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

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Abstract

Although formal health insurance has been at the centre of the economic debate, little is known about the role of informal health insurance. The latter is especially important in developing countries and poor regions, where formal insurance contracts are affected by severe asymmetric information problems. Using a dynamic structural life-cycle model, this paper investigates the interaction between formal and informal health contracts. Consumers are allowed to respond to health shocks in two 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 care provided by family. Results on social cohesion confirm three relevant social literature findings on the strength of family ties: social cohesion generally rises with age, it declines with wealth and it is stronger in poorer regions. Also, high social cohesion is typically associated with increased life expectancy. Finally, counterfactual experiments confirm that health, medical spending and health insurance are indeed the main drivers of the slow wealth decumulation after retirement.

Key Words: health, health insurance, social cohesion, life expectancy.

JEL Classification: D1, D31, E27, H31, H51, I1.

1 Introduction

The economic literature has long noted the importance of health insurance contracts in shaping economic decisions. Precautionary savings and bequests are just two examples of

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economic choices that are affected by this type of contracts. Moreover, the availability of formal (market provided) and informal (family provided) health insurance appears to be crucial at a later stage in life, when medical consumption accounts for a large share of total expenditures. Although formal health insurance has been at the centre of the economic debate, little is known about the role of informal insurance, which is especially important when the formal market is imperfect. This is often the case in lower income countries, where formal insurance contracts are affected by severe asymmetric information problems. This work extends the literature, by studying the extent to which family transfers are used by the elderly to obtain health care when sick.

In a seminal paper, Kotlikoff and Summers (1981) used the estimated level of intergenerational transfers to argue for the dominance of bequest motives for savings. However, in a world filled with uncertainty, Dynan et al. (2002) found that it is impossible to disentangle the strategic and altruistic bequest motives ex-ante "because each dollar can effectively serve both purposes". In the current paper I assign an important role to potentially high health care costs as reasons to: i) insure, either formally by purchasing private insurance or informally through family transfers, and ii) self-insure by accumulating wealth. Therefore, the paper is also connected to the well-established literature (Hubbard et al., 1994, 1995; Palumbo, 1999; Dynan et al., 2004; de Nardi et al., 2010) that examines how the risk of future health expenditures determines the slow decrease of wealth during retirement. This occurs because health spending is a substantial source of risk for the elderly that is difficult to diversify.

On the other hand, the fact that informal insurance is more prevalent in poor regions is confirmed by several studies. For example, the studies by Kohli (2005) and Bonsang (2007) on European data show that family cohesion and informal care generally increases with age and declines with wealth. There are two main reasons why informal insurance is more prevalent in poor regions. First, formal insurance agreements are not subject to asymmetric information problems, but they depend on social ties (cohesion). Thus, an imperfect formal insurance market may well be accompanied by a perfectly functional informal one. Second, formal and informal insurance are subject to a certain degree of substitutability. Health care provided by the family, especially at an advanced age, can offer additional benefits to the elderly. Family members can provide emotional support, and they are generally endowed with additional information regarding the elderly individual's tastes and preferences. On the other hand, medical care provided by the family might be more substitutable or expensive (due to the risk-pooling feature of the formal insurance market) than that provided through professional services (e.g., in a hospital).

This paper studies the interactions between formal and informal insurance by estimating a realistic life-cycle model with endogenous medical spending. The model I present has several novel elements. First, the demand for health insurance is integrated within the household decision making process. This is because individuals can anticipate to some extent the future health status and the demand for medical goods when deciding whether or not to maintain their health insurance coverage. Second, I allow family transfers to be used by the elderly to obtain health care in the case of a health shock. 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. Insurance contracts can be formal (provided by the market) or informal (provided by the family). Formal insurance contracts may be affected by asymmetric information problems, whereas informal insurance depends on social ties (family cohesion) and bequeathable wealth. Third, the model captures the interactions between public, private and informal health insurance markets. Fourth, important country-specific details on mortality, morbidity and health insurance markets are accounted for. Finally, the model also captures the effect of social norms regarding caring for one's elderly parents (family cohesion) on the demand for private formal insurance and on wealth decumulation.

A first estimation of the model is based on data from the Survey of Health, Ageing and Retirement in Europe (SHARE),[1] using the simulated method of moments (SMM) for four levels of wealth and three European country groups, assuming no country-specific shocks.[2] I

[1] See www.share-project.org.

[2] Consistent with the evidence documenting the demographic, political and cultural differences in Europe (Gullestad and Segalen, 1997), I mapped the eleven SHARE countries into three regions: Scandinavia, Central Europe and the Mediterranean.

plan to further extend this model to study the role of informal insurance agreements under different market conditions. In particular, I plan to estimate the model using data from selected developing countries, including India.

I find that health risks and potentially high medical spending can explain the slow wealth decumulation (and consequently the bequests) after retirement in Europe. For instance, with no health risks, an individual would dissave roughly 22 percent more at age 75 and 19 percent more at age 95. These differences are due to the fact that out-of-pocket health costs quickly increase with age and wealth for all elderly Europeans.[3]

I also show that private insurance is a key factor in shaping wealth profiles. With no formal insurance, the wealth patterns would remain unchanged for poor individuals, but would be considerably lower for the rich. Alternatively, in the absence of informal insurance, the elderly would decumulate their wealth much faster. For example, poor Mediterraneans would reach the age of 95 with 90 percent less wealth, whereas the equivalent reduction would be 56 percent for rich Scandinavians.

The impact of informal insurance on wealth decumulation varies greatly due to wealth disparities across Europe. Other key elements are heterogeneity in social cohesion and life expectancy across wealth and country groups. The family cohesion and mortality estimates are consistent with two relevant social and demographic facts. First, family cohesion generally increases with age and declines with wealth (Hank, 2007). Second, it is higher in Mediterranean countries than in Central European and Scandinavian countries (Kohli et al., 2005). Interestingly, I also find that high family cohesion is typically associated with high life expectancy. In Mediterranean countries, survival probabilities are high and the level of formal insurance is relatively low, as health expenses are mainly covered by the family. On the contrary, in Scandinavian and Central European countries, individuals register shorter life expectancies despite the high formal coverage (Bolin et al., 2008).

Finally, by introducing informal insurance, the current paper allows for intentional strate-

[3]For the poor, data show the slowest growth in the Mediterranean, where the annual out-of-pocket spending rises by roughly 39 percent between the ages of 85 and 95, compared to 88 percent for Scandinavians. Also, rich 95-year-old Scandinavians spend nearly three times more than when they were 85, but roughly only 13 percent less than a 95-year-old rich Mediterranean because of the high rates of morbidity registered in Southern Europe.

gic bequests. The reason why the strategic motive could be predominant relative to altruism, especially towards the end of life, is uncertainty in health and medical spending. As individuals age, they decumulate their wealth and diminish the amount of insurance purchased. This reduction is however mitigated by the fact that, at advanced ages, health risks tend to be more severe and medical spending higher, resulting in greater demand for care. Because informal care is likely to increase with bequeathable wealth (Bonsang, 2007), individuals have an incentive to slow their wealth decumulation. Also, cohesion coefficient and mortality increase with age, making bequests more valuable with age.

To capture this effect, I simulate an experiment in which individuals incur zero medical spending. As a result, they have no incentive to keep wealth for health care provision purposes, and the strategic bequest motive vanishes. Simulations show that with no medical spending, individuals run down their wealth to between 4 and 12 percent of what it would have been had they faced the health costs.

The remainder of the paper is organized as follows: Section 2 gives an overview of some interesting European facts that motivate this study. Section 3 develops the dynamic model, and Section 4 describes the data. Section 5 presents the estimation method, using the quadrature and the SMM methods. Results are illustrated in Section 6, and experiments are conducted in Section 7. Section 8 concludes.

2 Some European Facts

As mentioned before, there is substantial evidence documenting the demographic, political and cultural differences between specific European regions (Gullestad and Segalen, 1997). Based on this evidence, I grouped the eleven SHARE countries into Scandinavia (Denmark and Sweden), Central Europe (Austria, Belgium, France, Germany, the Netherlands and Switzerland) and the Mediterranean (Italy, Spain and Greece).

Consider first the demographic and health differences. In a 2005 paper, Avendano et al. have documented the existence of a North-South health gradient: older people in Southern Europe have higher morbidity rates than their Northern European counterparts, but also higher life expectancy. Interestingly, this situation persists despite the better Northern health care system.

Second, demographic factors have a considerable impact on the type and degree of the welfare systems in Europe. The public systems across Europe vary in terms of the design of organizing and financing health care,[4] but they all provide universal health care: all major health shocks are covered by the public system. However, individuals have also the option to purchase private supplementary insurance to cover for special circumstances, such as specialist or diagnostic outpatient service, certain drugs and dental care, alternative medicine, occasional choice of faster or better inpatient care, etc. Moreover, public spending on health care differs significantly between the regions. For instance, Sweden and Denmark spend on long-term care for females roughly four times more than Germany and Belgium and five times more than Italy.[5] This is not surprising, as the elderly in Denmark, Sweden and partially the Netherlands are mainly taken care of through professional services (formal care). Formal care quality and utilization rates in these countries are relatively high compared to other European countries (Bonsang, 2007). This is especially true when comparing them to the Mediterranean countries, where family-provided informal care is preferred.

The prevalence of formal care in the North and informal care in the South is also related to cultural factors that refer to family norms on filial and parental responsibility. The differences between the three regions have been well-documented. Reher (1998) argues that family ties in the northern and continental countries are generally 'weak'. In these countries, the elderly do not rely on their children and the youths detach from their parents relatively early. In the southern regions, a 'strong' family cohesion implies children's care of their parents in old age and intragenerational co-residence. Kohli et al. (2005) also associate the "weak-strong" dichotomy to a North-South European gradient: the Scandinavian countries are found to have the "weakest" family ties, the Mediterranean countries the "strongest", with all the continental countries in between.

All these factors have a strong impact on the elderly wealth decumulation patterns and

[4]Scandinavians have national health services, Central Europeans have social-insurance systems and Mediterraneans have a system established in the early 1980s that may be seen as a 'third way' (Freeman, 2000).

[5]Economic Policy Committee and the European Commission (DG ECFIN). Special Report n 1/2006.

they will be accounted for in the model. As a result, the model will be calibrated and estimated separately for each region.

3 The Model

3.1 Utility function

For simplicity, I consider households that consist of a single individual who has just retired. This approach focuses on consumption, health insurance and savings decisions without considering choices related to retirement timing or household dynamics. 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 a maximum age of 100 years. The retirement age is assumed to be exogenous and deterministic, with all individuals retiring at the age of 65.[6] Periods are indexed by t, the number of years in retirement, and in each period there is a stochastic survival probability $s_t \in [0, 1]$.

Consider an individual seeking to maximize her expected lifetime utility at time t, with exponential discount factor $\beta > 0$, by choosing current and future level of non-medical and insurance-provided medical consumption. Note that the latter is covered by the insurance only if a certain health status is realized.[7] In each period, the individual's utility depends on health status m_t, non-medical consumption C_t and value of the formal and informal insurance, F_t and I_t respectively.[8] Consumption and insurance are additively separable, and F_t is at least of class C^1. Finally, the utility of insurance-provided medical goods is a CES embedded in a constant-elastic function, with substitution parameter θ.

The within-period utility function is given by

$$u(m_t, C_t, F_t, I_t) = \delta(m_t)\frac{C_t^{1-\gamma} - 1}{1-\gamma} + \epsilon(m_t)\frac{\left[\alpha_t F_t^{\theta} + (1-\alpha_t) I_t^{\theta}\right]^{\frac{1-\sigma}{\theta}} - 1}{1-\sigma}, \tag{1}$$

where $\gamma, \sigma > 0$ are the relative risk aversion parameters for consumption of non-medical and

[6] The maximum length of the retirement period therefore includes 36 periods ($T = 36$).

[7] So, choosing the insurance-provided medical consumption is equivalent to choosing insurance coverage.

[8] I refer to face value of a health insurance policy as the total amount payable for medical goods and services if a certain medical condition is verified, as stated in the policy's conditions.

medical goods, respectively; σ measures the nonseparability between formal and informal insurance, i.e., it increases as individuals become less willing to substitute.

Note that medical goods not only affect utility indirectly through the budget constraint, but also affect it directly. This assumption is particularly important. The utility derived from a given health service can vary substantially depending on the provider. Health care provided by the family, especially at an advanced age, can offer additional benefits to the elderly. Family members can provide emotional support, and they are generally endowed with additional information regarding the elderly individual's tastes and preferences. However, medical care provided by the family might be more substitutable or expensive (due to the risk-pooling feature of the formal insurance market) than that provided through professional services (e.g., in a hospital). By allowing medical consumption to affect utility directly, it is possible to study these additional elements and to analyze the interactions and complementarities between formal and informal insurance.

The terms $\delta_t(m_t)$ and $\epsilon(m_t)$ capture the health status dependency of utility from consumption of non-medical and medical goods, respectively (Palumbo, 1999). Health status, m_t takes four values between 0 and 1 and decreases with the severity of medical conditions. State 1 is death; state 2 implies some form of long-term care (invalidity or poor health); in state 3 the individual has medical problems but no need for long-term care (fair health) and state 4 is the good health state. As health deteriorates, the marginal utility for non-medical consumption decreases (consumption goods are complements for good health), whereas the marginal utility for medical consumption increases (medical consumption goods are substitutes for good health). Specifically, $\delta_t(m_t)$ determines how a person's utility from consumption of non-medical goods depends on her health status, and is given by

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

Therefore, the healthier an individual is ($m_t \rightarrow 1$), the more she enjoys consumption, while if dead ($m_t = 0$), health status does not affect utility from consumption.

