Health and Business Workshop

30 November 2017, UNSW Sydney

Modelling Health Status and

Long Term Care Insurance

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Coverage

Projects
Focus is Post Retirement and Older Ages

• Health Status and Retirement Income Streams – Life Annuities, Pooled Annuities

• Long Term Care Insurance – Modelling Functional Disability Risks, LTCI Product design, Insurer Pricing and Capital

• Housing and Long Term Care Insurance – Individual retirement Financing, Reverse Mortgages, Life annuities

Industry Partners and Collaborators
Health Status and Retirement Income Streams – Life Annuities, Pooled Annuities

Models for health status and mortality heterogeneity and implications for retirement income stream products

• Frailty and Markov Ageing Models – calibration to population mortality data

• Markov ageing models calibrated to cross sectional health status data and longitudinal population mortality data – applied to annuity pricing, adverse selection and tail risks of life insurers

• GLMM for health risk factors using individual level HRS data – pricing underwritten life annuities, risks and capital requirements for life insurers

• Mortality heterogeneity and health status and impact on mutual risk pooling products – GSA’s, pooled annuities – equitable methods of determining annuity payments
Frailty and Markov Physiological Ageing Models

Life insurers “select” lives using underwriting allowing for heterogeneity in individual mortality

Frailty Model – 1945 Australian Male Cohort with varying levels of frailty

Markov Physiological Age Model – Distribution of Physiological Ages for a 65 year old Australian male


Source: Shu and Sherris (2010)
Life Annuity Portfolio Mix

Writing a portfolio representative of the population – less profitable and more risky

Mixed

Best Health Only

Markov ageing model

Le Bras model – lower mean and less volatility

Models of Mortality Heterogeneity – Annuity Pricing allowing for Risk Factors

\[
q_{it} = E(Y_{it}|X_{it}) = 1 - e^{\exp(-\exp(X_{it}\beta + b_i))}
\]

GLMM can allow for both underwriting risk factors and residual variability (frailty)

Heterogeneity still significant after underwriting

Insurer can adjust annuity prices by pricing using adjusted mortality reflecting risk profiles and a frailty factor


<table>
<thead>
<tr>
<th>Education</th>
<th>Low risk</th>
<th>Avg risk</th>
<th>High risk</th>
</tr>
</thead>
<tbody>
<tr>
<td>College or above</td>
<td>HS or some college</td>
<td>No completed HS</td>
<td></td>
</tr>
<tr>
<td>Partnered</td>
<td>Yes</td>
<td>Yes</td>
<td>No</td>
</tr>
<tr>
<td>BMI</td>
<td>Normal</td>
<td>Overweight</td>
<td>Underweight</td>
</tr>
<tr>
<td>Smoker</td>
<td>Never</td>
<td>Before, not currently</td>
<td>Before and currently</td>
</tr>
<tr>
<td>Medical conditions</td>
<td>None</td>
<td>High BP</td>
<td>High BP and Diabetes</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Frailty - 50%</th>
<th>Baseline Standard</th>
<th>Low</th>
<th>Average</th>
<th>High</th>
</tr>
</thead>
<tbody>
<tr>
<td>GLM</td>
<td>12.33</td>
<td>18.57</td>
<td>17.29</td>
<td>4.20</td>
</tr>
<tr>
<td>Frailty - 50%</td>
<td>12.28</td>
<td>18.66</td>
<td>17.03</td>
<td>3.57</td>
</tr>
<tr>
<td>Frailty - 75%</td>
<td>15.95</td>
<td>19.92</td>
<td>19.15</td>
<td>6.75</td>
</tr>
<tr>
<td>Frailty - 85%</td>
<td>17.54</td>
<td>20.25</td>
<td>19.78</td>
<td>8.85</td>
</tr>
<tr>
<td>Frailty - 95%</td>
<td>19.36</td>
<td>20.54</td>
<td>20.34</td>
<td>12.55</td>
</tr>
<tr>
<td>Frailty - 99.5%</td>
<td>20.44</td>
<td>20.68</td>
<td>20.63</td>
<td>17.33</td>
</tr>
</tbody>
</table>
Long Term Care Insurance – Modelling Functional Disability Risks, LTCI Product design, Insurer Pricing and Capital

Models for functional disability, LTC insurance products

- Multiple state models for functional disability and mortality - calibrated to HRS data
- Incorporating systematic trends and uncertainty into multiple state models and implications for healthy life expectancy – calibrated using HRS data
- International comparison of functional disability and long term trends in disability
- LTC product design, pricing and capital
- Models and product innovations using Australian individual data
Multi-State Life Tables for Functional Disability

Disability & recovery transition
Intensities – Males on left, Females on right

U.S. HRS (Health and Retirement Study) data:
- Rates of becoming LTC disabled are significantly higher for women than men.
- Force of disability > mortality hazard for females of all ages.
- Distinct age patterns of recovery.
- Used to produce life tables by health state

