, F_{t-1}), & corr(C_t/a_t, C_{t-1}/a_{t-1}), & corr(C_t/a_t, C_{t-2}/a_{t-2}) \end{array}\right\}$$

Common wisdom would suggest that the simulated variables profiles at the wealth-specific level (disaggregated profile) fit the real ones much better than the average profiles, displaying less elevated values of the overidentification test statistics. While this is the case for the Scandinavian countries, it is not equally true for the Mediterranean wealth-specific models (all wealth-specific models register a worse fit than the representative agent model), or for the Central European group (only the 75th-wealth percentile model outperforms the representative agent one).

The structural parameters are estimated quite precisely.[9] In most of the cases, we are unable to reject the null hypothesis, that the sets of unconditional moments in the model and in the data are the same. Only in few cases, the model does not display a high goodness of fit with the empirical data. Nonetheless, even though the models are formally rejected, the generated life-cycle profiles resemble, for the most part, the life-cycle profiles displayed by true data.[10]

As estimates illustrate, the simulated wealth profiles of the fitted models track the actual wealth in a good proportion, and they can be considered to produce fairly good predictions. Analyzing the second-order moments, it is easily noticed that the simulated wealth profiles are flatter than the actual profiles, but this might reflect a weakness of the data, rather than a weakness of the model. The simulations show, for all twelve estimated models, that the profiles generated by the data display quite high coefficients of relative risk aversion associated with consumption. With a lower discount factor, individuals are not willing to save, and this is shown by a drop in wealth for the first three quarters of the retirement period. Because health-transition probabilities predict that health worsens with age, simulated wealth turns back to increasing in the last period quarter, since health and medical spending uncertainty give an incentive to insure.

The simulated consumption profiles follow the wealth profiles, monotonically falling during the entire period except for the last quarter. Even if neither monotonicity nor smoothness of the decline are displayed by the actual data, they do record a decreasing trend. This general tendency is consistent with most empirical studies of old-age consumption, suggesting that consumption falls with age (Banks et al. 1998).

Turning finally to the formal insurance profile, this also seems to register a monotonically decreasing path: the lower the level of wealth, the lower the formal coverage purchased for the next period. This effect can be noticed for all wealth percentiles, especially in the first part of the time framework, while in the last years, even though wealth increases, formal insurance continues to decrease. Besides wealth, what determines the values of formal insurance are not just differences in mean medical expenses. More important, the differences in the persistence coefficient and the variance of the

[9] The overidentifying restrictions implied by the models pass a χ^2 -test at standard significance levels.

[10] These weak significance levels registered for some models are also due to the real data profiles. For instance, in the case of Scandinavian countries, institutionalized individuals that enter nursing homes are excluded by sample design. As a result, it can be seen that the moments of the real data are quite different with respect to Mediterranean and Central European data.

TABLE 2
Estimated Structural Parameters, Mediterranean Countries

Param.	*25th wealth percentile*	*50th wealth percentile*	*75th wealth percentile*	*Represent. agent*
σ	-0.0169	-0.7135	-5.5296	-0.0009
	(0.0352)	(0.0096)	(0.0990)	(0.0013)
γ	3.4731	4.7171	3.9661	5.6015
	(0.1269)*	(0.1282) **	(0.0388) **	(0.2793)*
θ	0.1006	-0.5426	0.5465	-0.0012
	(0.0059)*	(0.0125)	(0.0058) **	(0.0075)
a	0.3931	0.2300	-2.0994	0.0025
	(0.0015) **	(0.0296)*	(0.0015)	$(0.10 * 10^{-4})$ **
ρ_ψ	1.2937	0.8501	-0.7148	0.9500
	(0.1499)*	(0.0080) **	(0.0045)	(0.0279) **
σ_{ε_t}	0.1697	0.1120	0.0453	3.6617
	(0.0035) **	(0.0609)*	(0.0007) **	(0.0172) **
c_1	0.0010	0.00088	0.00065	0.0024
	(0.0152)	(0.0378)	(0.0287)	(0.0001)*
c_2	1.1142	1.0902	$1 + 10^{-7}$	10.1230
	(0.0036) **	(0.0308) **	(0.0626) **	(0.0097) **
c_3	0.1634	0.0012	10^{-7}	0.5470
	(0.0036) **	(0.0006)	(0.0056)	(0.1821)
β_0	1.5690	2.8535	0.3902	1.1453
	(0.2015)*	(0.0337) **	(0.0109)*	(0.0105) **
$\beta_1 * 10^{-2}$	-0.0517	0.3247	-0.0051	-0.0388
	(0.0115)	(0.2555)	(0.0062)	(0.0937)
$\beta_2 * 10^{-4}$	0.0120	-0.0092	$0.85 * 10^{-4}$	$-0.268 * 10^{-4}$
	(0.0495)	(0.7421)	$(0.96 * 10^{-6})$ **	$(0.77 * 10^{-6})$
$\beta_3 * 10^{-4}$	0.0082	0.0015	0.1507	0.0037
	(0.0725)	(0.0004)	(0.0038) **	(0.0513)*
$\beta_4 * 10^{-8}$	0.1993	1.6948	$-0.43 * 10^{-4}$	$0.69 * 10^{-4}$
	(0.0030) **	(0.0040) **	$(7.41 * 10^{-6})$	$(4.26 * 10^{-6})$*

Standard errors are in parentheses below each estimated parameter. (*) indicates significance at 5%, while (**) stands for significance at 1%.

TABLE 3
Estimated Structural Parameters, Central European Countries

Param.	*25th wealth percentile*	*50th wealth percentile*	*75th wealth percentile*	*Represent. agent*
σ	1.7638	−0.0069	−1.4470	−0.0011
	(0.0121) ∗∗	(0.0085)	(0.0197)	(0.0188)
γ	2.4325	6.1664	8.4024	6.4460
	(6.714)	(0.0287) ∗∗	(0.0030)∗	(0.6250)∗
θ	−1.2733	−0.7040	0.0739	−0.0113
	(0.1743)	(0.0008)	(0.0003)	(0.0121)
a	−1.8572	−0.0009	4.4950	−0.0100
	(0.1202)	(0.0651)	(1.3605)	(0.0144)
ρ_ψ	2.0432	1.4332	0.9331	0.9472
	(0.0108) ∗∗	(0.0408) ∗∗	(0.0066) ∗∗	(0.0164) ∗∗
σ_{ε_t}	0.2192	0.1141	0.0731	3.0756
	(0.0102)∗	(0.0051) ∗∗	(0.0008) ∗∗	(0.6404)
c_1	0.00173	0.00172	0.00017	0.0015
	(0.0030)	(0.0005)∗	(1.4810^{-5})∗	$(2.67 * 10^{-4})$ ∗∗
c_2	0.3123	0.2883	0.2620	0.6067
	(0.7190)	(0.0571)∗	(0.0462)	(0.4303)
c_3	0.1230	0.0008	2.2850	0.0039
	(0.0017) ∗∗	(0.0007)∗	(0.0266) ∗∗	$(3.55 * 10^{-4})$ ∗∗
β_0	−1.4336	−3.5498	−1.6974	0.7259
	(5.3515)	(0.7818)	(0.0164)	(0.0137) ∗∗
$\beta_1 * 10^{-2}$	−0.0215	0.0680	0.1300	−0.7195
	(0.1024)	(0.0008) ∗∗	(0.0046) ∗∗	(0.0204)
$\beta_2 * 10^{-4}$	$-7 * 10^{-5}$	0.0024	$-1.5 * 10^{-5}$	$-2.06 * 10^{-4}$
	(0.319)	$(2.4 * 10^{-3})$ ∗∗	(0.0408)	(0.0696)
$\beta_3 * 10^{-4}$	0.0242	0.0012	0.1634	0.0614
	(0.0009) ∗∗	$(1.8 * 10^{-4})$∗	(0.0378)∗	(0.0022) ∗∗
$\beta_4 * 10^{-8}$	0.0239	10.2053	0.0725	$2.50 * 10^{-4}$
	(0.0009) ∗∗	(0.5738) ∗∗	(0.0085)∗	(0.0055)