Similarly, $\epsilon(m_t)$ captures the need for medical goods, as follows:

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

such that being sick ($m_t \to 0$) has a positive effect on utility from health care. Note that when an individual receives no care (if healthy, $m_t = 1$, or dead, $m_t = 0$), the second part of the utility function is equal to zero, so that utility is defined solely by ordinary consumption.

Finally, α represents the consumption value of care financed by private insurers relative to that provided by the family. This parameter depends on health status,

$$\alpha_t\left(m_t\right) = a \cdot m_t,$$

and captures the possibility that individuals may get less utility from formal insurance than they do from informal contracts. If $\alpha = 1$, care is paid through formal insurance; otherwise, care might be paid via a combination of formal and informal insurance (Bonsang, 2009).

3.2 Formal insurance

All Europeans 65 or older are eligible for government-provided universal health care.[9] Some choose to further supplement the public plan with private (formal) insurance.[10] Formal health insurance is financed by risk-rated premiums which vary with the extent of the costs-sharing and the benefit eligibility rules. Generally, insurance companies use costs-sharing schemes to prevent moral hazard. With no form of copayment, individuals will consume more care than if they were to pay for all or some of it. In Europe, however, it has been repeatedly reported that insurers contain costs by increasing premiums and "getting tougher

[9] In most European countries, major health shocks are covered by the public health system. Thus, individuals face health costs partially covered or not reimbursed by the public insurance (i.e., specialist or diagnostic outpatient services, drugs, dental care, medical appliances, glasses, alternative medicine, occasional choice of better or faster inpatient care for important interventions) (see Paccagnella et al., 2008).

[10] Private health insurance coverage can be offered as a short-term or as a long-term contract with premiums used to finance health care costs. Short-term (typically annual) contracts are the norm for private health insurance in the European Union. Some insurers terminate contracts when people reach retirement age but this is more common among group policies rather than individual policies. Subscribers often have the option of switching to an individual policy, sometimes for the same level of benefits and at a reasonable rate.

on claims"[11] rather than by adjusting the copayment schemes. Data on the costs-sharing structure in Europe are limited, but available evidence suggests that claims ratios are approximately 80 percent in more than half of European Union countries.[12]

As a result, I model a simplified version of a typical contract. In exchange for paying an annual premium, individuals have their medical costs covered by private insurance (in addition to their public coverage). For these contracts, the premium exceeds the expected discounted benefits by country-specific loading factors.[13] At the beginning of each period, individuals can choose whether to buy or hold on to their private formal insurance. The face value of the formal insurance is given by

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

where $\overline{F}$ is the public insurance coverage,[14] ω is the inverse of the loading factor and f_{t-1} represents the private (formal) insurance premium paid in period $t-1$, before health and medical spending shocks are realized at time t.

3.3 Informal insurance

The face value of informal health insurance I_t represents the value of time and financial transfers from the family.[15] This value is assumed to be a function of the following three variables: i) the bequeathable wealth, B_t; ii) an individual's probability of dying before the next period $(1 - s_t)$[16] and iii) the social cohesion coefficient η_t[17], as follows:

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

[11] See Thomson and Mossialos (2009).

[12] See CEA Statistics N° 41: The European Health Insurance Market in 2008. The only exception is Germany, which has a high level of provisions for ageing.

[13] The loading factor has the following standard interpretation: if above one, it allows for a tax subsidy for the insurance, whereas if below one it captures the case of administrative costs or adverse selection.

[14] $\overline{F}$ represents the country-specific minimum health care consumption floor.

[15] The model assumes that financial and time-related transfers are substitutes (see Bonsang, 2007). Moreover, the family in this context is understood as extended family.

[16] s_t represents the standard survival probability at time $t+1$, given that the individual is alive at time t.

[17] This coefficient captures the strength of social ties or the social norm on caring for one's elderly parents.

This formulation is consistent with the findings in Bonsang (2007). Results using SHARE data showed that the probability of benefitting of a transfer from the family is explained, among other things, by three key characteristics of the elderly, namely age, health status and bequeathable wealth. The age of parents and being in poor health significantly increases the likelihood of both time and financial transfer. The expectation of receiving an inheritance has a dual effect. On the one hand, it significantly increases the occurrence of time assistance, as parents compensate their caregiving family by leaving them a bequest. On the other hand, it slightly decreases the chances of providing financial transfers, as money transfers are more likely to occur when the parents live in poor conditions.

The cohesion coefficient is given by

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

where β_0 represents the time-invariant level of family cohesion, whereas the fourth-order polynomial captures its age-structure.

Due to informal insurance, individuals have a strong incentive not to decumulate wealth quickly. As health deteriorates with age, the chance of severe medical conditions and high health spending increases. This boosts the demand for care and the need for insurance in general. Also, family cohesion makes bequeathable wealth increasingly valuable, via its impact on informal care. Therefore, the model allows for intentional bequests through the strategic motive for care provision.[18]

The market for informal insurance is assumed to be perfect from the informational point of view. In each period, the family knows exactly what states are realized and provides an amount of informal care that equals a fraction of the elder's wealth, weighted by the probability that the bequest will be received (i.e., the individual will die). Informal insurance differs from formal insurance in its timing, as benefits are received each period, but costs are paid only after one's death. Also, note that the informal insurance scheme does not imply a complete lack of commitment. There is an extended literature (Bernheim et al.,

[18] Consistent with de Nardi et al.'s (2010) findings, the model does not feature purely altruistic bequests.

1985, Venti and Wise, 2004, Chiuri and Jappelli, 2010) arguing that only illiquid assets can be considered as instruments for the commitment to leave bequest. Rather than using this approach, I considered the scenario in which the informal care scheme is a function of the whole amount of wealth that can constitute bequest, adjusted for the individual's probability of dying in the next period. Thus, family members expect the bequest with certainty. This is consistent with SHARE data that shows more than 80% of the bequests being transferred within families.

3.4 Uncertainty

There are two main sources of uncertainty related to medical spending[19] and health status.

i) Medical spending risk. Besides formal and informal insurance, there is a third possibility to finance health spending, namely out-of-pocket. Out-of-pocket health costs , hc_t, are defined as the difference between total health care costs h_t[20] and total insurance coverage (formal and informal), plus a medical spending shock ψ_t,

$$hc_t = h_t(m_t, t) - (F_t + I_t) + \psi_t(m_t, t). \tag{7}$$

After individuals purchase insurance coverage, the health and medical spending shocks are realized and medical costs are incurred. The exogenous health care risk persists according to an AR(1),

$$\ln(\psi_t) = (1 - \rho_\psi) \ln \overline{\psi} + \rho_\psi \ln(\psi_{t-1}) + \varepsilon_t \ , \varepsilon_t \backsim N(\overline{h}, \sigma^2_{\varepsilon t}). \tag{8}$$

Given the high expenses associated with poor health, the issue of health dynamics and death is crucial to the insurance motive. 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. Each health status is associated with a deterministic health cost, and so the health costs of an individual who passes from poor to good health exceeds the

[19] Although older people have already shaped their health and lifestyle, they still choose how to respond to the medical spending risks through saving and insurance.

[20] We consider h_t exogenously given for every realization of the health status. See Appendix D for details on how this variable was constructed.

costs of an individual persisting in good health.[21]

ii) Health status risk. Individuals face heterogeneous health status risks, modeled as a Markov chain with an age-varying one-period state transition, as described below. Retirees reaching age 100 die with probability one in the following year. Considering the initial empirical health state, the Markov transition matrices $P(t)$, with $t \in [1, T]$, generate the future probability patterns for all health states, including death.[22]

I allow the transition probabilities for health status to depend on previous health, age and wealth, as follows:[23]

$$p_{kj}(t) = \Pr(m_t = j|\, m_{t-1} = k, t, a_t), \qquad k, j \in \{1, 2, 3, 4\}$$

and model the one-period ahead transition matrix at age $65 + t$ as

$$P(t) = \begin{bmatrix} 1 & 0 & 0 & 0 \\ p_{21} & p_{22} & p_{23} & 1 - p_{21} - p_{22} - p_{23} \\ p_{31} & p_{32} & p_{33} & 1 - p_{31} - p_{32} - p_{33} \\ p_{41} & p_{42} & p_{43} & 1 - p_{41} - p_{42} - p_{43} \end{bmatrix} * A_t, \tag{9}$$

The A_t matrix is an age-adjustment matrix. It shifts probability mass from the left (worse health, death) towards the right (better health), relative to the transition matrix at 65, $P(1)$ (Ameriks et al., 2005).

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

[21] Funeral expenses, $h_t(m_t = 0)$, are also deterministic and subtracted from the bequest.

[22] Given the initial health state m_1, the transition matrix is applied repeatedly to the age-structure to derive the probability $p_{kj}(t)$ that a retiree is in one of the four health states at time $t > 1$.

[23] Note that $p_{k1}(t)$ denotes the probability that an individual will die at time t, conditional on being alive at time $(t - 1)$ with health status m_{t-1}, and having a certain age. The survival probability in the value function can equivalently be computed as $s_t = (1 - p_{k1}(t))$.

The three parameters c_1, c_2 and c_3 control how fast this shift occurs: 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 fair or good health and c_3 determines how much more likely an individual is to persist in good health. Since only cross-sectional data are available, c_1, c_2 and c_3 will be estimated for each country group to obtain health transitions.

3.5 Budget constraint

Individuals enter retirement with wealth $a_1 \geq 0$ and during each period they receive constant pension benefits y. Wealth at the beginning of time t is denoted by a_t. Assuming there is one composite riskless asset in which a household can invest and which yields a constant interest rate r, the next period's wealth is given by

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

Equation (11) shows that wealth in the next period equals current wealth plus inflows (capital income ra_t and pension benefits y) minus outflows (premium payments f_t, consumption C_t and out-of-pocket health care expenditures hc_t). The associated borrowing constraint is

$$a_{t+1} \geq 0, \forall t, \tag{12}$$

which eliminates the possibility that individuals may die in debt. Note that the borrowing constraint includes the out-of-pocket medical expenses, assumed to be realized at the beginning of the period, after health and medical spending shocks are realized. This assumption is reasonable given that time-t medical expenses are not completely unknown[24] when individuals decide whether to maintain their formal or informal health insurance. Given the timing of medical expenses, due to this borrowing constraint, an individual with extremely high medical expenses in the current year could have zero net worth in the next.

[24] Due to the AR(1) stucture of the medical spending shock.

3.6 Timing of the model

The timing of events is as follows: The individual enters period t with health m_t, wealth a_t and formal insurance purchased during the previous period $F_t(f_{t-1})$. At the beginning of the period, she receives annuity benefits y and pays the premium for the next period f_t. Then, the health shock is realized. If she is alive, medical costs are incurred[25], and she consumes and saves. If she does not survive the next period, funeral costs $h_t(m_t = 0)$ are paid[26] and bequest B_t equals the remaining net resources, down to a minimum of zero,

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

3.7 Recursive framework

Assuming the existence of a maximum, and given the continuity on the compact space of wealth and premium, the recursive Bellman equation is

$$\begin{aligned} V_t(m_t, \psi_t, f_{t-1}, a_t) = \underset{C_t, f_t}{Max} \Bigg\{ & (1+m_t)\frac{C_t^{1-\gamma}-1}{1-\gamma} + \\ +(1-m_t)&\frac{\left[\alpha_t(\omega f_{t-1} + \overline{F}\,)^{\theta} + (1-\alpha_t)\left(\eta_t(1-s_t)B_t\right)^{\theta}\right]^{\frac{1-\sigma}{\theta}} - 1}{1-\sigma} + \\ +\beta s_t E_t &\left[V_{t+1}(m_{t+1}, \psi_{t+1}, f_t, a_{t+1})\right] \Bigg\}. \end{aligned} \tag{14}$$

The individual chooses the optimal medical and non-medical consumption paths to maximize the value function in (14) subject to three constraints: i) an initial level of wealth and health; ii) the wealth accumulation equation (11) and iii) the no-borrowing constraint (12).

Optimality requires

$$C_t^{-\gamma} = \beta s_t (1+r) E_t \left[\frac{(1+m_{t+1})}{(1+m_t)} \frac{(1-\eta_{t+1}(1-s_{t+1}))}{(1-\eta_t(1-s_t))} C_{t+1}^{-\gamma} \right], \tag{15}$$

[25] Except if the individual persists in good health. In this case there are no medical costs ($h_{(t,m_t=1)} = 0$).
[26] Note that there is no medical spending shock in this case.

where the probability of dying is

$$(1 - s_t) = p_{k1}(t) = \Pr(m_{t+1} = 1 | m_t = k, t, a_t), \qquad k, j \in \{1, 2, 3, 4\}.$$

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

$$\phi = (\sigma, \gamma, \theta, a, \beta, \rho_\psi, \sigma_{\varepsilon t}, c_{i=\overline{1,3}}, \beta_{j=\overline{0,4}}, \omega, \overline{F}, r, \overline{h}, e) \in \mathbb{R}^{20}.$$

By discretizing the relevant states (the health and medical spending shocks, wealth and formal premium),[27] I solve for the optimal medical and non-medical consumption path iteratively from the final period ($T = 36$) backwards.[28] In the last period, the decision is trivial, with the individual consuming and transferring the remaining wealth as bequest. Because at time T she has no probability to survive through to the next period, she will not purchase formal insurance. During each period, the individual indirectly decides how much to informally insure through the amount she leaves as a bequest. She does so by directly choosing consumption and formal premiums, whereas the family provides informal care according to the cohesion measure η_t. From the discrete dynamic optimization principle it follows that the solution is found in two steps. The first step consists of finding the set of rules for consumption $\{C_t(X_t, \phi)\}$, and formal premium $\{f_t(X_t, \phi)\}$. Inserting these decision rules into the wealth accumulation equation yields the next period's wealth, $\{a_{t+1}(X_t, \phi)\}$, for all of the values that compose the grid of the previous period's premium, f_{t-1}. Using the optimal values for wealth in the second step, the value function is maximized and the optimal $\{C_t(X_t, \phi)\}$ and $\{f_t(X_t, \phi)\}$ are found.[29]

4 Data

I estimated the dynamic model using data from the first wave of the SHARE dataset, a cross-national microeconomic database that contains household-level information regarding

[27] The shocks are discretized using Gaussian quadrature. The wealth and premium grids match the data.
[28] Given that $t \in [1, T]$, the solution of the problem is obtained in a finite number of periods.
[29] For further details, see Appendix C.

the health, socioeconomic status and social and family networks of individuals aged 50 and over. SHARE was conducted in 2004 in eleven countries covering the representative regions of Europe as follows: Scandinavia (Denmark and Sweden), Central Europe (Austria, France, Germany, Switzerland, Belgium, and the Netherlands) and the Mediterranean (Spain, Italy and Greece). Data were collected on a total of 28,853 individuals. The dataset used to estimate the model was formed by the annual values of voluntary (supplementary) private insurance premium (formal premium henceforth), total expenditures on non-durables (consumption henceforth) and total net worth (wealth henceforth). Total net worth is evaluated in 2004 PPP adjusted Euros. It represents the value of all financial and real assets, plus yearly income flow - pension and capital income, net of any debts and liabilities, including taxes. To insure the cross-country comparability, total consumption was calculated using 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.[30] Finally, the missing values for formal premium were replaced using an OLS procedure involving consumption, total wealth and individual observable characteristics (age, number of children, health). The dataset included 4,564 observations on single individuals[31] aged 65 and over. I further excluded individuals with missing or negative net worth[32] or consumption and those with net worth less than the consumption of food at home, the consumption of food outside home or the cost of telephone bills, which resulted in 2,425 observations.

