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

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Motivation

The problem...

- Ageing society and increasing medical spending.
- People face heterogeneous health shocks and medical spending risks.
- Consumers respond to health shocks in two different ways:
  1. they can directly pay for their health care expenses (self-insure) or
  2. they can rely on health insurance contracts, formal or informal.

... was addressed by:

- Dynamic structural life-cycle model,
- Health risks and uncertain future medical spending,
- Mediterranean (MD), Central European (CE) and Scandinavian (SC).

- *Unit of analysis*: Single individual, who has just retired;
- *Time is discretized*: each period corresponds to one year;
- *First period of observation*: occurs when individual is 65 years old, entering retirement;
- *Last period of observation*: occurs by maximum age 100;
- *Periods* are indexed by t, starting at 1 at age 65, so that overall $1 \leq t \leq T$ and each year there is a survival probability (maximum $T = 36$);
    - *Focus* is on consumption, health insurance and savings decisions and includes bequest motive - emphasizing the potential effects of informal insurance on medical expense and mortality risk.

The Model

Utility function

- The within-period utility function is given by

$$u(m_t, C_t, f_{t-1}, l_t) = \delta(m_t)\frac{C_t^{1-\gamma}-1}{1-\gamma}+$$
$$+\epsilon_t(m_t)\frac{\left[\alpha F_t(f_{t-1})^{\theta}+(1-\alpha)l_t^{\theta}\right]^{\frac{1-\sigma}{\theta}}-1}{1-\sigma}$$

- where

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

and

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

The Model

Formal and Informal Insurance, Distribution parameter

- Formal Insurance,

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

- Informal Insurance,

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

and

$$\eta_t = \beta_0 (1 + \beta_1 * t + \beta_2 * t^2 + \beta_3 * t^3 + \beta_4 * t^4).$$

- Distribution parameter $\alpha(m_t) = a * m_t$, captures the importance of informal care function of health states.

- Health status uncertainty,

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

  - State1=Death,State2=Poor Health (Invalidity), State3 =Fair Health, State4=Good Health;

- Survival uncertainty,

$$(1 - s_t) = \pi_{k1} = \pi(m_t(1)), \textit{where } k \in \{1, 2, 3, 4\}.$$

- 1-period ahead transition matrix at 65+t, with At as age-adjustment matrix,

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

  - with

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

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  - $c_1 \rightarrow$ transition from invalidity to death as age increases;

- 1-period ahead transition matrix at 65+t, with At as age-adjustment matrix,

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  - $c_1 \rightarrow$ transition from invalidity to death as age increases;
  - $c_2 \rightarrow$ how much likely is death wrt invalidity if in fair/good health;

- 1-period ahead transition matrix at 65+t, with At as age-adjustment matrix,

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  - $c_1 \longrightarrow$ transition from invalidity to death as age increases;
  - $c_2 \longrightarrow$ how much likely is death wrt invalidity if in fair/good health;
  - $c_3 \longrightarrow$ how much likely good health state is when in good health.

- Medical expense uncertainty,

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

    - Person-specific effect,

$$\ln\left(\psi_t\right) = \rho_\psi \ln\left(\psi_{t-1}\right) + \varepsilon_t \text{ }, \varepsilon_t \backsim N(0, \sigma^2_{\varepsilon_t}).$$

- Health costs out-of-pocket are considered as residual of total health care costs after deducting formal & informal coverage + a shock.

The Model

Budget Constraint

- Next period's wealth is given by,

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

- and associated borrowing constraint,

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

The Model

Timing...