Standard errors are in parentheses below each estimated parameter. (*) indicates significance at 5%, while (**) stands for significance at 1%.

TABLE 4
Estimated Structural Parameters, Scandinavian Countries

Param.	*25th wealth percentile*	*50th wealth percentile*	*75th wealth percentile*	*Represent. agent*
σ	11.3468	7.9393	0.4968	−0.9787
	(6.5991)	(0.0064) **	(0.0034) **	(0.1164)
γ	2.0872	8.7925	9.0303	7.7751
	(0.2420)*	(44.5089)	(0.8525)*	(3.2682)
θ	−2.1693	−3.4009	−0.8630	−2.2705
	(0.6424)	(0.0075)	(0.0196)	(0.0433)
a	0.2135	−1.6057	−0.0804	0.8859
	(0.0726)*	(0.0016)	(0.0211)	(0.0111) **
ρ_ψ	2.1500	1.4540	0.9906	1.0077
	(0.0766) **	(0.0018) **	(0.0017) **	(0.0098) **
σ_{ε_t}	0.2291	0.7538	0.1549	2.4373
	(0.0023) **	(0.0036) **	(0.0011) **	(0.1833)*
c_1	0.0008	0.0042	0.0032	0.0020
	$(3 * 10^{-5})*$	(0.2650)	(0.0002)*	(0.0041)
c_2	0.0632	0.0101	0.0250	0.0411
	(0.0012) **	(0.1039)	(0.0075)	(0.0024)*
c_3	1.3987	0.0024	0.0758	0.0051
	(0.018) **	(0.105)	(0.0022) **	(0.0193)
β_0	1.4956	−2.5466	−1.2619	−2.1472
	(0.0045) **	(2.2644)	(0.0012)	(2.8192)
$\beta_1 * 10^{-2}$	−0.0654	5.2107	2.3081	3.5298
	(0.0100)	(2.5801)	(0.0033)*	(0.0617)
$\beta_2 * 10^{-4}$	0.0083	$-9.4 * 10^{-4}$	$7.5 * 10^{-5}$	$2.242 * 10^{-2}$
	(0.0352)	$(2.66 * 10^{-4})$	$(2.26 * 10^{-3})$	(0.0044)
$\beta_3 * 10^{-4}$	0.0156	0.0565	0.0182	0.2340
	$(1.1 * 10^{-4})$ **	(0.0460)	(0.0093)*	(0.9837)
$\beta_4 * 10^{-8}$	0.4282	−0.0162	−0.0064	−0.0518
	(0.0029) **	$(1.56 * 10^{-2})$	(0.2652)	(0.0019)

Standard errors are in parentheses below each estimated parameter. (*) indicates significance at 5%, while (**) stands for significance at 1%.

medical spending risk are relevant for the formal insurance purchase. If health insurance in general reduces health cost volatility, risk averse individuals may value health insurance at well beyond the cost paid. However, since they are at the end of their life, they may value more informal insurance.

Results show that medical expenses for the elderly are high, and they tend to be more persistent for the poor and median wealth individuals rather than for the rich.[11] Additionally, I find that for Mediterranean and Central European countries, health spending volatility is higher for the poor than for median wealth individuals, and higher for the latter ones than for the rich. Since the poor are the ones that experience worse health with age, they will also register higher and more volatile medical expenses with respect to median and high wealth individuals. The same is not registered for the Scandinavian group, where, although the poor have more volatile medical spending than the rich, median wealth individuals have the highest spending variability. At the country level, for each wealth specific model, Mediterraneans experience less persistent and less volatile medical expenses than Central Europeans who, in turn, register a lower persistence and variability of health spending than the Scandinavians.

Within the same country-group, the poor are more risk averse to medical care than the rich. On the other hand, Mediterraneans display lower risk aversion than Central Europeans, who respectively register lower risk aversion than Scandinavians. This finding is consistent with the higher risk registered for out-of-pocket health expenditures in Scandinavian countries rather than in the Mediterranean ones, and for the poor rather than for the rich, so it is not surprising that we find a high risk aversion for the poor and also for the Scandinavians. Moreover, this result is confirmed by the substitution coefficient estimates. As expected, the poor substitute less than the rich and Scandinavians less than Central Europeans and Mediterraneans.

Standard values for the relative risk aversion coefficient for consumption in life-cycle models are between 2 and 6. The estimated coefficient for this model displays values between 3.2 and 5.6 for the Mediterranean countries, 2.4 and 8.4 in Central European ones and between 2.1 and 9.1 for the Scandinavian ones. These high values in some cases reflect the relationship of age and wealth with the relative risk aversion, which indicates its tendency to increase with age at any given level of wealth.[12] While the absolute risk aversion decreases with wealth, there is no such clear consensus on the relative risk aversion tendency to increase or decrease. In this case, for all country groups, I find that poor individuals are less risk averse than the rich, the median and the average ones. Furthermore, Scandinavians are more risk averse than Central Europeans, who are more risk averse than Mediterraneans, except for the poor who are less risk averse. Consequently, those with low wealth will tend not to save for consumption of non-durables, while their consumption of medical goods will never drop under a certain threshold, even in the presence of a high negative health spending shock.

The main result of family cohesion and life expectancy adds considerably to the existing knowledge on inter-individual health and life expectancy disparities by wealth in Europe. Figure 1 shows relative cohesion coefficients: the top four graphs refer to

[11] I estimate the medical spending structural parameters, allowing for differences from one health status to another to be function of age. The estimates of the health spending risk are not understated because the measure of medical expenditures risk included compulsory formal insurance provided by the government.