Given the cross-sectional nature of the first wave of SHARE, it was not possible to obtain a temporal dimension for the relevant variables. To overcome this problem, data were further grouped for each age in the following four wealth categories: below the 25th percentile, between the 25th and the 75th percentile, above the 75th percentile and equal to the mean wealth in the entire sample (representative agent). For the representative agent, profiles were created using the mean values across the whole dataset for each age. For the percentile wealth groups, I re-created the life-profiles of an individual aged 65 to 100 by

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

[31] Single individuals were those who were divorced, widowers or without a registered partner.

[32] Due to the no-borrowing constraint of the model.

taking the median wealth, consumption and premium values at each age. In order for this approach to be rigorous, it's important that one's wealth relative to others does not change over time, i.e., someone who starts with a high wealth at retirement but receives a series of negative shocks must not end up, say, in the lowest quartile. This is not a concern for the representative agent profiles, but only for the quartile profiles. To assess the validity of this assumption, I used the recently available SHARE data from the second wave that took place in 2006-2007. Specifically, I checked whether the individual relative position in the wealth distribution changed between the first and second wave. I found that only a very small proportion of respondents decumulated to the extent of actually changing their net worth quartile.[33] This is not surprising since most of the net worth is in illiquid assets and their value remained on average fairly stable over the three years between waves.[34] In other words, at every age, poor remained poor and most of the rich remained rich, which confirms the lack of significant bias in the quartile profiles. The missing values within each profile were obtained by linear interpolation. For ages beyond the last year of age reported, extrapolation proved much less reliable than did interpolation, especially because decision rules were non-linear. I extrapolated to age 100 based on the average relative rate of growth of the variables in the last 15 years. Each profile was then double smoothed by taking five year moving averages.

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.[35] For the insurance loading parameters, I used national statistics data to compute the average value within each country group, considering the respective administrative costs.[36]

The main issue lies in using cross-sectional data to give a time dimension to the profiles. First, individuals from earlier birth cohorts appear poorer at every age, which is a

[33] The proportion of respondents that changed their net worth quartile was 15.4% in the Mediterranean, 16.2% in Scandinavia and 12.5% in Central Europe.

[34] There has been a slight appreciation of the housing market in Spain, Netherlands and partially in Greece.

[35] See Appendix D.

[36] The loading factor reflects the administrative costs as a percentage of premia in 1999 (as no other data were available). See Comino (2003).

consequence of technical progress rather than a real feature of the data (wealth bias). Also, poorer individuals have a shorter life expectancy. Therefore, the advanced age observations will tend to be more biased towards rich people, who expect to live longer and hence run down their wealth slowly (mortality bias). The solution is to account for these biases directly through a structural model and then re-create them in the simulations. As in de Nardi et al. (2010), endowing a simulated individual with a certain age, wealth and health drawn from the data distribution will recreate the wealth bias in the simulation. Moreover, I allowed life expectancy to vary extensively with wealth and geographic regions, which should address the mortality bias.[37]

5 Calibrations and Estimation Methodology

The life-cycle literature based on European data is quite limited. Taking this limitation into consideration, I estimated most of the model parameters, i.e., $\phi' = (\sigma, \gamma, \theta, a, \beta, \rho_\psi, \sigma_{\varepsilon t}, c_{i=\overline{1,3}}, \beta_{j=\overline{0,4}})$ and calibrated only those that appear as instruments for the dynamic programming model, i.e., $\phi'' = (\omega, \overline{F}, r, \overline{h}, e)$.[38] Using the SMM, I estimated the values for ϕ' that generate life-cycle profiles that best fit the empirical profiles.

As the main focus of the analysis was to explain the dissaving pattern and the formal and informal insurance decisions, I matched total wealth, consumption and premium profiles, conditional on age and wealth. The grid and the initial level of wealth, consumption and formal insurance are set to match the data; for the bequest, I used the same grid of values as I used for wealth. The real risk-free asset return was set to $(1 + r) = 1.04$[39] and in the adjustment matrix, e was set to 1.5. Public insurance coverage $\overline{F}$ was set to the average level of public expenditure with health per capita.[40] Finally, the parameter $\overline{h}$ was set to match the total expenditure on health per capita.[41]

[37] See de Nardi et al. (2010) for an excellent discussion on accounting for cross-sectional biases by considering different samples by gender, wealth and health. They found that for income-specific households, mortality bias was fairly small. However, for the aggregated profiles, wealth decreased quickly for those alive in all five data waves they used, but slower than the one-wave wealth profiles.

[38] See Gourinchas and Parker (2002), Cagetti (2003), and French and Jones (2011).

[39] The average of long-term interest rate in 2004 for the Mediterranean countries was 4.2 percent, for Central Europe 3.9 percent and for Scandinavia 4.4 percent (OECD Statistics 2010, Key Economic Indicators).

[40] OECD in Figures 2006-2007, Demography and health - Health spending and resources.

[41] Evaluated in 2004 PPP adjusted Euros.

The SMM technique used for this work is standard, although as a novelty, I considered both first and second order moments. To compute the optimal choices, the state space of the shocks was discretized using the Gauss-Hermite quadrature method. I solved the model numerically by backward induction and simulated wealth, consumption, premium and health histories for $N = 20$ artificial individuals,[42] using random draws for the two stochastic variables. For each individual, the model assigned a value of the state vector $X_t = (m_t, \psi_t, f_{t-1}, a_t)$ which endows her with a certain level of wealth, corresponding formal coverage, health and medical costs. For each artificial profile, I calculated the moments. Finally, comparing the mean of the artificial moments to the data moments, parameters were adjusted to minimize their difference.[43] The goodness of fit between the two series was assessed by a χ^2-test statistic or corresponding $p-value$. This statistic assesses 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 only one realization $(m_n(\widetilde{\phi'}))$. Analytically, as $T \to \infty$, keeping the number of random sequences fixed, if the weighting matrix W is chosen optimally, then

$$J_T = \arg\min_{\widetilde{\phi'}} \left[m_T - \frac{1}{N}\sum_{n=1}^{N} m_n(\widetilde{\phi'})]'\widehat{W}[m_T - \frac{1}{N}\sum_{n=1}^{N} m_n(\widetilde{\phi'}) \right],$$

and

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

where j is the number of moments, k is the number of estimated parameters and $\phi' \in R^k$ is the unknown parameter vector.

The choice of moments remains an open issue in the literature. To ease the interpretation and restrain the set of moments, the model was limited to a set of sixteen true and simulated

[42] The estimation used profiles obtained from a cross-sectional dataset. Consequently, I set $N = 20$ since I want to capture the variability. Increasing the number of simulations, although only marginally improving the means, would actually generate smoother profiles. Nevertheless, the number of simulations is approximately equal to the model's average number of periods (i.e., 20.7), hence maintaining the rule that $N \geq T$.

[43] In practice, minimization of the SMM estimator is done by a grid search, with each parameter takes on different values. The first stage takes place under the condition that the weighting matrix $W_T = I_T$. Using the first-stage estimates I repeated the procedure and used, 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.

moments (m_T/m_N) for wealth, consumption and formal premiums (see Table 1).

6 Results

This section reports the estimation results. In Appendix A, Tables 2 - 4 show the structural parameters estimates, whereas Tables 5 - 8 present the empirical and simulated moments. The structural parameters were estimated quite precisely and were economically reasonable. In some cases, the models fit well, and we are unable to reject the null hypothesis that the simulated and empirical moments are the same. However, in most of the cases, the models did not display a high goodness of fit. Despite their formal rejection, the generated life-cycle profiles resembled the life-cycle profiles displayed by true data.[44]

6.1 Data profiles

Figures 1 - 3[45] display both the actual and simulated profiles of the decision variables, together with 95 percent confidence intervals. Most simulated profiles resemble the real ones, which is remarkable considering that the latter came from cross-sectional data.

Wealth levels were extremely heterogeneous both across and within European countries, varying with age, cohort, education and health. As expected, wealth increased in Europe from South to North, with the poorest rich Scandinavian being nearly twice as wealthy as the richest Mediterranean elderly. In all European regions, for the bottom and median part of the wealth distribution (up to the 75th percentile) both the empirical and the simulated profiles showed mild decumulation in older age. These patterns are consistent with large coefficients of (consumption) relative risk aversion and with a low discount factor.

Because wealth finances consumption, most of the simulated consumption profiles fell slowly during retirement. Generally, the same pattern was also displayed by the actual data, which maintained both the monotonicity and the smoothness of the decline.[46] These

[44] 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, the moments of the real data can be seen to be quite different with respect to the Mediterranean and Central European data.

[45] See Appendix B.

[46] The exception is the 75th percentile model for Central European countries and the 25th percentile model in the Scandinavian group where consumption registers a peak in the last quarter of the time span.

profiles are consistent with most empirical studies of old-age consumption, suggesting that consumption falls with age (Banks et al., 1998). Intuitively, as individuals age and as their life expectancy decreases, they should allocate less wealth for future consumption because they are less likely to benefit from it. Thus, the decline in consumption should be faster for individuals with higher mortality rates. The magnitude of this effect also depends on the degree of risk aversion and on the discount factor.

As for the formal premium profiles, they appeared to increase slightly[47] for all wealth groups, throughout the age of 90. Indeed, if insurance reduces health cost volatility, risk averse individuals may value health insurance at well beyond the cost paid. As a result, they will continue to purchase and even slightly increase their insurance coverage. However, with increasing age, they may value formal insurance differently, conditional on the availability of informal insurance.

A note on adverse selection/moral hazard in the European context. The formal insurance market may be affected by adverse selection and moral hazard. Individuals who are unwell benefit more from buying health insurance, and hence they are more willing to buy it. Healthy individuals will opt out, choosing informal coverage or paying out-of-pocket. However, in Europe these effects are strongly mitigated by two factors. First, informal insurance becomes more important with age. As an individual ages, the survival probability diminishes (especially for the sick) and the cohesion coefficient rises (see Figure 9), making bequeathable wealth more valuable in terms of informal care. To the extent that formal and informal care are substitutable, informal insurance can considerably reduce formal insurance demand for sick people. Second, healthy individuals are typically richer and can more easily afford to pay for insurance, whereas the poor face tighter budget constraints. The formal insurance market shows that indeed this is the case in Europe. Interestingly, those who would most benefit from formal insurance were less likely to buy it: Mediterraneans and generally poor Europeans had low formal coverage, relying mainly on the family-provided informal care.

Formal insurance can also affect health spending. Insured individuals tend to spend

[47] The only exception were rich Scandinavians, who registered a more volatile path. In Denmark and Sweden however fewer individuals reach advanced ages, and therefore the volatility might be due to the cross-sectional nature of the data profiles.

more on medical services due to moral hazard. This effect is moderated by the extensive European public health coverage and by the limited access to formal insurance. Private insurers attempt to prevent moral hazard through higher premiums and "getting tougher on claims". This practice limits the ability of the poor and sick, who typically have higher morbidity rates, to access formal insurance. Also insurers can delay payments to raise justifiable questions about submitted claims.

6.2 Preferences

Substantial heterogeneity exists in the estimated discount factor and risk aversion parameters. These results indicate that heterogeneous preferences play a role in explaining the large wealth dispersion observed in the data, even for individuals with similar health histories. These preferences also have implications for studying aggregate consumption, insurance and saving patterns based on representative agent models.

The discount factor varied quite a lot with wealth and geographic region. Scandinavians displayed the highest discount factor, and across all countries, the poor discount the future more than do the rich. The only exception was poor Mediterraneans who registered the lowest discount factor. In valuing the future however, one must consider the interaction between the discount factor and survival probability.