- *Phase* 0. The household enters period t with health state mt, wealth state at and formal insurance Ft(ft-1) bought the previous period.
- *Phase* 1. At the beginning of the period, the individual receives the pension income and pays the formal insurance premia for the next period.
- *Phase* 2. Then the health shock is realized and
  1. if she is still alive, the medical costs $h_t(m_t(2/3/4))$ are realized, then she consumes and saves, while
  2. if she doesn't survive the next period, funeral costs $h_t(m_t(1))$ are paid and the bequest B_t equals the remaining net resources, down to a minimum of zero,

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

The Data

Survey of Health, Ageing and Retirement in Europe (SHARE), 2004

- cross-national database of data on microeconomic level, for 50+ individuals;
- 11 countries: Scandinavia (Denmark and Sweden), Central Europe (Austria, France, Germany, Switzerland, Belgium, and the Netherlands) and the Mediterranean (Spain, Italy and Greece);

- dataset formed by annual values of voluntary (supplementary) private health insurance, expenditures on non-durables and wealth (financial and real assets +yearly pension), by age and wealth groups (25th, 50th, 75th percentile and mean),
  - noise within each variable smoothing 5 years moving average filter missing observations linear interpolation.

Parameters Estimated,

$$\Delta = (\sigma, \gamma, \theta, a, \rho_{\psi}, \sigma_{\varepsilon_t}, c_1, c_2, c_3, \eta_t(\beta_0, \beta_1, \beta_2, \beta_3, \beta_4))$$

Choice of Moments,

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

Estimation

From the literature/data

Parameter	*Value* :	*Description* :
$1 + r$	1.02	Real risk-free asset return
β	$1.02 - \Delta c * \gamma$	Discount factor
ω	$1/\mathit{loading\ factor}$	Country group - specific administrative cost for the formal insurance plan
m_1	$m(4)$	Initial health status
e	1.5	Parameter in Age-Adjustment Matrix

Results

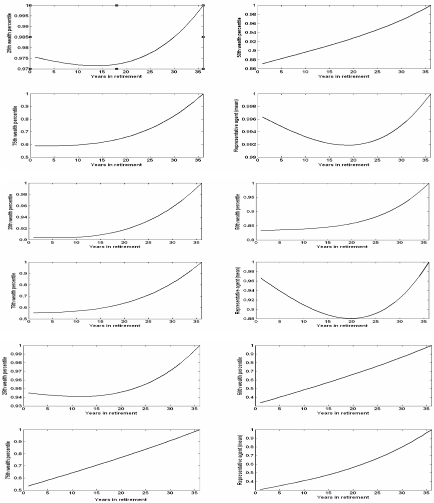
- First, all *parameters estimates* are quite reasonable and make good economic sense.

- Second, *heterogeneity* sources have a significant role in explaining *elderly savings behaviour*.

- Third, elderly *medical expenses* are high and rising fast with age,
  1. more persistent and volatile for the poor than for the rich, and
  2. less persistent for MD than for CE, who in turn are less persistent than SC.

Results

Cohesion Coefficient

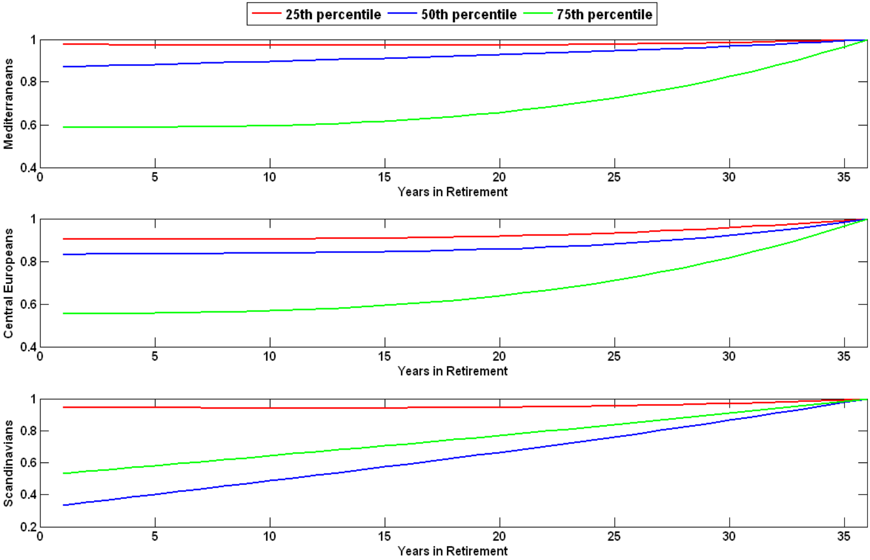


Cohesion Coefficient - generally displays an increasing structure of age and declines with wealth:

- MD countries experience higher cohesion coefficient than CE ones → SC countries,
- Cohesion among poor is higher than among median → rich,
- Exception: poor CE less cohesion than poor SC.