[12] Based on the life-cycle of risky asset positions, some research has argued that older investors are more risk averse (Morin and Suarez 1983), but there is debate about their findings (Wang and Hanna 1997 and Bajtelsmit and Bernasek 2001). Note that wealth does not include housing, and, although there are no minimum wealth and consumption levels specified in the model, I considered a minimum formal insurance provided compulsory by the government and I calibrated the model to fit wealth and consumption data when constructing wealth profiles.

Mediterranean countries, the middle ones to Central Europe, and the last ones to the Scandinavian group.

For all European country groups, estimates certify the social literature findings and indicate that family cohesion rises with age, while it decreases with wealth. More accurately, for poor and rich, family cohesion slightly decreases with age during the first retirement years, which corresponds to a drop in wealth, and then rises in the last part of the period (more for poor than for rich), causing wealth accumulation. A reasonable explanation is that advanced ages are equivalent to higher probability of getting sick, which translates into an increased need for health care (especially informal) that induces wealth accumulation (for bequest) and family cohesion strengthening. Regardless of the wealth level, the Mediterranean group benefits from a stronger family cohesion than Central European group, that, in turn, displays a higher cohesion coefficient than the Scandinavian group, which is consistent with the sociological explanations provided in Reher (1998).[13]

Finally, confirming the demographic literature, I find that high family cohesion is usually accompanied by a high life expectancy and *vice-versa*. Figures 2 - 5 present health-transition probability matrices conditional on age, previous health status and wealth for the three country groups.

For Mediterranean countries, the lowest two panels in Figure 2 show the invalidity and death probability for the individuals in good health. As can be seen, the probability of death within the next year of life rises from 0.20% at age 65 to 10.19% at age 100, while the probability of poor health (invalidity) is about 9.70% at age 65 and increases to 17.53% for the poor and to 14.65% for the rich at age 100. Moreover, for each age-group, rich people in poor health are less likely to die than poor people with the same health condition and age: being in the 75th wealth percentile instead of the 25th percentile lowers the probability of dieing by 40.74% at age 80. Likewise, invalidity is a very persistent health status: being a 69-year-old and having poor health implies a 55.79% probability of having poor health also at age 70, and this probability falls with age, as the survival probability decreases. Moreover, rich people, at any age, have a lower probability of dieing than poor individuals of the same age. In addition, rich are more likely to maintain and to return in good health: high-wealth percentile individuals display a higher probability of persisting in a good health state and returning to it if in a fair or poor health state.

In Central Europe, healthy poor have a 7.50% higher chances of dieing than the healthy rich at age 65, but only 9.52% higher chances at age 90 (see Figure 3), which is similar to the Mediterranean countries. Overall, probability of death within one year of life if in good health increases from 0.27% at age 65 to almost 30% at age 100. Regardless of the wealth levels, individuals in these countries tend to maintain good health less than their Mediterranean counterparts, but the fact that the rich stay healthy more than the poor is maintained. Rich people in Central Europe display a lower probability to become invalid than the poor who are in good health, but each category is more likely to die than its Mediterranean match.

In Scandinavian countries, the probability of death when in good health rises with age, surprisingly faster for rich and median wealth people than for the poor as shown by Figure 4; furthermore, it must be noted that the chances that death occurs when in good health are extremely high, both in general (0.57% at age 65 and 89.91% for 100 years old) and with respect to the Mediterranean and Central European countries. The same is not registered when the individual suffers poor health (invalidity), where healthy 65 year-old Scandinavians are as likely to become invalid as the Mediterranean

[13] The only exceptions are poor Central Europeans who display less cohesion than poor individuals in Scandinavian countries.