Standard values for consumption relative risk aversion are generally between 1 and 6. The results showed values between 4.0 and 5.8 for the Mediterranean countries, 2.9 and 4.8 in Central Europe and between 1.3 and 3.5 for Scandinavia. High values reflect the relationship between risk aversion, age and wealth: *ceteris paribus*, risk aversion increases with age[48] and decreases with wealth. Consistently, Scandinavians were less risk-averse than were Central Europeans, who were less risk averse than were Mediterraneans. Surprisingly, within each region, the poor were generally less risk-averse than were the rich. This phenomenon may be due to the rich relying on private savings more than the poor, who benefit from additional social support programs. As a result, those with low wealth tended to save less

[48] Based on the life-cycle of risky asset positions, Morin and Suarez (1983) argued that older investors are more risk-averse. However, these findings have been debated (Wang and Hanna, 1997, Bajtelsmit and Bernasek, 2001).

for consumption. The exception is again Southern Europe, where the poor were more risk-averse than were both the rich and all the other poor Europeans, due to a complete lack or an insufficiency of such institutional programs.

The opposite applies for medical goods consumption. The rich appeared to be less risk-averse than the low- or median-wealth individuals. Even with public health programs in place, health shocks can be severe and can require substantial medical spending that the poor may not be able to afford. Across Europe however, Mediterraneans were less risk-averse than were Central Europeans or Scandinavians. This finding is consistent with the risk of higher out-of-pocket expenditures registered in Scandinavia than in Central Europe or the Mediterranean. This finding complements the estimates for the coefficient of substitution between formal and informal care: the rich substitute less than the poor and representative Scandinavians substitute less than do Central Europeans and Mediterraneans.

6.3 Health Status and Out-of-Pocket Medical Spending

Medical expenses can impose a significant financial burden on individuals and families. However, the European public insurance system extensively covers prescription drugs and doctor visits, as well as inpatient and outpatient care. As a result, for the current sample, the out-of-pocket mean medical expenses were EUR523 with a standard deviation of EUR314.

Remarkably, even if the model did not specifically fit out-of-pocket medical spending, Figure 4[49] shows that the simulated and actual data profiles were quite similar. As expected, health expenses for the elderly significantly increased with age, as health worsened over time. Clearly, high medical spending is an important economic risk for the elderly. However, little is known about the differences in the persistence and volatility of such out-of-pocket expenditures in Europe.

Medical spending persistence was relatively low in Northern Europe, compared to in Central Europe and in the Mediterranean. The rationale is twofold. First, in Northern Europe few individuals remain in the highest-cost categories for more than one year. Second, the high mortality rates of Scandinavians, who use medical services heavily, limits the extent

[49]See Appendix B.

of expenditure persistence. Still, wealth-specific coefficients indicate that persistence was not significantly different for the poor and rich, except for the case of Mediterraneans. This is due to the health status dynamics. Poor Southern Europeans experience the worst health with age, but also have high life expectancy. With high expenditures in one year, they are likely to have higher-than-average expenditures in other years.[50]

Because the poor can afford to pay less than the rich, their out-of-pocket medical spending will tend to be less volatile. This holds true both within and between the three European regions. For all three country groups, the magnitude of the variation in health spending was higher for the rich than it was for the poor. Accordingly, Mediterraneans faced less volatile medical spending than do Central Europeans, who in turn registered a lower variability of health spending than do Scandinavians.

Individuals' level of health care expenses is strongly correlated with their health status, and SHARE offers detailed information on this topic. A quick analysis revealed an expected age-dependent health decline, but an unexpected North-South gradient in Europe. All health indicators in the data[51] clearly showed higher morbidity rates in the South than in the North. Spain, Italy and Greece had substantially higher prevalence of medical conditions than did Denmark and Sweden, with Central Europe countries falling in between. Interestingly, the high morbidity rates did not translate into low life expectancies for Southern Europe and, therefore, Scandinavians generally die quicker but Mediterraneans are sicker.[52]

With this paradox in mind, I estimated the parameters that generate health status and control for age transitions. Remarkably, the model reproduce the North-South health gradient quite well. Figures 5-8[53] 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 5 plot the invalidity and

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

[51] The health indicators considered were self-perceived health, long-standing health problems and daily activity limitations. For self-perceived health these differences likely reflect cultural differences, at least partly, but the same differences are registered for physical health indicators.

[52] See Avendano et al. (2005).

[53] See Appendix B.

death probability for individuals in good health. Results show that the probability of death within the next year of life, if an individual is currently healthy, rose from 0.16 percent at age 65 to 3.63 percent at age 100. Invalidity appeared to be a persistent state: being a 69-year-old in poor health implied a 55.72 percent chance of remaining in poor health in the next year, and this probability fell with age, as the survival probability decreased. As confirmed by the actual demographic trends, at each age, the rich were more likely to maintain or return to good health and less likely to die than were the poor. At age 80, being in the 75th percentile instead of the 25th lowered the probability of dying by 16.21 percent.

The rich are less likely to die than are the poor also in Central Europe. The healthy poor have a 11.76 percent higher chance of dying than do the healthy rich at age 65, but they have a 89.85 percent higher chance of dying at age 90 (see Figure 6). This figure translates into nearly 23 percent higher chance of death than for poor Mediterraneans. Simulations show that this figure reflects a general trend. For each wealth level, Central Europeans were more likely to die than were South Europeans, especially if they were below the median wealth level. Along the same lines, poor Central Europeans were also less likely to become invalid or stay healthy than were both rich Central Europeans and poor Mediterraneans.

Finally, Figure 7 shows the health transitions for Scandinavians. I found that the probability of death when an individual was healthy was high (0.19 percent at age 65) and quickly rose with age (8.27 percent at 100), significantly overcoming both the Mediterranean and Central European countries. Rather surprising, however, 65-year-old Scandinavians were as likely to become invalid as were Mediterranean or Central Europeans of the same age. Remaining healthy or returning to good health was less likely as age increased, but the poor did so at a rate that was only approximately 4 percent lower than that for the rich.

For the representative agent, although maintaining good health became less possible as one ages, Central Europeans seem to succeed less so than other Europeans. They also registered the smallest survival probability and the lowest chances of becoming invalid if they were in good health (see Figure 8). On the contrary, individuals in Italy, Spain and Greece displayed both higher life expectancies and higher invalidity probabilities than Scandinavians. In these two regions, at each age, the rich were only slightly less likely to die than were the poor, despite more accentuated wealth discrepancies with respect to Central Europeans.

6.4 Social cohesion

The findings on health and mortality were all consistent with the real demographic trends but challenged two considerations. First, they underlined an input-output discrepancy in the European health care systems. The mortality and morbidity profiles seemed to be in contrast with the expected outcome of the Central and especially the North European health care systems, recognized to be wider and more efficient than the South European system. Second, the results did not display an accentuated health gradient by wealth, which challenges the belief that poor are considerably more likely to die than are the rich.

This discrepancy can be explained, among other factors, by social cohesion. The 'map' of family systems in Europe is simple, with Central and Northern Europe being characterized by relatively weak family ties and the Mediterranean by strong family cohesion (Reher, 1998, Kohli, 2005). Figure 9[54] plots the relative cohesion coefficients by wealth and region.

For all European regions, estimates confirmed two findings of the social literature. First, family cohesion decreases with wealth and rises with age, slightly more towards the end of life, causing wealth accumulation. A reasonable explanation is that advanced age is characterized by a higher prevalence of diseases, which translates into an increased need for health care (especially informal). This trend induces wealth accumulation (for bequest and hence informal care) and the strengthening of family cohesion.

Second, high family cohesion is typically accompanied by a high life expectancy and vice-versa. Mediterraneans benefit from stronger family cohesion than do Central Europeans or Scandinavians. In both the North and the South, the poor display higher family cohesion than do median-wealth individuals, who in turn have stronger family ties than do the rich. These relations are mirrored by health status and mortality. Despite the significant wealth differences, the poor appear only slightly less likely to maintain good health than the rich. On the other hand, they have only a slightly greater chance of dying than do the rich in the South and an even lesser chance of dying in Denmark and Sweden.[55]

[54] See Appendix B.

[55] For Central Europe, the rich have a higher invalidity probability than do the poor. Moreover, poor Cen-

7 The Drivers of Wealth Decumulation

This section presents results on some counterfactual experiments that help explain the wealth decline determinants for European elderly. Specifically, I considered how wealth patterns would have changed over time had the individuals i) not incurred any health risk (maintained their 65-years-old health and transition probabilities to other states throughout their life); ii) not incurred any health-related costs (remained healthy throughout their life); iii) experienced no medical spending risk; iv) not purchased any formal insurance and v) not benefitted from any informal care. Each experiment modified certain parameters and obtained the dynamic programming solution. It then computed the rates of change relative to the baseline model and applied them to the wealth profiles obtained from the empirical data. The issue is how wealth in each scenario compares with the actual empirical profile.

Figure 10 plots wealth for the representative agent model in each European region. First, with no health risk, the retirees would have saved 16 percent less at age 80 and 52 percent less at age 100. The reason for this progressive decumulation is that health deteriorates over time. Because maintaining a 65-years-old health status has a higher impact towards the end of one's life, individuals will respond by dissaving increasingly faster.

Second, consider the case in which individuals persist in good health. As expected, results show that having no medical costs has a much stronger effect than does removing the health risk. For a certain wealth level, staying healthy would induce individuals to deplete their wealth almost entirely immediately. Indeed, I found that with no health costs individuals would keep only between 4 and 12 percent of what they would have otherwise saved.

Third, completely cancelling out the out-of-pocket risks and keeping medical spending at their average health-related levels had almost no effect on wealth. This result is consistent with those of Palumbo (1999) and de Nardi et al. (2010), who found that eliminating the health expense risk had only a small impact on consumption and assets for U.S. elderly. Thus, in Figure 10, the "No OOP Risk" coincides with the "Baseline" scenario.

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tral Europeans are less likely to become invalid than are poor Mediterraneans. Both findings are supported by the estimates of family ties: rich rather than poor in Central Europe and poor Mediterraneans rather than poor Central Europeans display stronger cohesion.

Fourth, in countries where health coverage is universal and free, as in most European countries, the demand for formal insurance should be absent. However, the private health system might offer better medical services, so people may choose to increase coverage against health risks. Running an experiment in which the formal insurance is shut down, I found a negative effect on wealth profiles. With no formal insurance, the entire burden of medical spending (net of the public coverage) is left to the elderly, causing a significant decrease in their wealth. Interestingly, this effect had the same magnitude as did the decumulation effect obtained in the experiment (ii). So, for Mediterranean and Central European countries, the "No Formal Insurance" scenario yields very similar wealth as the "No Medical Spending" scenario. The exception is Scandinavia, where wealth was not affected by the lack of formal insurance (the "No Formal Insurance" coincides with the "Baseline" scenario). This result is expected, given their extensive and efficient public system.

With imperfect insurance markets, formal insurance is supplemented by informal agreements. Results showed that shutting down this channel goes a long way towards explaining the wealth profiles. With no access to informal insurance, individuals have no incentive to keep wealth for care purposes and, thus, dissave faster. Towards the end of life, however, wealth registers a slight increase because health costs rise, inducing the share covered through public insurance to increase. Finally, as expected, not allowing for this type of insurance had more of an impact in South Europe than in the North.

8 Conclusions

The risk of living a long life and facing high medical expenses are important factors in elderly saving behavior (de Nardi et al., 2010). However, there is significant heterogeneity in the magnitude of the effects of these risks. The absence of perfect insurance markets coupled with borrowing constraints creates a strong incentive for precautionary saving. As individuals place a high value on insurance, the provision of both formal and informal benefits may have a large effect on retirement behavior.

To see if this is the case, I estimated a life-cycle model designed to outline the savings decisions of retired single households. It simultaneously considered the effects of health risks and medical spending uncertainty on the insurance and wealth decumulation choices of European elderly. Health insurance can be provided formally by the market and informally by the family, as is quite common in Europe. Informal insurance depended on family cohesion and bequeathable wealth, whereas medical spending was endogenized. Using the first wave of SHARE data and the SMM, I estimated the model for four levels of wealth and three European regions, the Mediterranean, Central Europe and Scandinavia.

The paper makes several contributions. First, results from countefactual experiments show that health risks and total medical spending, as well as formal and informal insurance are the main determinants of the slow wealth decumulation. Indeed, simulations demonstrated that, among different factors, poor health and high medical expenses are key determinants of the decision to slowly dissave. Also, formal insurance did not appear to impact on wealth for poor Mediterraneans and Scandinavians, but it made the rich almost completely run down their assets to pay for medical spending. Finally, if informal insurance is made unavailable to the elderly, wealth will drop by 80 to 90 percent. This drop will be faster for the poor than for the rich and greater for Mediterraneans than for Scandinavians.

Second, the model offered realistic estimates of out-of-pocket medical costs, capturing their rapid increase with age. As expected however, the out-of-pocket spending risks were found to have almost no effect on wealth.

Third, the estimates on morbidity and mortality probabilities by age, previous health and wealth managed to recreate the European health gradient. Although health generally deteriorates with age, Mediterraneans have a higher life expectancy than do Central Europeans and Scandinavians. The latter have a vast and more efficient health system, which in turn lowers their morbidity rates with respect to Southern Europe.

Fourth, the results on social cohesion, together with the health gradient, add considerably to our comprehension of the morbidity and mortality disparities in Europe. Estimates show that people with informal support live longer than those without it, and this is especially true for those in poor health. Indeed, Mediterraneans register stronger family cohesion and worse health but higher life expectancies than do Danes, Swedish and Central Europeans. This finding confirms the commonly-observed behavior, particularly in South Europe, of postponing receiving professional care in favor of family care. As a result, morbidity rates increase, but so is life expectancy.

Fifth, I constructed a realistic structural life-cycle model that reproduced many features of the data. In particular, it replicated the heterogeneity in wealth decumulation patterns in Europe.

From a policy perspective, it is important to understand why retirees decumulate so slowly. If the reason is to cover longevity or medical spending risks, then changes in health insurance programs or in social and family policies may influence elderly saving behavior by controlling risk exposure. Still, for the European elderly, it is important to consider country-specific factors such as social cohesion and its relation to life expectancy, age and wealth. In this sense, identifying a model that is capable of explaining the choices of European elderly can improve the understanding and design of reforming policies.