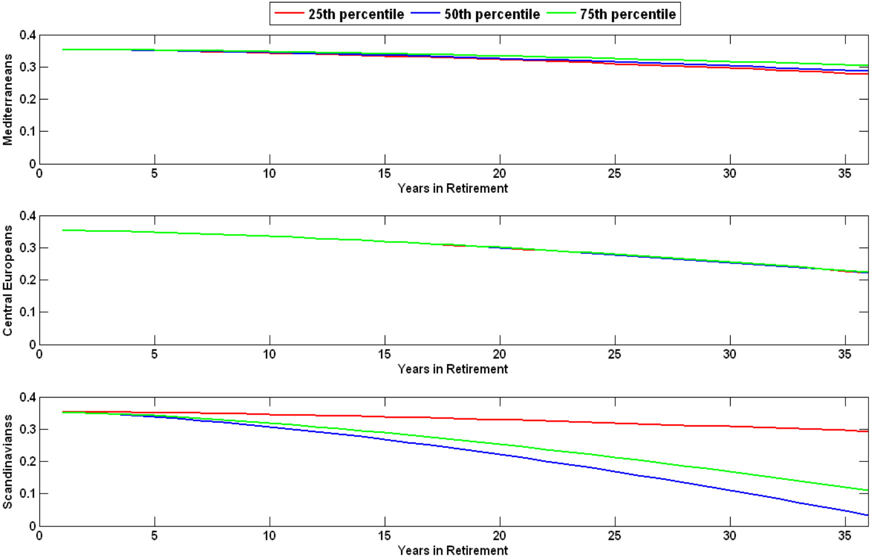
Results

Cohesion Coefficient - Country detail



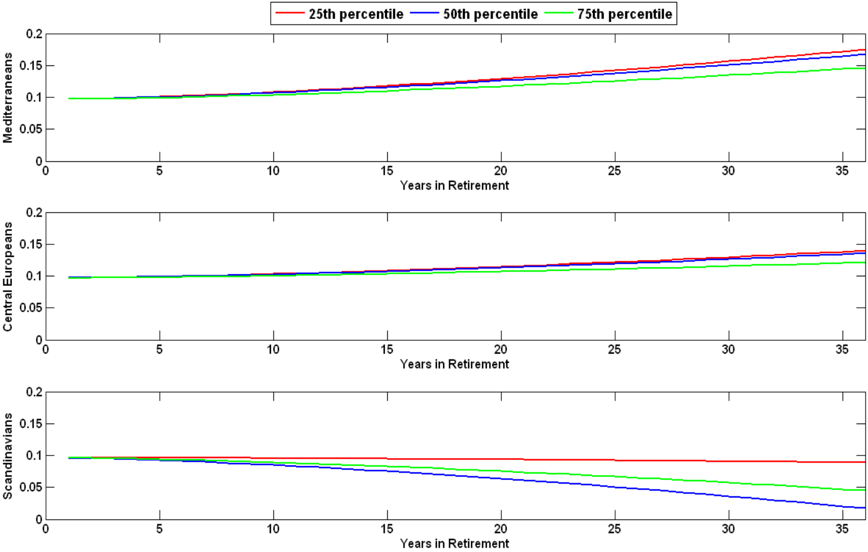
Results

Health transition in time (with age) for good health



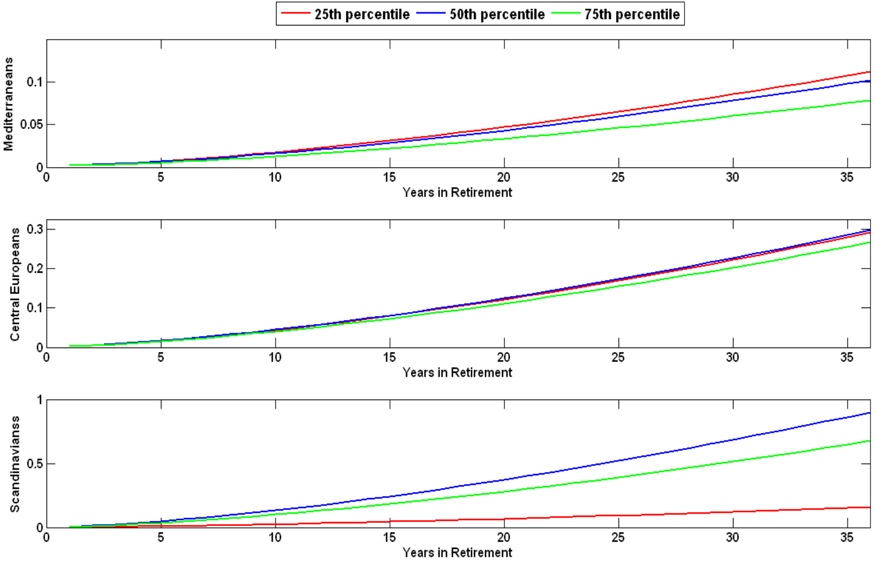
Results

Health transition in time (with age) for poor health (invalidity)



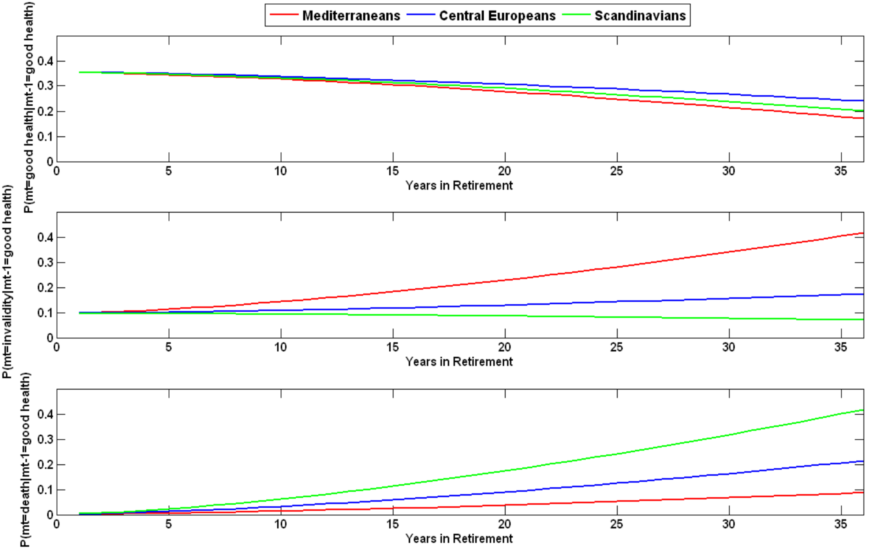
Results

Health transition in time (with age) for death