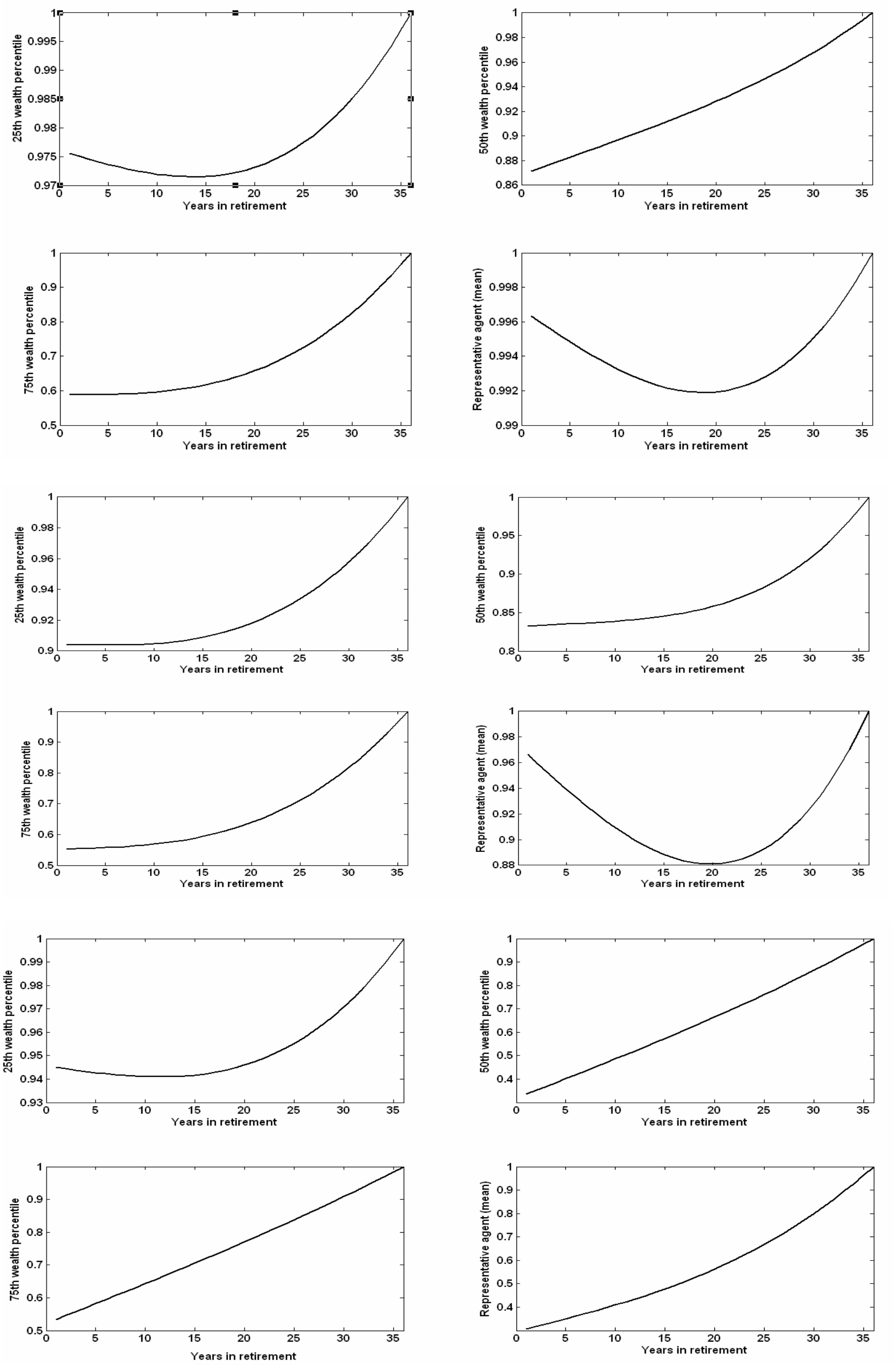

FIG. 1 Cohesion Coefficient by Country Group and Wealth Percentile

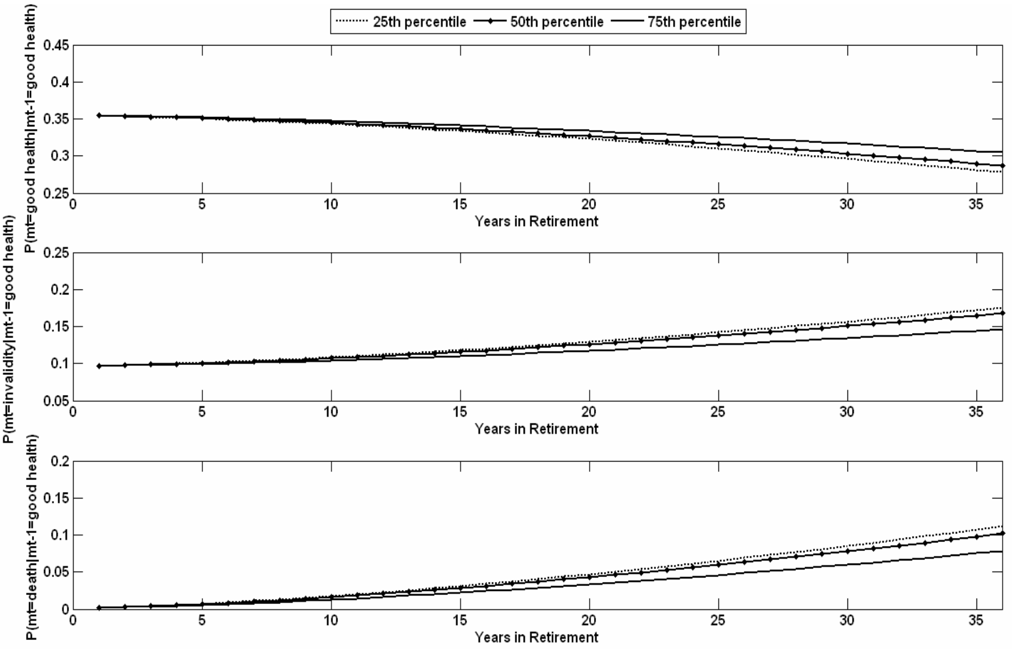

FIG. 2 Health transition probabilities, Mediterranean countries

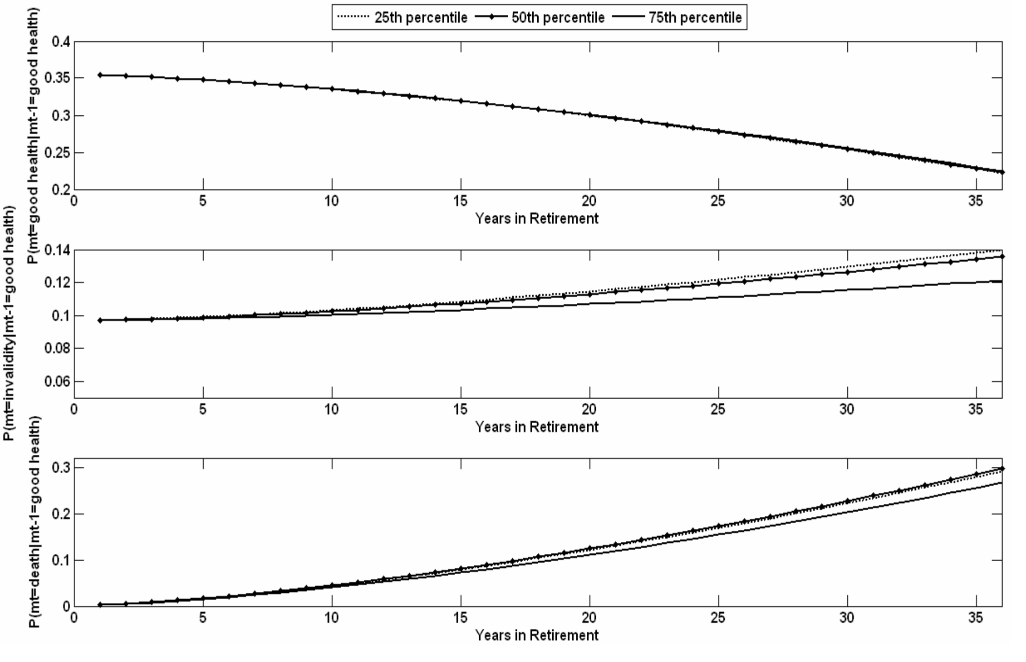

FIG. 3 Health transition probabilities, Central European countries

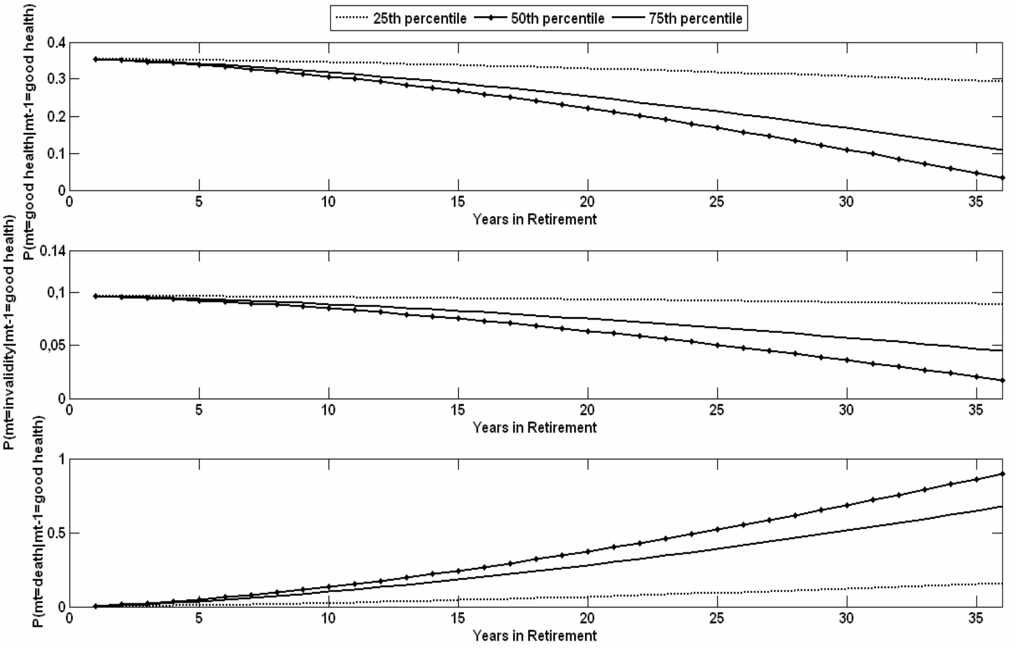

FIG. 4 Health transition probabilities, Scandinavian countries

or Central Europeans. Staying healthy or returning to good health is less likely as age increases, and the poor will do so at a rate of only 20% higher than the rich's rate of staying healthy or returning in good health. Overall though, Scandinavians are more likely to die than both Mediterraneans and Central Europeans.