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Appendix

A Moments, Estimates and Goodness of Fit

Table 1.Choice of Moments

$\overline{a}$,	$\overline{C}$,	$\overline{F}$,	$\overline{C/a}$,
$\sigma_{\ln(a_t)}$,	$\sigma_{\ln(C_t)}$,	$\sigma_{\ln(F_t)}$,	$\sigma_{\ln(C_t/a_t)}$,
$corr(a_t, C_t)$,	$corr(a_t, \frac{C_t}{a_t})$,	$corr(C_t, \frac{C_t}{a_t})$,	$corr(C_t, F_t)$,
$corr(a_t, a_{t-1})$,	$corr(C_t, C_{t-1})$,	$corr(F_t, F_{t-1})$,	$corr(\frac{C_t}{a_t}, \frac{C_{t-1}}{a_{t-1}})$.

Table 2. Parameter Estimates, Mediterranean Countries

Param.	*25th wealth percentile*	*50th wealth percentile*	*75th wealth percentile*	*Represent. agent*
σ	0.6946	1.3464	1.0820	1.8785
	(0.0352)	(0.0150)***	(0.0133)***	(0.0602)**
γ	5.5137	5.8431	4.0464	2.9278
	(0.1269)*	(0.0520)***	(0.0183)***	(0.3587)**
θ	3.2227	0.0028	0.6181	1.7264
	(0.0059)*	(0.00001)***	(0.0077)***	(0.00001)***
a	1.5138	1.1361	1.0380	0.0105
	(0.0015)**	(0.2509)*	(0.0904)**	(0.00001)***
β	0.7889	0.9206	0.9278	1.0038
	(0.1499)*	(0.0042)***	(0.0224)***	(0.0235)***
ρ_ψ	1.6056	1.9181	1.0110	1.2923
	(0.1499)*	(0.00001)***	(0.00001)***	(0.00001)***
σ_{ε_t}	0.0991	0.0942	0.1357	0.0739
	(0.0035)**	(0.00001)***	(0.0352)*	(0.00001)***
c_1	0.0001	0.0002	0.00003	0.0001
	(0.0152)	(0.0002)	(0.0001)	(0.0001)
c_2	0.9481	0.2728	0.1804	0.3168
	(0.0036)**	(0.00001)***	(0.4871)	(0.00001)***
c_3	$1.7*10^{-5}$	0.0001	0.0002	0.0002
	(0.0036)**	(0.0003)	(0.0007)	(0.0003)
β_0	0.0247	0.0839	0.1197	0.1558
	(0.2015)*	(0.0024)	(0.0268)*	(0.0216)**
β_1*10^{-2}	0.0621	0.0513	0.0775	0.0503
	(0.0115)	(0.00001)***	(0.00001)***	(0.00001)***
β_2*10^{-4}	0.0005	0.0007	0.0016	0.0018
	(0.0495)	(0.00001)**	(0.0001)**	(0.00001)***
β_3*10^{-4}	0.0004	0.0020	0.0020	0.00387
	(0.0725)	(0.00001)***	(0.0001)**	(0.00001)***
β_4*10^{-8}	0.0052	0.0029	0.0141	0.0046
	(0.0030)**	(0.00001)***	(0.00001)***	(0.00001)***

Standard errors are in parentheses. (*), (**), (***) indicate significance at 10%, 5% and 1%.

Table 3. Parameter Estimates, Central European Countries

Param.	*25th wealth percentile*	*50th wealth percentile*	*75th wealth percentile*	*Represent. agent*
σ	2.9521	2.3492	1.2232	1.9283
	(0.2198)**	(0.0329)***	(1.5477)	(0.0006)***
γ	2.9062	4.8112	3.2941	4.7093
	(0.0104)***	(0.0170)***	(0.8471)*	(0.0018)***
θ	1.4818	0.2502	1.1346	1.0149
	(0.0037)***	(0.00001)***	(0.00001)***	(0.0167)***
a	0.0815	1.1450	0.9390	0.1891
	(0.0169)***	(0.0845)**	(0.3768)	(0.0600)*
β	1.0326	0.9974	0.9120	0.9125
	(0.0252)***	(0.0224)***	(0.00001)***	(0.0821)**
ρ_ψ	1.8125	1.5202	1.8243	0.5897
	(0.00001)***	(0.00001)***	(0.00001)***	(0.00001)***
σ_{ε_t}	0.1026	0.1582	0.1347	0.0262
	(0.00001)***	(0.00001)***	(0.00001)***	(0.00001)***
c_1	0.0001	0.0002	0.00001	0.0002
	(0.0005)	(0.0002)	(0.00001)	(0.0005)
c_2	0.0038	0.0739	0.1101	0.0018
	(0.0137)***	(0.0910)	(0.00001)***	(0.00001)***
c_3	0.0002	0.00001	0.0003	0.0001
	(0.0001)	(0.00001)	(0.00001)***	(0.0002)
β_0	0.0405	0.1142	0.1168	0.0653
	(0.0042)*	(0.0399)*	(0.3489)	(0.1737)
$\beta_1{*}10^{-2}$	0.1595	0.0859	0.0921	1.5452
	(0.2086)	(0.00001)***	(0.00001)***	(0.0073)***
$\beta_2{*}10^{-4}$	0.0049	0.0021	0.0006	-0.0011
	(0.00001)***	(0.00001)***	(0.00001)***	(0.00001)
$\beta_3{*}10^{-4}$	0.0017	0.0008	0.00001	0.0025
	(0.00001)***	(0.00001)***	(0.00001)	(0.00001)***
$\beta_4{*}10^{-8}$	-0.0209	0.0056	0.0253	0.0387
	(0.00001)***	(0.00001)***	(0.00001)***	(0.00001)***

Standard errors are in parentheses. (*), (**), (***) indicate significance at 10%, 5% and 1%.

Table 4. Parameter Estimates, Scandinavian Countries

Param.	*25th wealth percentile*	*50th wealth percentile*	*75th wealth percentile*	*Represent. agent*
σ	0.4116	3.6936	−0.3426	−0.9007
	(0.0086)***	(0.0044)***	(0.0919)	(0.0525)
γ	1.3401	3.5580	1.5361	0.9117
	(0.6973)	(0.0277)***	(0.0585)**	(0.1079)**
θ	1.0659	1.3512	−1.0357	0.2444
	(0.00001)***	(0.0122)***	(0.0160)	(0.0804)*
a	0.1105	0.3581	1.5043	1.4987
	(0.00001)***	(0.0020)***	(0.0219)***	(0.2377)**
β	1.1059	0.9176	1.0788	1.0615
	(0.0324)***	(0.0081)***	(0.0013)***	(0.0147)***
ρ_ψ	0.2445	1.2394	0.3794	1.0223
	(0.000001)***	(0.0004)***	(0.00001)***	(0.00001)***
σ_{ε_t}	0.0565	0.2000	0.0998	0.0108
	(0.00001)***	(0.00001)***	(0.00001)***	(0.00001)***
c_1	$3.6{*}10^{-5}$	0.0004	0.0002	0.0001
	(0.0002)*	(0.00001)***	(0.0001)*	(0.0001)
c_2	0.1426	0.0704	0.0256	0.0178
	(0.9039)	(0.00001)***	(0.00001)***	(0.00001)***
c_3	0.0003	0.00001	0.00001	0.00001
	(0.0023)	(0.00001)**	(0.00001)	(0.00001)
β_0	0.0905	0.1191	0.1009	0.1066
	(0.1727)	(0.0024)***	(0.1436)	(0.0130)**
$\beta_1{*}10^{-2}$	0.0820	0.2050	0.5833	0.0982
	(0.00001)***	(0.00001)***	(0.00001)***	(0.2585)
$\beta_2{*}10^{-4}$	0.0039	−0.0083	0.0001	0.0017
	(0.0002)**	(0.00001)	(0.00001)***	(0.00001)***
$\beta_3{*}10^{-4}$	0.0022	0.0082	0.0039	0.0009
	(0.0003)**	(0.0003)**	(0.00001)***	(0.00001)***
$\beta_4{*}10^{-8}$	0.0032	−0.0077	0.0109	0.0048
	(0.0003)**	(0.00001)	(0.00001)***	(0.00001)***

Standard errors are in parentheses. (*), (**), (***) indicate significance at 10%, 5% and 1%.

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

$Moments$	25th per. Artif.	25th per. Emp.	50th per. Artif.	50th per. Emp.	75th per. Artif.	75th per. Emp.
$\overline{a_t}$	0.82	0.55	0.83	0.64	0.83	0.79
$\overline{C_t}$	0.15	0.29	0.06	0.36	0.09	0.33
$\overline{F_t}$	0.39	0.22	0.28	0.23	0.39	0.25
$\overline{C_t/a_t}$	0.18	0.23	0.08	0.13	0.11	0.06
$\sigma_{\ln(a_t)}$	0.33	0.14	0.34	0.22	0.34	0.19
$\sigma_{\ln(C_t)}$	0.55	0.39	0.29	0.18	0.33	0.22
$\sigma_{\ln(F_t)}$	0.37	0.19	0.31	0.20	0.36	0.18
$\sigma_{\ln\left(C_t/a_t\right)}$	0.38	0.38	0.21	0.20	0.24	0.15
$corr(a_t, C_t)$	0.60	0.22	0.72	0.57	0.67	0.66
$corr(a_t, C_t/a_t)$	0.05	-0.19	-0.45	-0.66	-0.33	-0.33
$corr(C_t, F_t)$	0.63	0.65	0.48	0.79	0.64	0.69
$corr(C_t, C_t/a_t)$	0.79	0.90	0.27	0.22	0.45	0.47
$corr(a_t, a_{t-1})$	0.85	0.71	0.92	0.86	0.92	0.82
$corr(C_t, C_{t-1})$	0.99	0.96	0.99	0.80	0.99	0.87
$corr(F_t, F_{t-1})$	0.90	0.82	0.81	0.84	0.91	0.80
$corr((C/a)_t, (C/a)_{t-1})$	0.80	0.98	0.70	0.94	0.76	0.90
$\chi^2(1)$	18.63		8.87		4.53	
$p-value$	$1.5*10^{-5}$		0.0029		0.0332	

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

$Moments$	25th per. Artif.	25th per. Emp.	50th per. Artif.	50th per. Emp.	75th per. Artif.	75th per. Emp.
$\overline{a_t}$	0.82	0.71	0.83	0.73	0.82	0.81
$\overline{C_t}$	0.23	0.34	0.10	0.29	0.18	0.32
$\overline{F_t}$	0.38	0.24	0.31	0.23	0.39	0.27
$\overline{C_t/a_t}$	0.31	0.32	0.13	0.14	0.22	0.05
$\sigma_{\ln(a_t)}$	0.33	0.24	0.34	0.37	0.33	0.19
$\sigma_{\ln(C_t)}$	0.12	0.20	0.18	0.22	0.43	0.28
$\sigma_{\ln(F_t)}$	0.35	0.20	0.41	0.18	0.37	0.20
$\sigma_{\ln\left(C_t/a_t\right)}$	0.25	0.07	0.22	0.25	0.29	0.21
$corr(a_t, C_t)$	0.80	0.95	0.78	0.61	0.61	0.51
$corr(a_t, C_t/a_t)$	-0.90	-0.70	-0.82	-0.86	-0.09	-0.14
$corr(C_t, F_t)$	0.73	0.21	0.66	0.80	0.61	0.72
$corr(C_t, C_t/a_t)$	-0.51	-0.46	-0.32	-0.16	0.70	0.78
$corr(a_t, a_{t-1})$	0.91	0.90	0.92	0.96	0.91	0.88
$corr(C_t, C_{t-1})$	0.93	0.85	0.99	0.87	0.99	0.91
$corr(F_t, F_{t-1})$	0.89	0.86	0.89	0.79	0.90	0.84
$corr((C/a)_t, (C/a)_{t-1})$	0.73	0.91	0.70	0.99	0.78	0.94
$\chi^2(1)$	10.14		6.14		4.37	
$p-value$	0.0014		0.0132		0.0364	

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

$Moments$	$25th$ $per.$ $Artif.$	$Emp.$	$50th$ $per.$ $Artif.$	$Emp.$	$75th$ $per.$ $Artif.$	$Emp.$
$\overline{a_t}$	0.83	0.58	0.82	0.78	0.83	0.86
$\overline{C_t}$	0.46	0.30	0.34	0.40	0.26	0.37
$\overline{F_t}$	0.39	0.20	0.39	0.21	0.33	0.22
$\overline{C_t/a_t}$	0.60	0.70	0.47	0.48	0.34	0.19
$\sigma_{\ln(a_t)}$	0.34	0.28	0.33	0.17	0.34	0.69
$\sigma_{\ln(C_t)}$	0.15	0.23	0.16	0.16	0.08	0.28
$\sigma_{\ln(F_t)}$	0.37	0.23	0.42	0.19	0.34	0.22
$\sigma_{\ln\left(C_t/a_t\right)}$	0.24	0.09	0.25	0.06	0.29	0.48
$corr(a_t, C_t)$	0.69	0.96	0.57	0.90	0.72	0.62
$corr(a_t, C_t/a_t)$	-0.93	-0.75	-0.90	-0.32	-0.94	-0.84
$corr(C_t, F_t)$	0.70	0.34	0.57	0.20	0.42	0.70
$corr(C_t, C_t/a_t)$	-0.46	-0.53	-0.19	0.12	-0.57	-0.63
$corr(a_t, a_{t-1})$	0.92	0.92	0.91	0.80	0.92	0.93
$corr(C_t, C_{t-1})$	0.98	0.88	0.83	0.80	0.89	0.92
$corr(F_t, F_{t-1})$	0.90	0.89	0.91	0.84	0.44	0.85
$corr((C/a)_t, (C/a)_{t-1})$	0.88	0.98	0.74	0.89	0.86	0.91
$\chi^2(1)$	9.46		18.04		9.46	
$p-value$	0.0021		$0.02 * 10^{-3}$		0.0021	