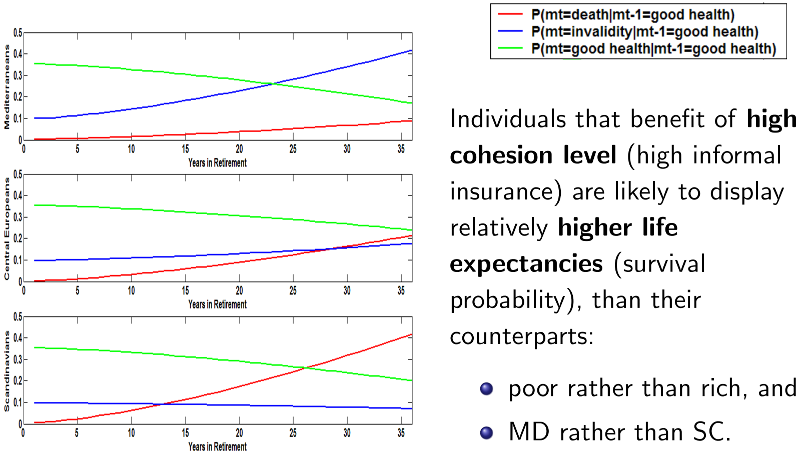
Results

Health transition in time (with age) for representative agent



Results

Health transition in time (with age) for representative agent



Individuals that benefit of **high cohesion level** (high informal insurance) are likely to display relatively **higher life expectancies** (survival probability), than their counterparts:

- poor rather than rich, and
- MD rather than SC.

