DIFFERENTIAL MORTALITY, UNCERTAIN MEDICAL EXPENSES, AND THE SAVING OF ELDERLY SINGLES

Mariacristina De Nardi
Federal Reserve Bank of Chicago, NBER, and University of Minnesota

Eric French
Federal Reserve Bank of Chicago

John Bailey Jones
University at Albany, SUNY

May 10, 2006
What we do

- Formulate and estimate a structural model of savings after retirement allowing for heterogeneity in
  - life expectancy
  - medical expenses
What are we trying to understand?

Median Assets by Birth Cohort and Income Quintile: Data
Figure 1: AHEAD data
Why our model?

Data show considerable heterogeneity in
- life expectancy
- medical expenses

by:
- Sex
- Permanent income
- Health
Heterogeneity implications

- For saving behavior
Heterogeneity implications

- For saving behavior
  - Differential mortality ⇒ heterogenous saving rates, with high PI people and women saving more.
Heterogeneity implications

For saving behavior

- Differential mortality $\Rightarrow$ heterogenous saving rates, with high PI people and women saving more.
- Medical expenses rise quickly with age $\Rightarrow$ keep assets for old age.
Heterogeneity implications

For saving behavior

- Differential mortality ⇒ heterogenous saving rates, with high PI people and women saving more.
- Medical expenses rise quickly with age ⇒ keep assets for old age.
- Medical expenses rising with PI ⇒ high PI people save at higher rate.
Heterogeneity implications

- For saving behavior
  - Differential mortality $\Rightarrow$ heterogenous saving rates, with high PI people and women saving more.
  - Medical expenses rise quickly with age $\Rightarrow$ keep assets for old age.
  - Medical expenses rising with PI $\Rightarrow$ high PI people save at higher rate.

- For observed sample
  - mortality bias
Figure 2: Median assets by birth cohort, AHEAD data
How we do it
How we do it

First step: estimate mortality and medical expenses as a function of age, sex, health and permanent income.
How we do it

First step: estimate mortality and medical expenses as a function of age, sex, health and permanent income.

Second step: use first step results to estimate our model with method of simulated moments.
Contributions

- Estimate medical expenses using better data and more flexible functional forms.
- Medical expenses rise quickly with age and PI.
Contributions

- Estimate medical expenses using better data and more flexible functional forms.
  - Medical expenses rise quickly with age and PI.
- Estimate mortality probabilities by age, sex, permanent income, and health.
  - Variation is large.
Contributions

- Estimate medical expenses using better data and more flexible functional forms.
  - Medical expenses rise quickly with age and PI.
- Estimate mortality probabilities by age, sex, permanent income, and health.
  - Variation is large.
- Construct and estimate a rich model of saving.
  - Reasonable parameter estimates
  - Model fits the data extremely well.
Contributions

- Estimate medical expenses using better data and more flexible functional forms.
  - Medical expenses rise quickly with age and PI.
- Estimate mortality probabilities by age, sex, permanent income, and health.
  - Variation is large.
- Construct and estimate a rich model of saving.
  - Reasonable parameter estimates
  - Model fits the data extremely well.
- Find that medical expenses and social insurance are key to understanding the elderly’s savings.
Related Literature (Subset)

- **Gourinchas and Parker (2001), Cagetti (2003):** Saving prior to retirement $\Rightarrow$ mortality not a big issue, also lack medical expense risk.
- **Hurd (1989, 1999):** Only risk is uncertain mortality.
- **Palumbo (1999):** Considers medical expense risk, not differential mortality.
Model

- **Singles only**, abstract from spousal survival.
- **Households** maximize total expected lifetime utility.
- **Flow utility** from consumption (CRRA). Utility can vary with health.
- **Rational expectations**. Beliefs about mortality rates, health cost distribution, etc., are estimated from the data.
- **No bequest motive**
Uncertainty
Uncertainty

- **Health status uncertainty:** Health status follows age-, gender- and permanent-income-specific Markov chain.
- **Survival uncertainty:** Mortality rates depend on gender, age, health status, and permanent income.
Uncertainty

- **Health status uncertainty**: Health status follows age-, gender- and permanent-income-specific Markov chain.