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

$Moments$	$Med.$ $Gr.$ $Sim.$	$Emp.$	$Centr.$ $Gr.$ $Sim.$	$Emp.$	$Scan.$ $Gr.$ $Sim.$	$Emp.$
$\overline{a_t}$	0.83	0.62	0.83	0.69	0.83	0.81
$\overline{C_t}$	0.25	0.32	0.12	0.40	0.26	0.33
$\overline{F_t}$	0.31	0.26	0.38	0.24	0.36	0.21
$\overline{C_t/a_t}$	0.32	0.09	0.15	0.10	0.34	0.29
$\sigma_{\ln(a_t)}$	0.34	0.30	0.34	0.22	0.34	0.44
$\sigma_{\ln(C_t)}$	0.20	0.23	0.39	0.28	0.08	0.23
$\sigma_{\ln(F_t)}$	0.45	0.23	0.46	0.18	0.33	0.21
$\sigma_{\ln\left(C_t/a_t\right)}$	0.21	0.21	0.24	0.22	0.28	0.27
$corr(a_t, C_t)$	0.75	0.79	0.69	0.58	0.76	0.75
$corr(a_t, C_t/a_t)$	-0.75	-0.66	-0.14	-0.31	-0.91	-0.92
$corr(C_t, F_t)$	0.70	0.48	0.70	0.59	0.71	0.42
$corr(C_t, C_t/a_t)$	-0.16	-0.09	0.59	0.59	-0.49	-0.59
$corr(a_t, a_{t-1})$	0.92	0.94	0.92	0.91	0.92	0.92
$corr(C_t, C_{t-1})$	0.99	0.91	0.99	0.92	0.78	0.89
$corr(F_t, F_{t-1})$	0.66	0.90	0.92	0.80	0.76	0.86
$corr((C/a)_t, (C/a)_{t-1})$	0.69	0.96	0.82	0.97	0.80	0.90
$\chi^2(1)$	7.40		6.68		4.14	
$p-value$	0.0065		0.0097		0.0419	

B Data Profiles

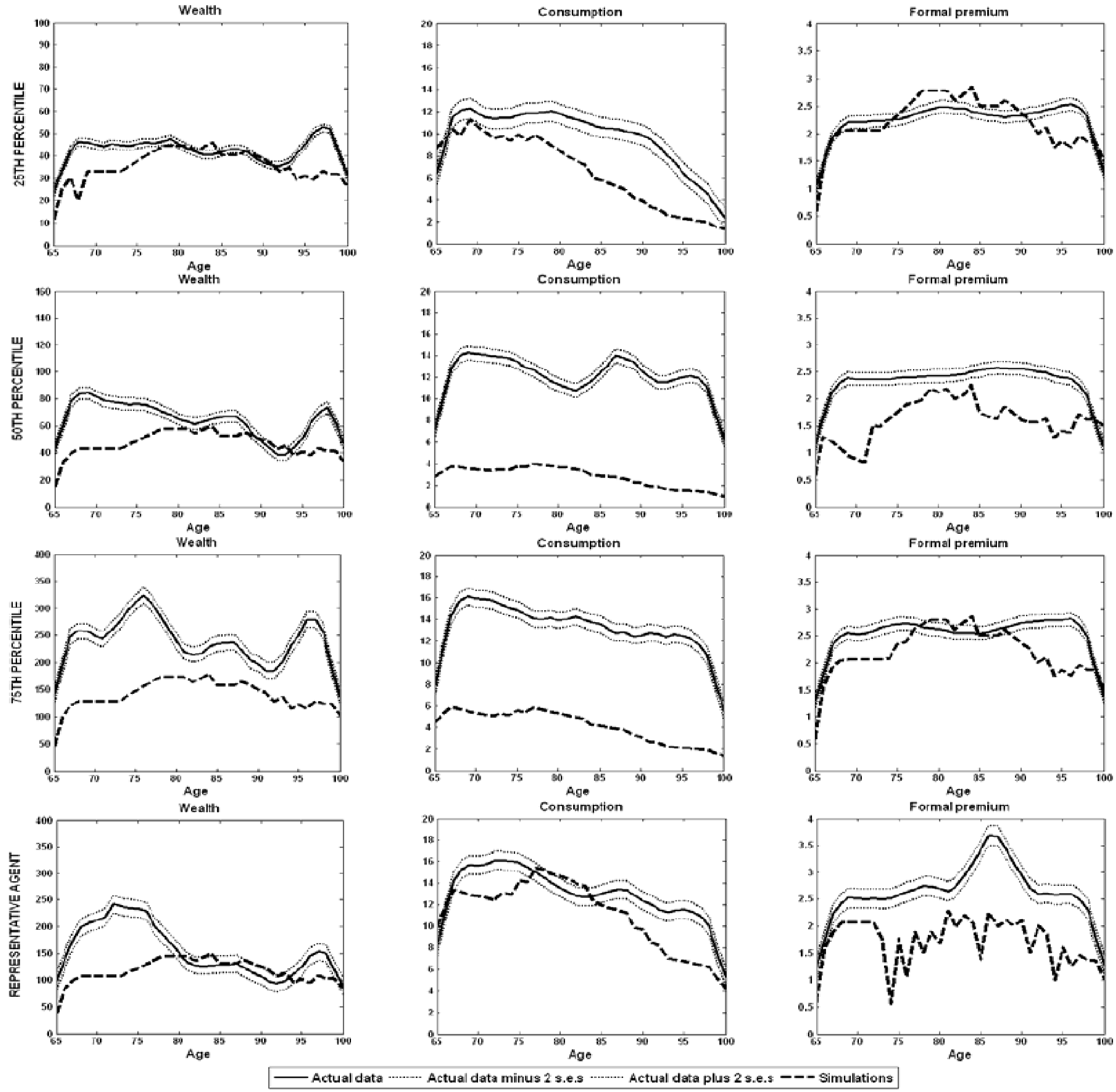

Figure 1. Data Profiles: Mediterranean Countries (2004 Euros, Wealth and Consumption are in thousands, Insurance premiums are in hundreds)

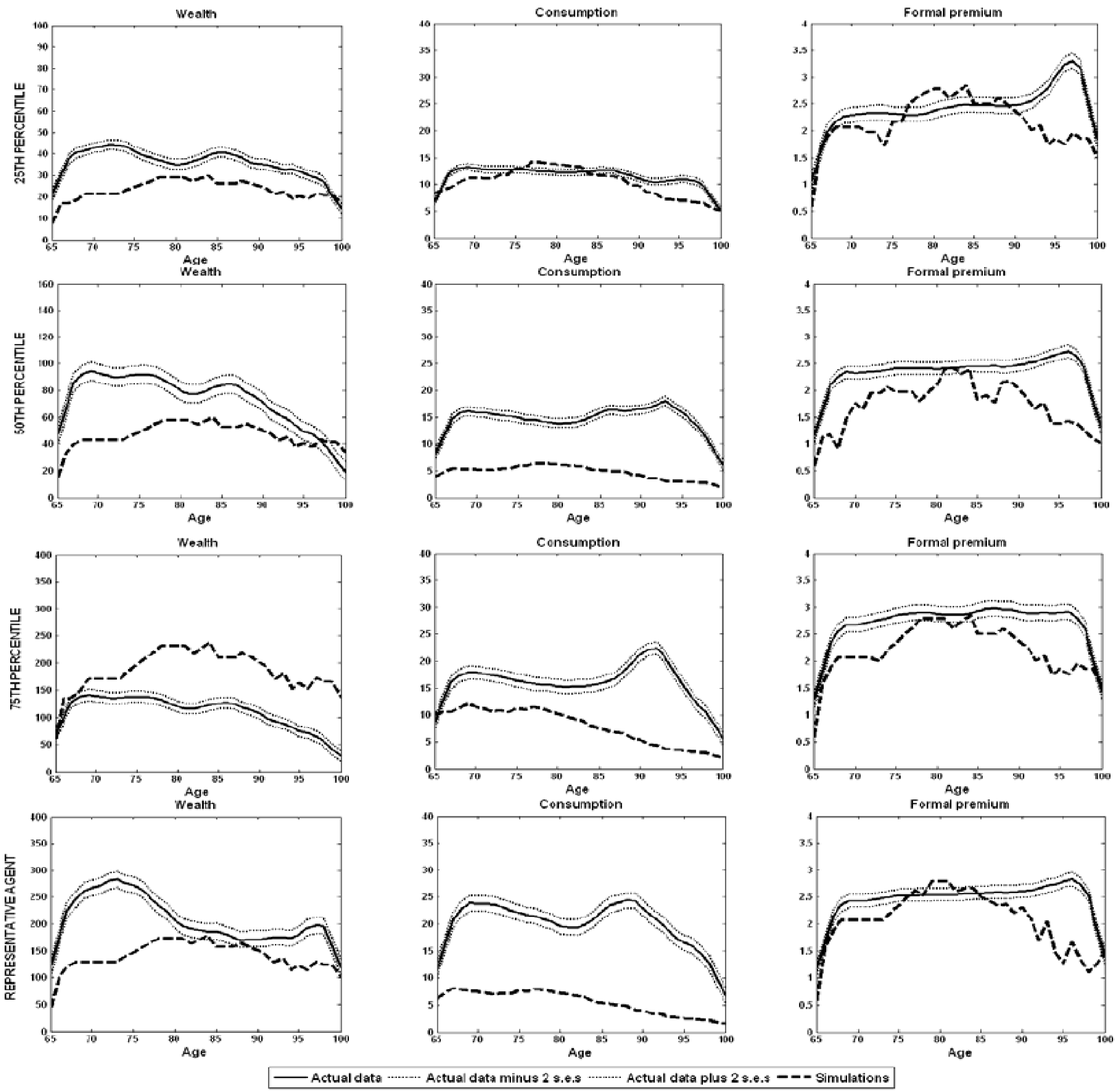

Figure 2. Data Profiles: Central European Countries (2004 Euros, Wealth and Consumption are in thousands, Insurance premiums are in hundreds)

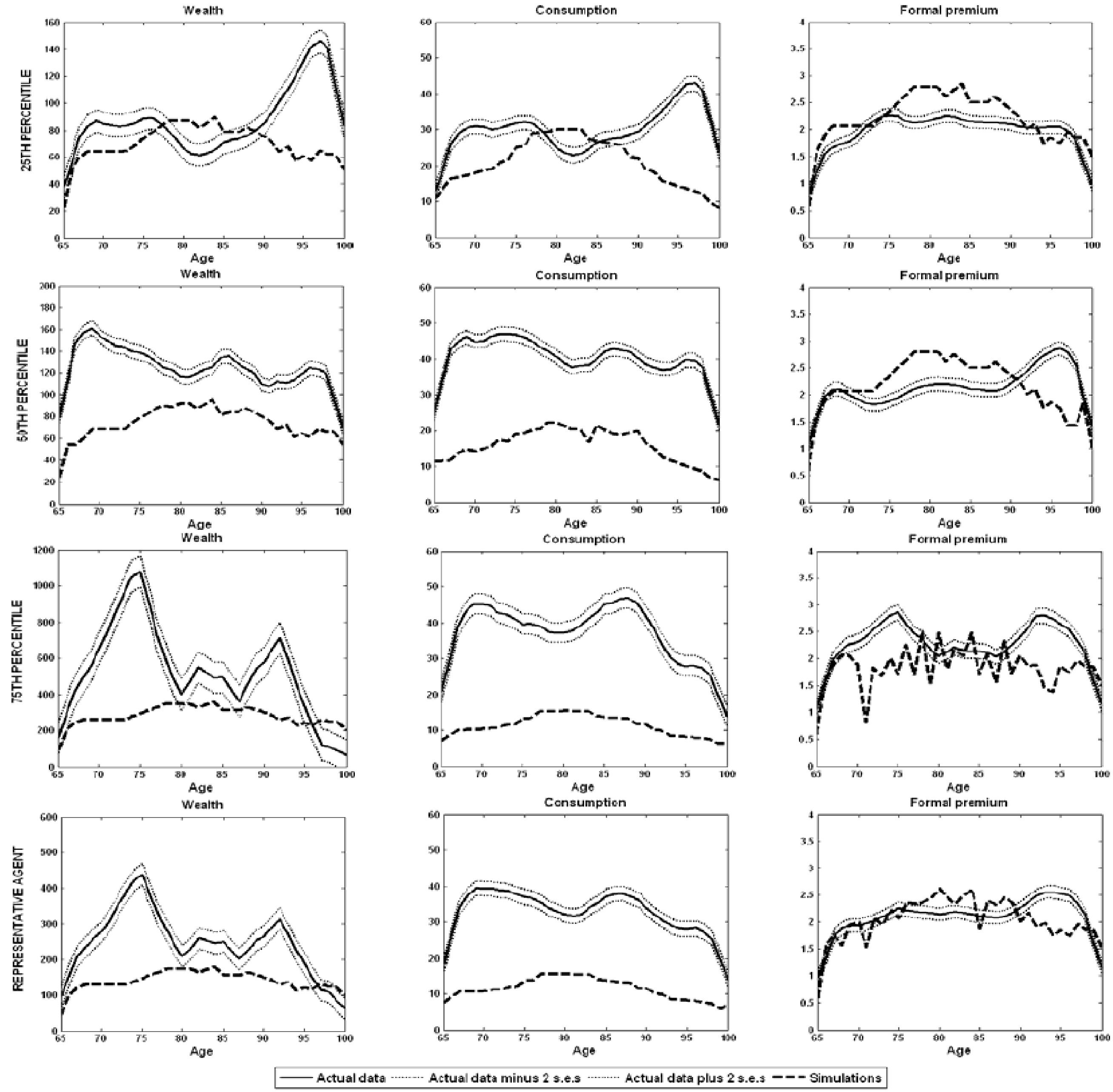

Figure 3. Data Profiles: Scandinavian Countries (2004 Euros, Wealth and Consumption are in thousands, Insurance premiums are in hundreds)