Although maintaining good health is becoming less possible as one moves to the end of life, Mediterraneans display both a higher life expectancy and a higher invalidity probability than Central Europeans. Scandinavians, on the other hand, are the ones that among all, register the smallest survival probability, having also the lowest chances of becoming invalid if they are in good health (see Figure 5). Moreover, in the Mediterranean and Central Europe, at each age, rich are only slightly less likely to die than poor, despite the wealth discrepancies, which are more accentuated in these countries than in the Scandinavian ones. This is inconsistent with the expected outcome of the North European health care system, recognized to be the widest and most efficient system in Europe, or with the fact that the poor are considerably more likely to die than the rich. Instead, these findings confirm the real demographic trends that indeed underline an input - output discrepancy in the European health care systems.

To summarize the empirical results, precautionary incentives implied by a dynamic model in which retirees' face uncertain future medical spending, help reduce predicted consumption towards levels of consumption actually registered among the elderly. Even with unusual estimates, such as the high risk aversion coefficients, this model succeeds in explaining the wealth profiles displayed by the elderly, decreasing right after the retirement and increasing towards the end of their life. Moreover, it fully confirms the sociological and demographic findings on family cohesion and life expectancy.

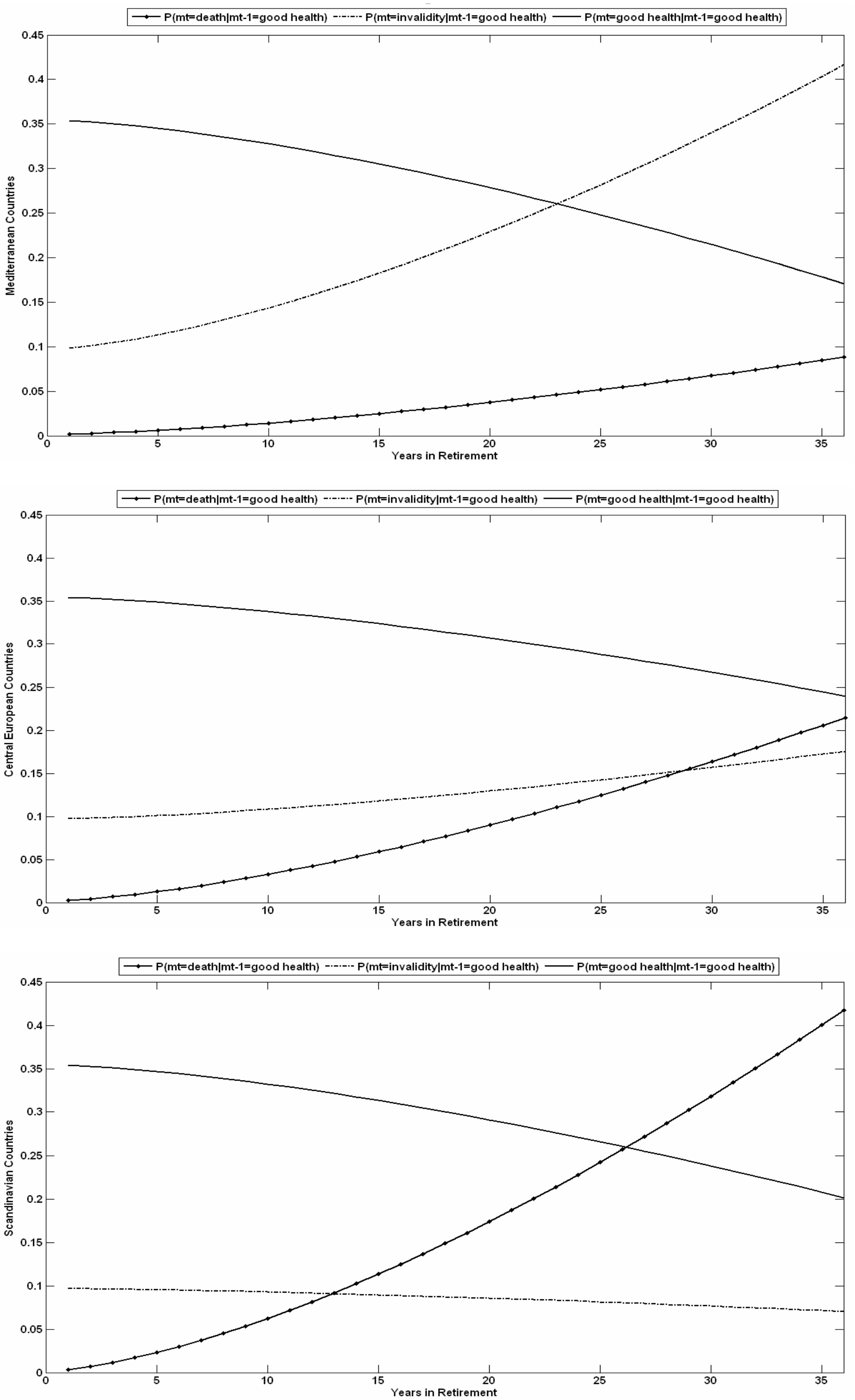

FIG. 5 Health Transition for Representative Agent

6. CONCLUSIONS

It is well known that the risk of living long and facing high medical expenses is an important factor in elderly behavior. However, there is large heterogeneity in the health shocks and the medical spending risks that people face. In some cases, even in the presence of health insurance, out-of-pocket health and nursing homes costs can be very high, generating significant low rates of dissaving among elderly. If individuals place a high value on health insurance, provision of both formal and informal benefits may have a large effect on retirement behavior.

To see if this is the case, I constructed and estimated a simulated life-cycle model designed to outline the savings decisions of retired single households. As a novelty, it simultaneously considered the effects of both health risks and medical spending uncertainty on the saving choices of elderly in eleven European countries. It did so in the context of health insurance, provided formally by the market and informally by the family. Informal insurance was considered to depend on the strength of family ties (cohesion) and on the wealth available for bequeathing. Using the first wave of SHARE data and SMM, I estimated the model for four levels of wealth and three country groups: Mediterranean, Central European and Scandinavian.