Multi-State Life Tables for Functional Disability

Mortality transition Intensities –
Males on left and Females on right

(a) Nondisabled to Dead, $\mu$

US Mortality rates from
HRS data
Higher male mortality
Higher disabled mortality

(b) Disabled to Dead, $\nu$

Multi-State Life Tables for Functional Disability

Male transition rates by age – HRS data

Female transition rates by age – HRS data

Functional Disability Life Table and LTC Insurance

- Disability (functional) free life expectancy
- Estimated from HRS data

<table>
<thead>
<tr>
<th>Demographic Characteristics</th>
<th>Males</th>
<th>Females</th>
</tr>
</thead>
<tbody>
<tr>
<td>Mean years of life after age 65</td>
<td>16.33</td>
<td>19.43</td>
</tr>
<tr>
<td>Mean years with mild disability</td>
<td>1.78</td>
<td>2.80</td>
</tr>
<tr>
<td>Mean years with severe disability</td>
<td>0.89</td>
<td>1.68</td>
</tr>
<tr>
<td>Share with disability</td>
<td>56.43%</td>
<td>72.70%</td>
</tr>
<tr>
<td>Share with mild disability</td>
<td>47.89%</td>
<td>63.37%</td>
</tr>
<tr>
<td>Share with severe disability</td>
<td>26.82%</td>
<td>42.39%</td>
</tr>
<tr>
<td>Average age of first disability, conditional on becoming disabled</td>
<td>76.23</td>
<td>76.52</td>
</tr>
<tr>
<td>Average age of first mild disability, conditional on becoming mildly disabled</td>
<td>75.83</td>
<td>76.38</td>
</tr>
<tr>
<td>Average age of first severe disability, conditional on becoming severely disabled</td>
<td>80.51</td>
<td>81.70</td>
</tr>
</tbody>
</table>

LTC Insurance Liabilities and Capital

Distribution of Functional Disability including Trends and Uncertainty

FIGURE 7  Simulated Proportion of Disabled Individuals for x = 50, 65.
Housing and Long Term Care Insurance – Individual Retirement Financing, Reverse Mortgages, Life annuities

Individual retirement planning incorporating life annuities, long term care insurance and housing

• Long term care insurance impact on demand for life annuities, role of reverse mortgages in unlocking illiquid housing equity
• Bequest motive reduces demand for life annuities but what about impact of bequest on long term care insurance demand?
• To what extent does housing crowd out demand for long term care insurance?
• Impact of lack of liquidity, asset rich cash flow poor retirees because of house equity, on demand for annuities and long term care insurance? Role for reverse mortgages?
• Product innovations – combining reverse mortgage with LTCI, combining life annuity with LTCI
LTC Insurance and Reverse Mortgages

Demand for reverse mortgages in presence of illiquid housing and LTCI

Figure 6. Optimal consumption paths for the 65-year-old female in different health states. It is assumed that the retiree is endowed with $300k liquid wealth and a house worth $150k at retirement and has no access to either reverse mortgage or LTC insurance.

Figure 7. Consumption Equivalent Variation (CEV) for a 65-year-old female endowed with $300k liquid wealth and home equity $150k. The black point indicates the optimal LTVR-PI combination that yields the highest level of CEV.

LTC Insurance and Reverse Mortgages

Figure 8. Average optimal consumption and wealth paths for a 65-year-old female with $300k initial liquid wealth and a house worth $150k.

Figure 11. Average optimal consumption paths, liquid wealth and bequest wealth for Scenario 3.1 for a 65-year-old female with $900k total wealth at retirement ($300k liquid wealth and $600k home equity). The top panel shows the optimal consumption paths, the middle panel the liquid wealth paths and the bottom panel the bequest wealth paths.

LTC Insurance and Demand for Life Annuities


| Wealth ($000) | Single product | | | | | Both products | | | | |
|--------------|----------------|------------------|----------------|------------------|----------------|-------------------|----------------|----------------|----------------|
|              | Total | Liquid | Housing | Annuity only | % Liquid | % Total | LTGI only | Annuity only | % Liquid | % Total | LTGI |
| 250          | 250   | 0      | 0       | 0.26         | 0.26     | 0.00   | 0.50     | 0.50         | 0.98   |
| 250          | 180   | 70     | 0       | 0.35         | 0.25     | 1.00   | 0.48     | 0.35         | 0.98   |
| 250          | 110   | 140    | 0       | 0.00         | 0.00     | 1.00   | 0.13     | 0.06         | 1.00   |
| 250          | 40    | 210    | 0       | 0.00         | 0.00     | 0.42   | 0.00     | 0.00         | 0.42   |
| 500          | 500   | 0      | 0       | 0.30         | 0.30     | 0.93   | 0.71     | 0.71         | 0.92   |
| 500          | 360   | 140    | 0       | 0.54         | 0.39     | 0.97   | 0.78     | 0.56         | 0.83   |
| 500          | 220   | 280    | 0       | 0.94         | 0.41     | 0.89   | 0.65     | 0.29         | 0.81   |
| 500          | 80    | 420    | 0       | 1.00         | 0.16     | 0.84   | 0.00     | 0.00         | 0.84   |
| 1,000        | 1,000 | 0      | 0       | 1.00         | 1.00     | 1.00   | 0.73     | 0.73         | 0.96   |
| 1,000        | 720   | 280    | 0       | 1.00         | 0.72     | 0.82   | 0.89     | 0.64         | 0.83   |
| 1,000        | 440   | 560    | 0       | 1.00         | 0.44     | 0.60   | 0.88     | 0.39         | 0.55   |
| 1,000        | 160   | 840    | 0       | 1.00         | 0.16     | 0.30   | 0.84     | 0.13         | 0.27   |

Table 8. Optimal annuitisation rate as a proportion of liquid wealth (% Liquid) and as a proportion of total wealth (% Total), and optimal LTCI coverage (LTCI) for different wealth endowments.
Industry Partners and Collaborators

Industry Partners in CEPAR and on Linkage Grants

- PwC
- APRA
- AMP
- World Bank
- Netspar
- SOA

Collaborators

- Prof Annamaria Olivieri (University of Parma), Prof Ermanno Pitacco (University of Trieste), Dr Adam Shao (Milliman), Dr Hua Chen (Temple University), Dr Ramona Meyricke (Suncorp)
- Research students and postdocs at UNSW
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References


Questions and Discussion