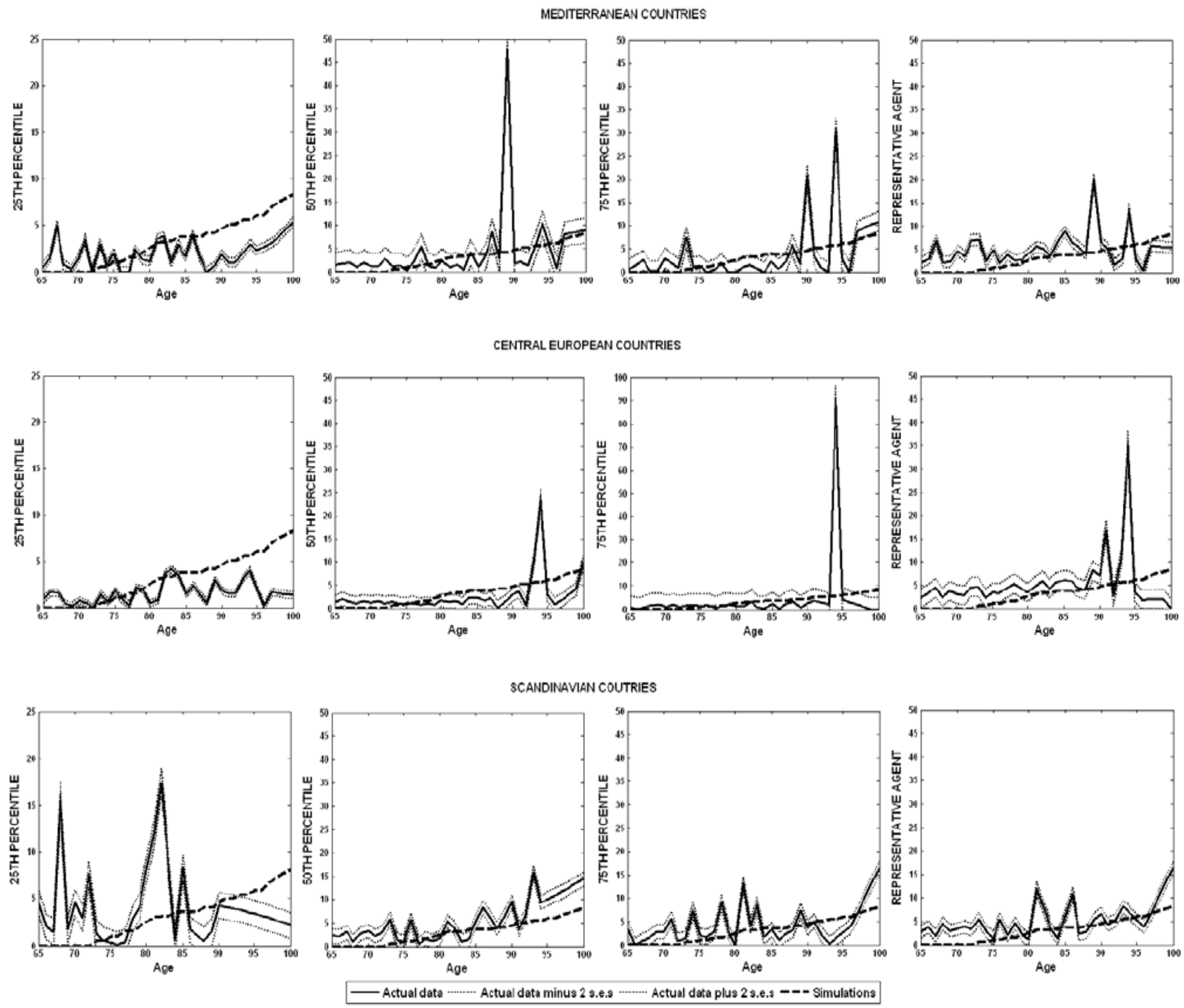

Figure 4. Health Spending Out-of-Pocket (in 2004 hundreds Euros)