This paper provides several contributions. First, for all twelve specifications, parameters estimates are quite reasonable and the model fits quite well. Second, I found that the sources of heterogeneity that I considered have a significant role in explaining the elderly savings behavior, with a high level of medical expenses at advanced ages being a key factor for insuring by keeping large amounts of wealth. Third, results showed that medical expenses for the elderly are high and rising fast with age, while they tend to be more persistent and volatile for the poor rather than for the rich, for all three categories of countries. In addition, poor Mediterraneans experience less persistent medical expenses than their Central European match that, in turn, register less persistent health spending than their Scandinavian counterparts. Fourth, the paper carefully estimated mortality probabilities by age as a function of health and wealth. It finds that, although health deteriorates with age across all country groups, Mediterraneans display both higher life expectancy and higher probability of poor health than Central Europeans, confirming the demographic data. Scandinavians, on the other hand, are the ones that among all, register the smallest survival probability, having also the lowest chances of becoming invalid if in good health, despite the vast and efficient health care system. Finally, I found that high life expectancy usually accompanies a high family cohesion. Empirically, the estimates on family cohesion for all European country groups confirmed the social literature findings that family cohesion rises with age, while it decreases with wealth. Moreover, Mediterranean countries benefit of a stronger family cohesion than Central European countries, that in turn display a higher cohesion coefficient than the Scandinavian group.

From a policy perspective, it is important to understand why retirees dissave so slowly. If the reason is to cover longevity risks or medical spending uncertainty, then direct government changes in the public health insurance programs or indirect changes in the social and family policies may influence saving behavior by controlling the exposure to such risks. In this sense, identifying a model capable of explaining consumers decisions of elderly Europeans and estimating parameters for that population segment, allows a better understanding of the effects of reforming policies. The fundamental message of this paper is that in order to correctly evaluate any policy reform affecting the elderly saving decisions in Europe, one needs to accurately account for health care spending and country-specific family cohesion in relation to life expectancy, both by age and wealth.

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APPENDIX A: ESTIMATED MOMENTS AND GOODNESS OF FIT

Table 5. Estimated Moments and Goodness of Fit Test - Mediterranean Countries

Moments	25th Artif.	per. Emp.	50th Artif.	per. Emp.	75th Artif.	per. Emp.
$\sigma_{\ln(a_t)}$	0.35	0.36	0.31	0.33	0.20	0.24
$\sigma_{\ln(C_t)}$	0.36	0.38	0.28	0.25	0.25	0.25
$\sigma_{\ln(\frac{C_t}{a_t})}$	0.62	0.61	0.39	0.33	0.24	0.21
$corr(a_t, C_t)$	-0.32	-0.38	0.28	0.37	0.58	0.66
$corr(a_t, F_t)$	0.87	0.26	0.95	0.89	0.81	0.79
$corr(a_t, \frac{C_t}{a_t})$	-0.69	-0.77	-0.60	-0.59	-0.38	-0.38
$corr(C_t, F_t)$	-0.07	-0.12	0.06	0.07	0.40	0.41
$corr(C_t, \frac{C_t}{a_t})$	0.79	0.77	0.49	0.47	0.42	0.42
$corr(a_t, a_{t-1})$	0.79	0.85	0.80	0.94	0.78	0.91
$corr(a_t, a_{t-2})$	0.54	0.64	0.55	0.88	0.52	0.81
$corr(C_t, C_{t-1})$	0.62	0.68	0.88	0.91	0.87	0.87
$corr(C_t, C_{t-2})$	0.50	0.47	0.81	0.73	0.78	0.69
$corr(F_t, F_{t-1})$	0.67	0.94	0.77	0.97	0.79	0.95
$corr(C_t/a_t, C_{t-1}/a_{t-1})$	0.79	0.80	0.84	0.91	0.66	0.78
$corr(C_t/a_t, C_{t-2}/a_{t-2})$	0.64	0.59	0.65	0.81	0.38	0.34
J_T	0.55		0.32		0.16	
$\chi^2(1)$	11.52		6.82		3.36	
$p-value$	0.0007		0.0100		0.0670	

Table 6. Estimated Moments and Goodness of Fit Test - Central European Countries

Moments	25th Artif.	per. Emp.	50th Artif.	per. Emp.	75th Artif.	per. Emp.
$\sigma_{\ln(a_t)}$	0.40	0.40	0.32	0.38	0.34	0.33
$\sigma_{\ln(C_t)}$	0.45	0.45	0.20	0.24	0.05	0.14
$\sigma_{\ln(\frac{C_t}{a_t})}$	0.40	0.25	0.35	0.37	0.35	0.37
$corr(a_t, C_t)$	0.74	0.87	0.28	0.20	-0.15	-0.24
$corr(a_t, F_t)$	0.97	0.90	0.96	0.84	0.86	0.79
$corr(a_t, \frac{C_t}{a_t})$	-0.33	0.02	-0.72	-0.84	-0.94	-0.95
$corr(C_t, F_t)$	0.73	0.84	0.19	0.86	0.09	0.10
$corr(C_t, \frac{C_t}{a_t})$	0.33	0.48	0.35	0.26	0.36	0.30
$corr(a_t, a_{t-1})$	0.78	0.95	0.80	0.88	0.78	0.85
$corr(a_t, a_{t-2})$	0.52	0.89	0.55	0.63	0.52	0.50
$corr(C_t, C_{t-1})$	0.94	0.94	0.87	0.94	0.67	0.68
$corr(C_t, C_{t-2})$	0.88	0.84	0.80	0.84	0.53	0.50
$corr(F_t, F_{t-1})$	0.74	0.98	0.74	0.98	0.73	0.94
$corr(C_t/a_t, C_{t-1}/a_{t-1})$	0.61	0.76	0.83	0.93	0.79	0.82
$corr(C_t/a_t, C_{t-2}/a_{t-2})$	0.30	0.31	0.62	0.78	0.55	0.40
J_T	0.45		0.40		0.1	
$\chi^2(1)$	9.45		8.52		2.1	
$p-value$	0.0020		0.0035		0.147	