- **Survival uncertainty**: Mortality rates depend on gender, age, health status, and permanent income.

- **Medical expense uncertainty**:
  - Persistent and transitory shocks
  - Distributions shift with age, gender, health status and permanent income.
Constraints

- **Budget constraint:**
  \[ a_{t+1} = a_t + y(r_t a_t + y_t, \tau) + tr_t - hc_t - c_t \]
  \[ = x_t - c_t. \]

  \( y(.) = \) post-tax income; \( y_t = \) “non-interest” income;
  \( tr_t = \) government transfers; \( hc_t = \) medical expenses;
  \( x_t = \) “cash-on-hand”.

- **Transfers support a consumption floor:**
  \[ x_t \geq c_{\text{min}}. \]

- **Borrowing constraint:**
  \[ a_{t+1} \geq 0 \iff c_t \leq x_t. \]
Recursive Formulation

\[ V_t(x_t, g, I, m_t, \zeta_t) = \max_{c_{t,x_{t+1}}} \left\{ \begin{array}{c} [1 + \delta m_t] \frac{c_{t}^{1-\nu}}{1 - \nu} + \\ \beta s_{g,m,I,t} \mathbb{E}_t \left( V_{t+1}(x_{t+1}, g, I, m_{t+1}, \zeta_{t+1}) \right) \end{array} \right\} \]

- \( m_t \) = health status (0 ⇒ bad, 1 ⇒ good)
- \( g \) = gender
- \( I \) = permanent income
- \( x_t \) = cash-on-hand
- \( \zeta_t \) = persistent health cost shock
\[ x_{t+1} = \max \{x_t - c_t + y(r(x_t - c_t) + y_{t+1}, \tau) - hc_{t+1}, c_{\min}\}, \]

\[ y_{t+1} = y(g, I, t + 1), \]

\[ x_t \geq c_{\min}, \]

\[ c_t \leq x_t, \]

\[ \ln(hc_{t+1}) = hc(g, m_{I,t+1}, t + 1, I) + \sigma(g, m_{I,t+1}, I, t + 1)\psi_{t+1}, \]

\[ \psi_{t+1} = \zeta_{t+1} + \xi_{t+1}. \]
Method of Simulated Moments

Our approach: Match median assets by permanent income quintile, cohort and age.
Method of Simulated Moments

**Our approach:** Match median assets by permanent income quintile, cohort and age.

Consider HH$_i$ of birth cohort $c$ in calendar year $t$, belonging to the $q$th permanent income quintile.
Method of Simulated Moments

Our approach: Match median assets by permanent income quintile, cohort and age.

Consider HH $i$ of birth cohort $c$ in calendar year $t$, belonging to the $q$th permanent income quintile.

Let $a_{qct}$ denote the model-predicted median asset level.
Method of Simulated Moments

Our approach: Match median assets by permanent income quintile, cohort and age.

Consider $HH_i$ of birth cohort $c$ in calendar year $t$, belonging to the $q$th permanent income quintile.

Let $a_{qct}$ denote the model-predicted median asset level.

Moment condition for GMM criterion function:

$$E \left( I \{a_{it} \leq a_{qct} \} - 1/2 | q, c, t, hh alive at t \right) = 0.$$
Econometric Problem 1: Cohort Effects

- Older HHs are born in earlier years and have lower lifetime incomes ⇒ understate asset growth and saving.
- Our solution: Cohort- and permanent income-specific moments
Econometric Problem 2: Mortality Bias

- Sample composition changes (High PI people live longer)

- Our solution: Allow mortality rates to depend on permanent income and gender.
AHEAD Data