Conclusion

In order to correctly evaluate any policy reform affecting the elderly saving decisions in Europe, one needs to accurately account for health care spending and country-specific family cohesion, in relation to life expectancy, both by age and wealth.

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

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

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

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

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

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

Using backward recursion, the set of rules was found for

- consumption $C_t(X_t, \phi)$;
- formal insurance benefits $f_t(X_t, \phi)$;
- informal insurance benefits $I_t(X_t, \phi) \longrightarrow$ consumption & formal insurance.
- Inserting these decision rules into the wealth accumulation equation yields next period's wealth, for all the values that compose the grid for formal insurance purchased in the previous period.

Using the optimal values for wealth, the value function is maximized and the optimal value for the formal insurance is found.

- In the last period, the decision is trivial, with agent consuming and leaving bequest all residual available wealth.

SMM minimizes distance between actual & simulated moments

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

where efficient W is the inverse variance-covariance of $[m_T - \frac{1}{N}\sum_{n=1}^{N} m_n(\widetilde{\Delta})]$.

- Simulated moments are conditional on state variables and set of parameters $m_n(X_0, \Delta_0)$.
- Lee & Ingram (1989) show under the null $W = \left[(1+\frac{1}{N})S\right]^{-1}$:
  1. S is VCV of m_T,
  2. N simulated data size, I use $N = 100$.

- Wealth falls for 3/4th of the time path and then raise due to health and medical spending uncertainty => incentive to insure,
- Consumption falls with age monotonically, confirming literature findings on consumption drop after retirement,
- Formal insurance falls with wealth for 3/4th of the time path and continues to fall due to higher value of informal insurance at the end of life.

Health spending for the elderly - high, more:

- persistent for poor and median wealth individuals $\longrightarrow$ rich,
- persistent for poor SC $\longrightarrow$ poor CE $\longrightarrow$ poor MD,
- volatile for poor $\longrightarrow$ median $\longrightarrow$ rich in MD and CE countries,
- volatile for median $\longrightarrow$ poor $\longrightarrow$ rich in SC,
- volatile for poor / median / rich SC $\longrightarrow$ CE $\longrightarrow$ MD.

Risk aversion associated to medical care is high and

- poor are more risk averse than rich,
- SC countries are more risk averse than CE $\longrightarrow$ MD countries (higher health spending risk for SC individuals rather than CE $\longrightarrow$ MD ones),
- Confirm *substitution coefficient* findings that:
  - poor substitute less than rich, and
  - SC less than CE $\longrightarrow$ MD.

Risk aversion associated to consumption is high and

- indicates a tendency to increase with age at any given level of wealth,
- poor are less risk averse than median → rich in CE, SC,
- poor are less risk averse than rich → median in MD,
- SC are more risk averse than CE → MD ones (except for the poor).

Results

Health transition probability matrix

MD countries:

- individuals good health last year, prob. death within one year $\longrightarrow$ **0.2% (65)** to **10.2% (100)**,
- rich people with poor health are less likely to die than poor, and are more likely to maintain or return to good health.

CE countries:

- individuals good health last year, prob. death within one year $\longrightarrow$ **0.3% (65)** to **30% (100)** => more than MD,
- healthy poor CE have 7.50% more chances to die than healthy rich at age 65, but only 9.52% at age 90.

SC countries:

- individuals good health last year, death prob. within one year $\longrightarrow$ **0.6% (65)** to **89.9% (100)** => more than CE and MD,
- healthy 65 years old are as likely to become invalid than CE & MD.