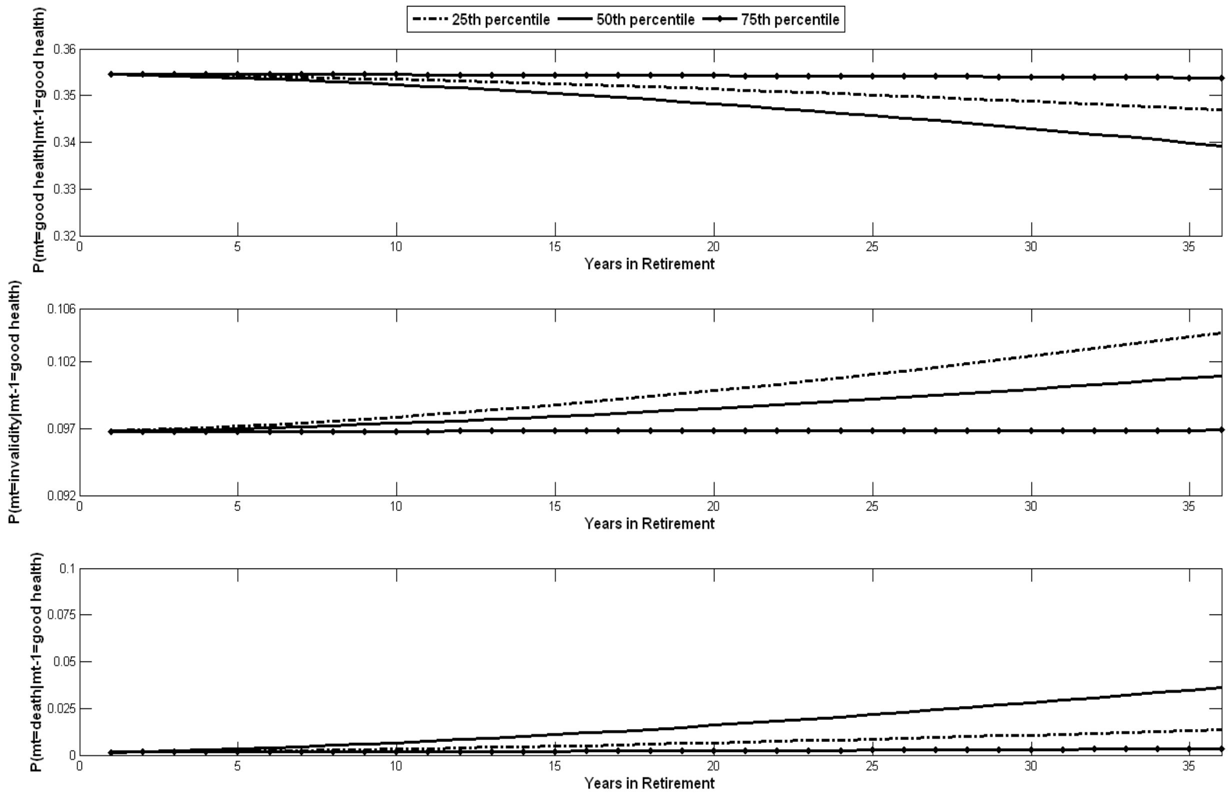

Figure 5: Health Transition Probabilities: Mediterranean Countries

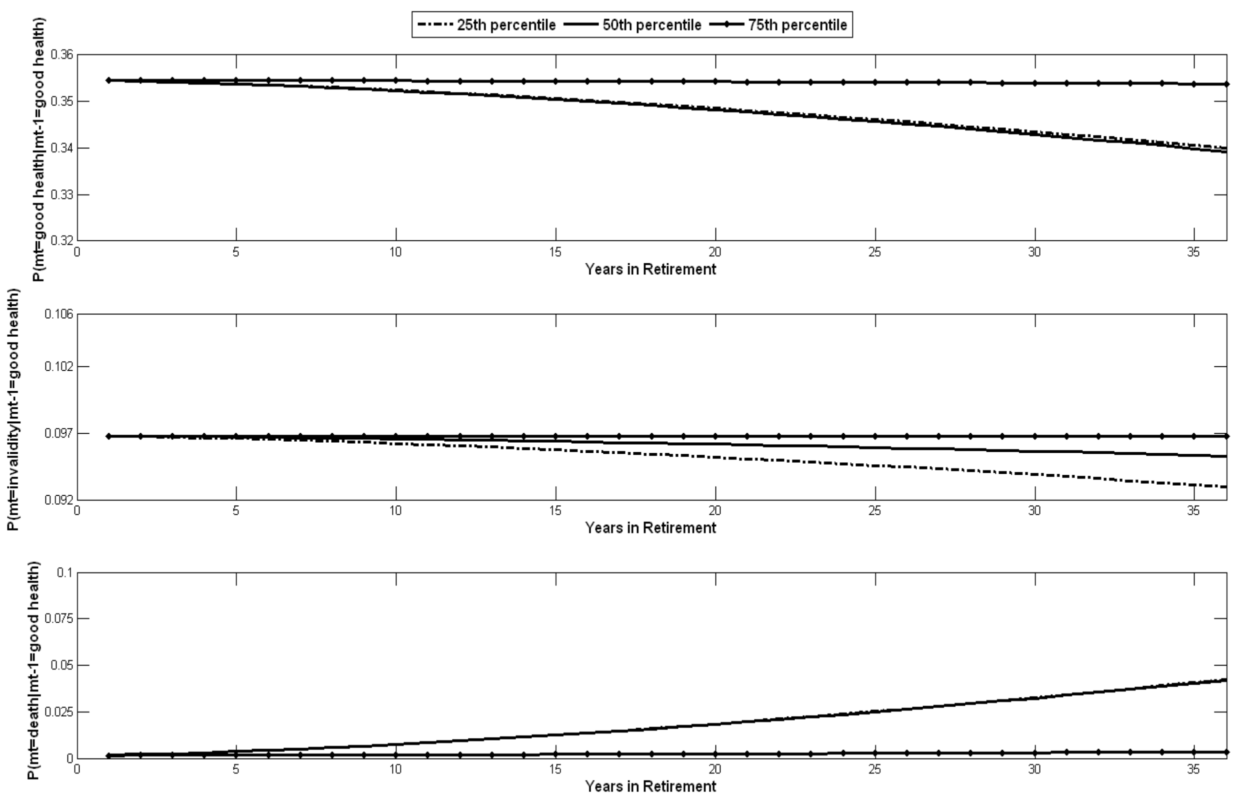

Figure 6: Health Transition Probabilities: Central European Countries

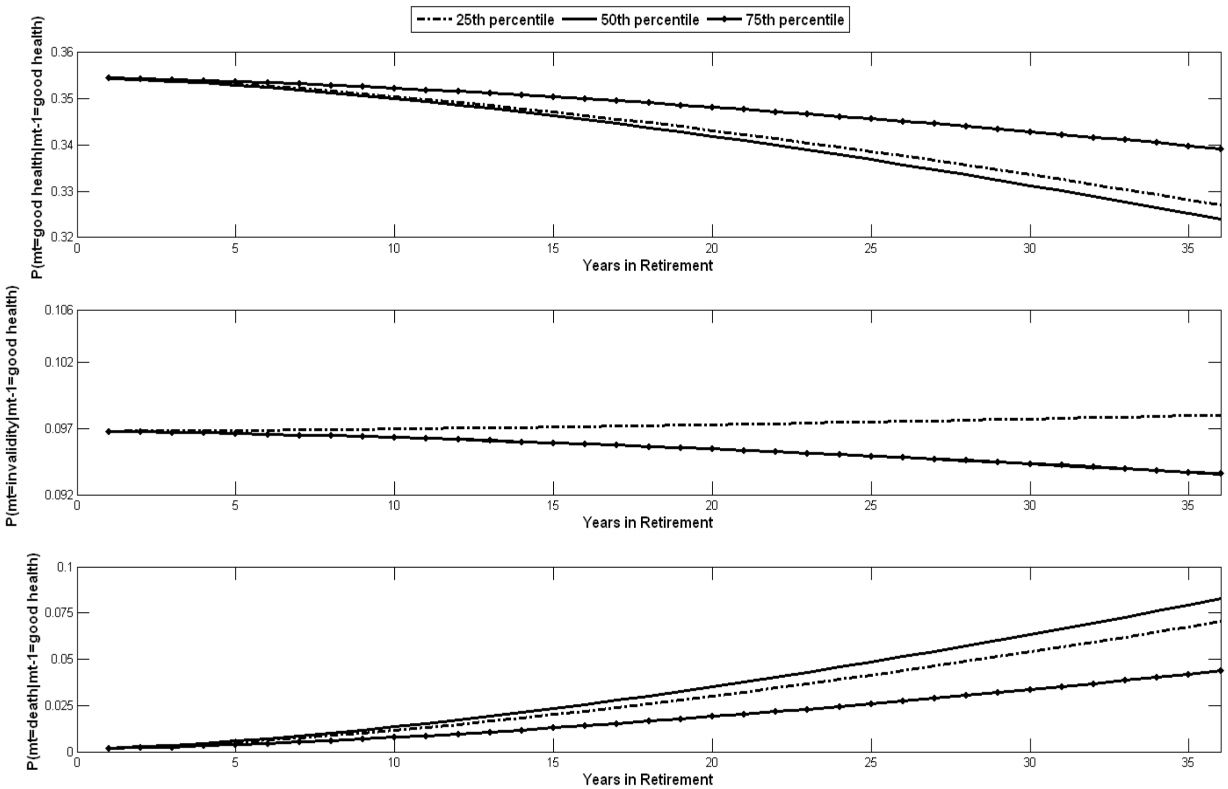

Figure 7: Health Transition Probabilities: Scandinavian Countries

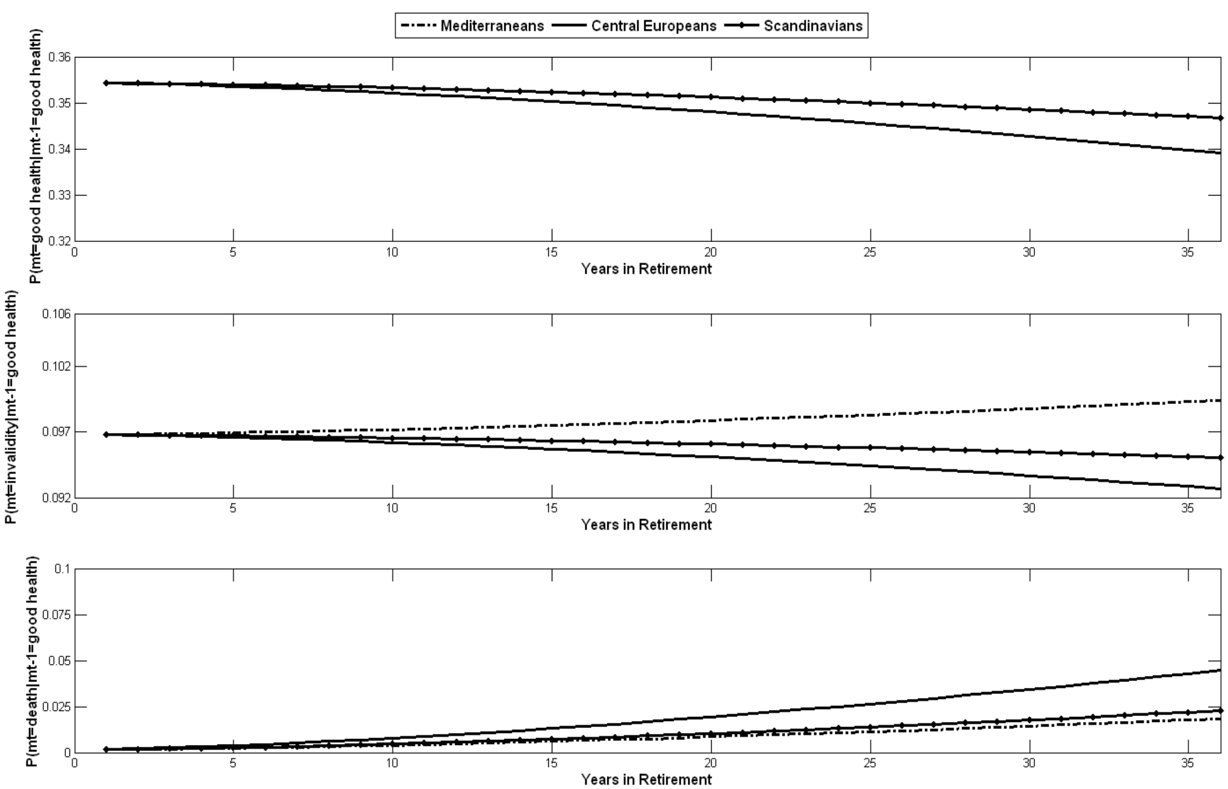

Figure 8: Health Transition for Representative Agent

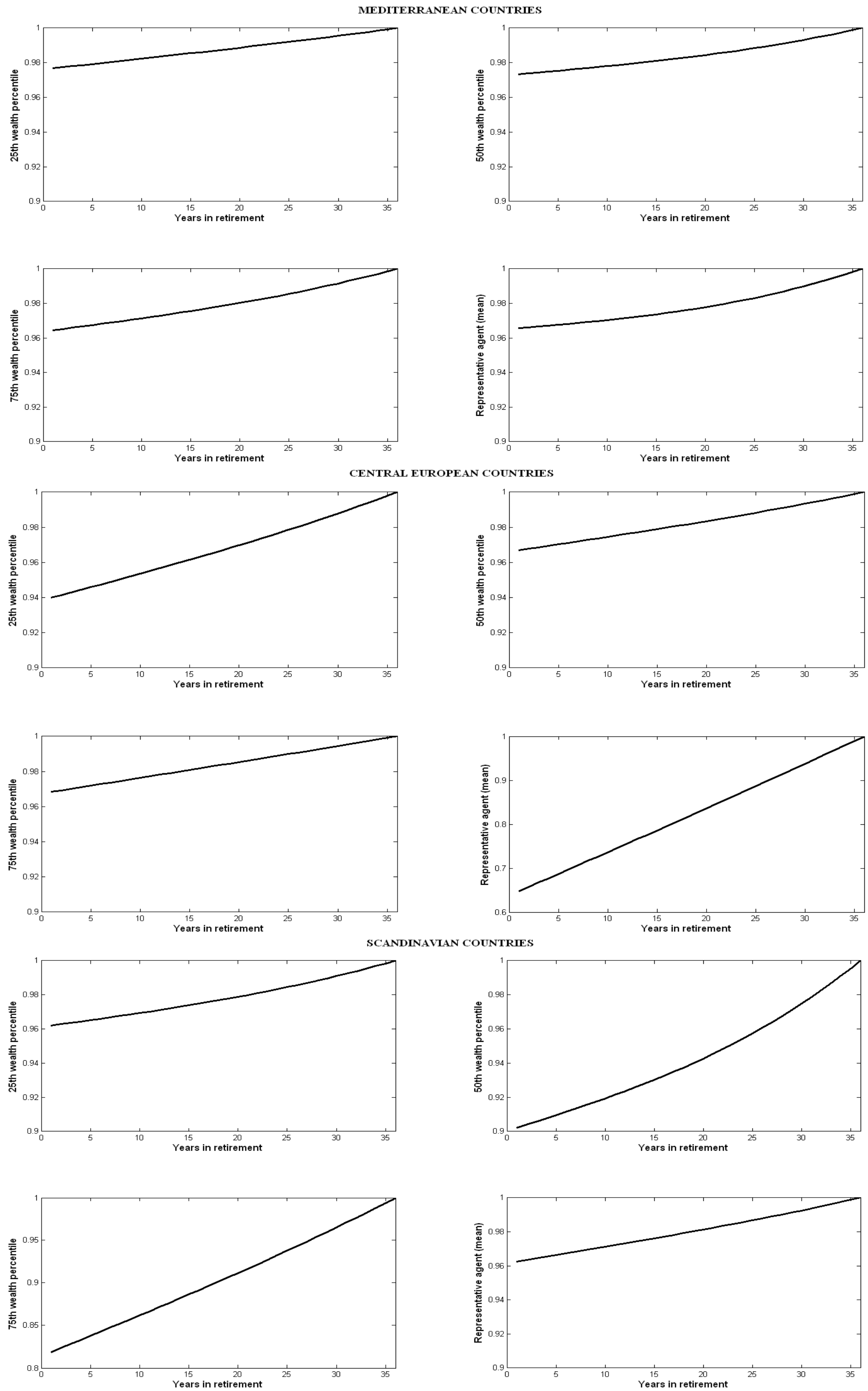

Figure 9: Cohesion Coefficient by Country Group and Wealth Percentile

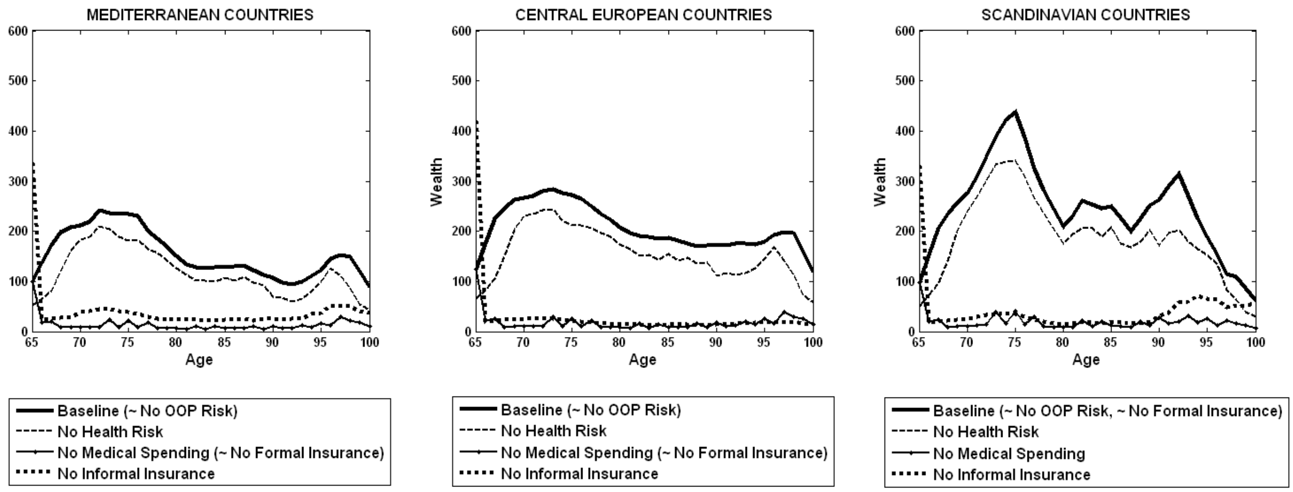

Figure 10: Wealth Profiles: Baseline Model vs. Alternative Scenarios (in 2004 thousands Euros)

C Numerical Simulation

To find the solution, my approach was twofold. First, I discretized wealth, consumption and premium decision space. Experiments with the fineness of the grids suggested that the number of points I selected[56] gave reasonable approximations. Further increasing the number of grid points seemed to have a minimal impact on the results. Second, to capture uncertainty over the stochastic components of medical expenses and health status, I converted m_t and ψ_t into discrete Markov chains and calculated the conditional expectation of V_{t+1} accordingly. I integrated the value function with respect to these stochastic components using a 4-node Gauss-Hermite quadrature for each chain.

I used the backward induction method of dynamic programming to compute value functions and policy functions. In the last period, the decision is trivial, with the agent consuming and leaving bequest all available residual wealth.[57] Here and throughout the paper, I set utility after death at zero. Once the policy rule for C_T was found, the corresponding value function in the last period, V_T, was obtained and used to compute policy rules for the previous period. The decision rules at time $T-1$ were found by solving equation (14) with the V_T defined previously. This iteration was continued backward using Euler equations until $t = 1$.

D Health and Medical Spending Data

The issue of medical costs is central to the analysis presented in this paper, as the aim is to properly account for potentially high costs for curative and rehabilitation and long-term care, when insurance is available. The distribution of these costs is controlled by the one-period 4×4 health state transition matrix $P(t)$ and by the medical spending associated with each health state.

[56]The value function was directly computed at a finite number of points within the wealth, $\{a_t\}_{ia=1}^{50}$, consumption, $\{C_t\}_{ic=1}^{4000}$, and premium, $\{F_{t-1}\}_{f=1}^{10}$, grids.

[57]At time T, the individual does not formally insure for the next period, and so the issue is choosing consumption, by solving (14) under the condition $s_T = 0$ and $f_T = 0$.

The transition matrix for health status is parameterized by twelve elements, nine probabilities that determine the value of $P(1)$[58] and three parameters (c_1, c_2 and c_3), that control the probability of passing from better health to poorer health as t increases. These parameters were estimated through SMM.

For the medical expenditure amounts, the curative and rehabilitation expenditure[59] comprises medical and paramedical services delivered during an episode of curative[60] and/or rehabilitative[61] care. These expenditures are to be incurred if the fair health status ($m_t = 3$) is verified. On the other hand, long-term health care[62] comprises ongoing health and nursing care given to inpatients who need assistance on a continued basis due to chronic impairments and who have a reduced degree of independence and ability to complete activities of daily living. Inpatient long-term care[63] is provided in institutions or in community facilities, and the corresponding expenditures are incurred if the poor health status ($m_t = 2$) is verified.

Based on Ameriks et al. (2005), I used the OECD Health Data Statistics (October 2006) reports for each country, on the 2004 average medical expenses for non-institutionalized and assisted individuals. I set $h(\text{good health}) = 0$ and found that $h(\text{fair health}) > h(\text{good health})$, reproduced these averages. For invalidity, I used Brown and Finkelstein's (2008) approach, which considers the cost of long-term care facility per capita. This approach leaves an annual expense for a full year of long term care at a lower amount than the costs of fair health. Consequently, I took $h(\text{poor health}) < h(\text{fair health})$. I also considered the costs associated with death to be the highest costs, according to the formula used in the OECD calculations[64], and set $h(\text{death}) > h(\text{fair health})$.

In practice, the primary data for funeral costs in the OECD countries analyzed are drawn from the AGIR dataset (Westerhout and Pellikaan 2005, based on EPC 2001) for EU-15 countries and from OECD calculations for 2005.[65] 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, where expenditure data for the oldest group were not available, the cost 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 for which no data were available, the cost of death for the oldest group was estimated by taking three 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 terms of percentage of GDP in 2005 was calibrated to fit the estimates of the OECD Long-term Care study (OECD,

[58] Of the sixteen elements, four are fixed by the death state being un-reversable and there are three further restrictions such that each row sums to one.

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

[60] 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 that could threaten life or normal function.

[61] 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 illness or injury or are recurrent (regression/progression). It includes services delivered to persons for whom the onset of disease or impairment to be treated occurred in the past or has not been subject to prior rehabilitation.

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

[63] 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.

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

[65] 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).

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