Table 7. Estimated Moments and Goodness of Fit Test - Scandinavian Countries

Moments	25th *Artif.*	*per. Emp.*	50th *Artif.*	*per. Emp.*	75th *Artif.*	*per. Emp.*
$\sigma_{\ln(a_t)}$	0.45	0.44	0.57	0.53	0.80	0.73
$\sigma_{\ln(C_t)}$	0.18	0.18	0.04	0.27	0.04	0.27
$\sigma_{\ln(\frac{C_t}{a_t})}$	0.54	0.53	0.54	0.29	0.77	0.49
$corr(a_t, C_t)$	-0.23	-0.26	0.71	0.93	0.69	0.92
$corr(a_t, F_t)$	0.76	0.47	0.99	0.96	0.99	0.80
$corr(a_t, \frac{C_t}{a_t})$	-0.84	-0.82	-0.99	-0.85	-0.99	-0.85
$corr(C_t, F_t)$	0.05	0.20	0.66	0.87	0.68	0.74
$corr(C_t, \frac{C_t}{a_t})$	0.61	0.60	-0.62	-0.72	-0.62	-0.79
$corr(a_t, a_{t-1})$	0.78	0.89	0.78	0.97	0.77	0.95
$corr(a_t, a_{t-2})$	0.52	0.70	0.52	0.93	0.52	0.86
$corr(C_t, C_{t-1})$	0.59	0.81	0.89	0.93	0.86	0.89
$corr(C_t, C_{t-2})$	0.45	0.45	0.81	0.82	0.78	0.74
$corr(F_t, F_{t-1})$	0.58	0.98	0.76	0.98	0.77	0.98
$corr(C_t/a_t, C_{t-1}/a_{t-1})$	0.81	0.88	0.73	0.94	0.74	0.92
$corr(C_t/a_t, C_{t-2}/a_{t-2})$	0.67	0.67	0.42	0.86	0.43	0.92
J_T	0.36		0.74		0.74	
$\chi^2(1)$	7.56		15.51		15.54	
$p-value$	0.0060		$0.08 * 10^{-3}$		$0.05 * 10^{-3}$	

Table 8. Estimated Moments and Goodness of Fit Test - Representative Agent

Moments	*Med. Sim.*	*Gr. Emp.*	*Centr. Sim.*	*Gr. Emp.*	*Scan. Sim.*	*Gr. Emp.*
$\sigma_{\ln(a_t)}$	0.22	0.25	0.25	0.24	0.55	0.49
$\sigma_{\ln(C_t)}$	0.13	0.15	0.19	0.26	0.10	0.23
$\sigma_{\ln(\frac{C_t}{a_t})}$	0.24	0.25	0.24	0.14	0.50	0.29
$corr(a_t, C_t)$	0.35	0.28	0.50	0.85	0.67	0.88
$corr(a_t, F_t)$	0.85	0.84	0.63	0.61	0.98	0.92
$corr(a_t, \frac{C_t}{a_t})$	-0.74	-0.79	-0.61	-0.78	-0.96	-0.91
$corr(C_t, F_t)$	0.27	0.28	0.34	0.32	0.59	0.74
$corr(C_t, \frac{C_t}{a_t})$	0.23	0.28	0.29	0.45	-0.45	-0.73
$corr(a_t, a_{t-1})$	0.79	0.92	0.79	0.87	0.78	0.96
$corr(a_t, a_{t-2})$	0.54	0.85	0.54	0.63	0.52	0.91
$corr(C_t, C_{t-1})$	0.72	0.51	0.76	0.82	0.80	0.89
$corr(C_t, C_{t-2})$	0.60	0.24	0.65	0.48	0.70	0.76
$corr(F_t, F_{t-1})$	0.81	0.97	0.80	0.98	0.76	0.98
$corr(C_t/a_t, C_{t-1}/a_{t-1})$	0.77	0.78	0.64	0.72	0.67	0.95
$corr(C_t/a_t, C_{t-2}/a_{t-2})$	0.51	0.51	0.34	0.46	0.31	0.88
J_T	0.15		0.32		0.87	
$\chi^2(1)$	3.15		6.72		18.27	
$p-value$	0.0759		0.0095		0.0002	

APPENDIX B: NUMERICAL SIMULATION

As mentioned, for the simulation I used the prospective-retrospective method of the dynamic programming and, more precisely, I used backward induction to compute value functions and policy functions. Given that the model lacks a closed form solution, these decision rules are found numerically. The optimization problem is solved by a grid search, and the state-space for wealth and formal insurance is made discrete. In the last period, the decision is trivial, with the agent consuming and leaving bequest all available residual wealth. Here and throughout the paper, I normalized utility after death at zero.

At time T, the individual does not formally insure for the next period, and so the issue is choosing consumption

$$\underset{C_t,f_t}{Max} V_t(m_t, C_t, F(f_{t-1}), I_t) = \underset{C_t,f_t}{Max} \left\{ (1+m_t)\frac{C_t^{1-\gamma}-1}{1-\gamma} + \right.$$

$$+(1-m_t)\frac{\left[\alpha(\omega f_{t-1}+\overline{f})^{\theta}+(1-\alpha)\left(\eta_t(1-s_t)B_t\right)^{\theta}\right]^{\frac{1-\sigma}{\theta}}-1}{1-\sigma}+$$

$$\left. +\beta s_t E_t\left[V_t(m_{t+1}, C_{t+1}, F(f_t), I_{t+1})\right] \right\},$$

$$s.t. a_{T+1} = a_T + y - C_T - \left(h_T - \left(\omega f_{T-1} + \overline{f}\right) - \eta_T(1-s_T)a_{T+1} + \sigma_{\varepsilon T} * \psi_T\right),$$

under the condition $s_T = 0$ and $f_T = 0$.

Once the policy function was solved, the corresponding value function and policy rule in the last period were obtained and used in computing policy rules for the previous period. I find the decision rules at time $T-1$ by solving the previous equation with V_T and the first order conditions for consumption and formal insurance. This iteration is continued backward using Euler equations until $t = 1$. For all the shocks, I evaluated the model using the Gauss-Hermite quadrature approach to discretization, and transform the continuous problem into a discrete one with the constraint that the asymptotic properties of the continuous and of the discrete processes should be the same. In this case, as shown in the model, I used Markov chains to represent each of the stochastic processes.

The value function is directly computed at a finite number of points within the wealth grid, $\{a_T\}_{ia=1}^{40}$, the consumption grid $\{C_T\}_{ic=1}^{1000}$, and within the formal insurance grid, $\{F_{T-1}\}_{f=1}^{5}$. Based on these grids, I used the decision rules to generate the three simulated time series. On the other hand, at time $t+1$, medical expenses (partially) and health status (totally) will be random variables. To capture uncertainty over the stochastic components of medical expenses and health status, I convert m_t and ψ_t into discrete Markov chains, and calculate the conditional expectation of V_{t+1} accordingly. I integrated the value function with respect to the stochastic component of medical expenses, ψ_t, and of health status m_t using 4-node Gauss-Hermite quadrature for each chain. In order to be able to find the solution, the approach is to discretize the consumption and formal insurance decision space and to search over these grids for each point in the grid of wealth. Experiments with the fineness of the grids suggested that the grids I used (with 20 points for wealth and 5 points for the health insurance) gave reasonable approximations. In particular, I increased the number of grid points until the stage at which a further increase seemed to have a small effect on the results.

APPENDIX C: DATA

As mentioned in Section 3, using data from SHARE, the true variables, chosen as the benchmark for the simulated ones, are referring to the amount of formal health insurance that individuals are contracting, their consumption of goods and services and finally to their total wealth, in which I included financial assets, real assets, as well as pension earnings/benefits and other annual income flows.