- Household heads aged 70 or older in 1993
- Consider only the retired
- Asset data begins in 1995 (1993 asset data faulty), uses 2,793 individuals
- Use full, unbalanced panel
Results from first step estimation
Figure 3: Average medical expenses, AHEAD data
<table>
<thead>
<tr>
<th>Income Percentile</th>
<th>Healthy Male</th>
<th>Unhealthy Male</th>
<th>Healthy Female</th>
<th>Unhealthy Female</th>
<th>All</th>
</tr>
</thead>
<tbody>
<tr>
<td>20</td>
<td>8.2</td>
<td>6.2</td>
<td>13.8</td>
<td>11.9</td>
<td>12.0</td>
</tr>
<tr>
<td>40</td>
<td>9.1</td>
<td>7.0</td>
<td>14.8</td>
<td>12.9</td>
<td>13.0</td>
</tr>
<tr>
<td>60</td>
<td>10.1</td>
<td>7.9</td>
<td>15.9</td>
<td>14.1</td>
<td>14.1</td>
</tr>
<tr>
<td>80</td>
<td>11.2</td>
<td>9.1</td>
<td>17.0</td>
<td>15.5</td>
<td>15.2</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Gender</th>
<th>Life Expectancy</th>
</tr>
</thead>
<tbody>
<tr>
<td>Men</td>
<td>10.2</td>
</tr>
<tr>
<td>Women</td>
<td>15.0</td>
</tr>
<tr>
<td>Healthy</td>
<td>15.3</td>
</tr>
<tr>
<td>Unhealthy</td>
<td>11.9</td>
</tr>
</tbody>
</table>

**Table 1: Life expectancy at age 70**
Figure 4: Mortality probabilities, AHEAD data
Results from second step estimation
Table: Estimated structural parameters

<table>
<thead>
<tr>
<th>Parameter</th>
<th>Baseline (1)</th>
<th>$\delta = 0$ (2)</th>
<th>$c_{min} = 5K$ (3)</th>
</tr>
</thead>
<tbody>
<tr>
<td>$\nu$: coeff. relative risk aversion</td>
<td>4.15</td>
<td>4.35</td>
<td>6.951</td>
</tr>
<tr>
<td></td>
<td>(0.90)</td>
<td>(1.03)</td>
<td>(1.73)</td>
</tr>
<tr>
<td>$\beta$: discount factor</td>
<td>0.976</td>
<td>.948</td>
<td>0.950</td>
</tr>
<tr>
<td></td>
<td>(0.07)</td>
<td>(0.08)</td>
<td>(0.09)</td>
</tr>
<tr>
<td>$\delta$: pref. shifter, bad health</td>
<td>-0.228</td>
<td>0.0</td>
<td>-0.251</td>
</tr>
<tr>
<td></td>
<td>(0.21)</td>
<td>–</td>
<td>(0.18)</td>
</tr>
<tr>
<td>$c_{min}$: consumption floor</td>
<td>2904</td>
<td>2661</td>
<td>5000</td>
</tr>
<tr>
<td></td>
<td>(319)</td>
<td>(468)</td>
<td>–</td>
</tr>
</tbody>
</table>
Figure 5: Median assets by cohort and PI quintile: data and benchmark model
**Mortality Bias**

**Figure 6:** Left panel → AHEAD data; right panel → benchmark model
Findings from estimated structural model

- Fix preference parameters at baseline estimates, vary other parameters.
- Lowering the consumption floor to $500 has a big effect on savings, even for the rich.
- Eliminating medical expense risk has small effects.
- Eliminating out-of-pocket medical expenditures has big effects.
- Life expectancy matters.
Figure 7: Benchmark and model with a $500 consumption floor
**Figure 8:** Benchmark and model with no medical expenditure risk
Figure 9: Benchmark and model with no medical expenditures
**Figure 10:** Benchmark and model in which everyone has the life expectancy of a healthy woman at the top 20% PI
Conclusions

- Medical expenses important.
Conclusions

- Medical expenses important.
- Consumption floor important.
Conclusions

- Medical expenses important.
- Consumption floor important.
- To correctly evaluate any policy reform affecting the elderly’s saving decisions, need to model both the consumption floor and the way in which medical expenditures by age and PI.
Figure 11: Average income
Figure 12: Health transition probabilities
Figure 13: Median consumption by cohort and PI quintile: benchmark model