For the formal health insurance that individuals acquired during the last year, I considered the amount spent on all voluntary and supplementary health insurance contracts. The rationale behind this choice is based on the fact that compulsory insurance in Europe is usually covered partially by the government[14] (constituting its public spending related to health care), and partially by the employers/employees (through contributions to the health system). Consequently, the amount of formal health insurance that individuals actually buy is identified by the supplementary, voluntary formal insurance contracts that they acquire. In order to eliminate the missing values in the formal insurance variable for those individuals who have reported wealth and consumption, I predicted formal insurance using a linear model that related the interest variable to the non-durable expenditures, wealth and individual observable characteristic (age, proxy for health status, number of children).

The value of total consumption of goods and services was obtained by aggregating the monthly data on consumption for all goods and services at the annual level, while the latter was imputed using the amount spent on food at home, food outside home and telephone bills, each weighted by external coefficients. These coefficients were obtained using an OLS procedure on the same consumption variables but from additional datasets, specific to the countries that I analyzed.[15]

The pension earnings and benefits were considered to their extensive definition, meaning I considered all the types of pensions and associated benefits: old age/early retirement/pre-retirement pension, public disability/unemployment /survivor/invalidity or incapacity/war pension and private (occupational) old age/early retirement/disability or invalidity/survivor pension.

SHARE collected comprehensive data on net worth, including level and interest on the amount in bank accounts, government and corporate bonds, amount in stocks and correspondent dividends, amount in mutual funds and correspondent interest or dividend, amount in individual retirement accounts and contractual savings and face value of life policies, and net of total amount of money owed to other parties. One last item that it was included in the category of income flow is the amount of income from renting other owned real estate, while the market values of the main property and of other real estate and car(s) (if any owned), net of the main residence mortgage, were considered to represent the real assets and income flow that the individual possesses. I do not include bequests in the wealth measure since the age for the individuals considered in the analysis was 65 and over, and so very few of them actually would receive any bequests.

APPENDIX D: THE HEALTH COST MODEL

The issue of medical costs is central to the analysis presented in this paper, especially since the aim is to properly account for the possibility of high costs associated with long-term care and invalidity, and the informal arrangement is highly important. The distribution of these costs is controlled by the medical spending associated with each

[14] OECD in Figures 2006-2007, Demography and health - Health spending and resources. The levels of minimum formal insurance were considered to be approximated by the public expenditure with health per capita in all the countries analyzed.

[15] For Italy, Spain and Greece, the dataset used to obtain the external weights was ISTAT, while for all the other countries I used the Dutch Consumption Dataset.

health state and by the one-period 4×4 health state transition matrix $P(t)$.

The transition matrix for health status is parameterized by twelve elements, nine probabilities that determine the value of $P(1)$ (of the sixteen elements, four are fixed by the death state being un-reversable and there are three further restrictions so that each row sums to one) and three parameters that control the row of probability from greater health to poorer health as t increases. I selected values for these parameters to match the values computed by Ameriks et al. (2005) as starting points and then I estimated them through SMM.

Some remarks on the significance of the terms that I will attach to each health status are as follow. The curative and rehabilitation expenditures[16] comprises medical and paramedical services delivered during an episode of curative[17] and/or rehabilitative[18] care. These expenditures will be adequate to be considered in the case that the fair health status (3) is verified. On the other hand, long-term health care[19] comprises ongoing health and nursing care given to in-patients who need assistance on a continued basis due to chronic impairments and a reduced degree of independence and activities of daily living. In-patient long-term care[20] is provided in institutions or community facilities. These expenditures will be adequate to be considered in the case that the poor health status (2) is verified.

In the spirit of the Ameriks et al. (2005) paper, I consider the OECD Health Data October 2006 Statistics reports in each country, namely 2004 average medical expenses for non-institutionalized individuals and for assisted ones. Confirming their study, I find that among the periods the simulated retirees spend out of invalidity and death status (health states 3 and 4), a certain average amount specific to each country, in state 3 (fair health) so that $h(m_t(4)) = 0$ and $h(m_t(3) > h(m_t(4))$ will reproduce these averages. For the invalidity state, I used Brown and Finkelstein's (2004) approach that considers the cost of long term care facility per capita. This leaves an annual expense for a full year of long term care at a lower amount than the costs of fair health. Consequently, I take $h(m_t(2)) < h(m_t(3))$. I also considered the costs associated with death to be the highest ones, according to the formula used in the OECD calculations[21], and set $h(m_t(1)) > h(m_t(2))$. For each and every country analyzed, I first determined these costs based on the OECD Health Data October 2006 Statistics reports, and further use this information in simulating the data.

In practice, the primary data for funeral costs in the OECD countries analyzed are drawn from the AGIR data set (Westerhout and Pellikaan 2005, based on EPC 2001) for EU-15 countries, and OECD calculations for 2005.[22] The cost of death for the oldest group (95+) is assumed to be the lowest and was proxied by their observed health expenditure per person when available. For France, Germany, Italy, Spain, and Netherlands for which the expenditure for the oldest group were not available, the cost

[16] This item corresponds to HC.1+HC.2 in the ICHA-HC classification of health care functions.

[17] An episode of curative care is one in which the principal medical intent is to relieve symptoms of illness or injury, to reduce the severity of an illness or injury or to protect against exacerbation and/or complication of an illness and/or injury which could threaten life or normal function.

[18] Rehabilitative care comprises services where the emphasis lies on improving the functional levels of the persons served and where the functional limitations are either due to a recent event of illness or injury or of a recurrent nature (regression or progression). Included are services delivered to persons where the onset of disease or impairment to be treated occurred further in the past or has not been subject to prior rehabilitation services.

[19] This item corresponds to HC.3 in the ICHA-HC classification of health care functions.

[20] Long-term care is typically a mix of medical (including nursing care) and social services. Only the former is recorded in the SHA under health expenditure.

[21] See Bjornerud and Oliveira Martins (2005), OECD (2006).

[22] I obtained the death related costs data for 2004 by applying the health expenditure real growth rate to the 2005 serie (see OECD Health Data 2008).

of people aged 75-79 was taken as a proxy. In fact, when available, expenditure at age 95+ is roughly equal to the level of expenditure at age 75-79. For the countries where no cost expenditures were available, the cost of death for the oldest group was estimated by taking 3 times the average health expenditure per capita, adjusted by the country-specific residual (Bjornerud and Oliveira Martins 2005, OECD 2006). The total long-term care expenditure in percentage of GDP in 2005 was calibrated to fit the estimates of the OECD Long-term Care study (OECD, 2005b), when available. Data for the countries not available in this study were obtained by applying the ratios of long-term care to GDP observed in 'similar' benchmark countries, as indicated in Table 9.

Table 9. Benchmark countries in OECD studies

Country estimated	Benchmark countries
Belgium	Netherlands
Denmark	average (Norway, Sweden)
France	Germany
Greece	Spain
Italy	average (Germany, Spain)
Switzerland	Germany