Optimal portfolio choice with health-contingent income products: The value of life care annuities

Shang Wu, Hazel Bateman and Ralph Stevens

CEPAR and School of Risk and Actuarial Studies
University of New South Wales

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Outline

Background

Health-contingent income products: a lump sum $\rightarrow$ regular incomes, amount depending on health status

Advantages: e.g.,

- smooth consumption when facing out-of-pocket healthcare expenditure (HCE)
- cash flow is attractive: small $\downarrow$ in regular income, large $\uparrow$ in bad-health income

Life care annuity—introduction

Product feature: the life care annuity (LCA) (Murtaugh et al., 2001)

- payment of two income streams:
  - survival-contingent income (annuity segment)
  - health-contingent income (long-term care insurance (LTCI) segment):
    - 2+ limitations in activities of daily living (ADLs); and/or
    - cognitive impairment.

Policy discussion:

- the Netherlands: choice between a lowered pension (with additional payments when need LTC) and a 'normal' pension at a fixed rate (Ooijen et al., 2014)
- the U.S.: offer LCA in the private market (Warshawsky et al., 2002; Spillman et al., 2003)

Why bundling? $\rightarrow$ a potential solution for low voluntary annuitization and LTCI take up

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Life care annuity—how it works

Rationale: bundling → minimal underwriting → inclusion of most of the currently rejected for LTCI (Murtaugh et al., 2001)

- for life annuities:
  - reduce adverse selection
  - (partially) hedge health costs risk
- for LTCI:
  - increase market potential
  - single premium: no lapses & dynamic selection

Availability of minimal underwriting (for LTCI): single premium

- single premium and lifetime cover: YES (Finkelstein and McGarry, 2006; Brown and Warshawsky, 2013)
- periodic level-premium: NO
  - survival-contingent premium

Research question and contribution

1. LCA against conventional life annuities:

- impact on annuitization choices for different health groups
  - from insurance feature (additional LTCI)
  - from risk pooling pricing
- impact on optimal consumption, savings and risky asset holdings.
- how much is the welfare gain?

2. Impact of out-of-pocket HCE: allowing for end-of-life HCE

- mixed results for effects of HCE on annuitization choices: e.g., Pang and Warshawsky (2010); Pashchenko (2013); Reichling and Smetters (2015); Peijnenburg et al. (2015)

Outline

Preference

Single individuals: age 65 at retirement ($t = 0$), maximum age 100 ($T = 35$), obtain utility from

- consumption: time-separable CRRA

$$u(C_t) = \frac{C_t^{1-\gamma}}{1-\gamma},$$

  where $\gamma = 5$ is the relative risk aversion, exponential discounting by $\beta = 0.96$.

- leaving bequests:

$$v(W_t) = \frac{(bW_t)^{1-\gamma}}{1-\gamma},$$

  where $b = 0.17$ for strength of bequest (Yogo, 2009), discounted by β.

Decisions

At retirement:

- retirement wealth $W = \$500,000$ (Dushi and Webb, 2004)
- **one-off** and irreversible annuitization, x : standard life annuities or LCA $\rightarrow$ income Y_t (health-contingent for LCA)

In each period:

- liquid wealth W_t, receive income Y_t, pay (exogenous) out-of-pocket HCE, M_t
- if cash-on-hand $\equiv W_t + Y_t - M_t <$ wealth floor $\underline{W} \longrightarrow$ subsidy $G_t = \max\{0, \underline{W} - (W_t + Y_t - M_t)\}$, where
  - $\underline{W} = \$22,000$
  - C^* with $\underline{W}$ in line with the consumption floor in Ameriks et al. (2011) and Peijnenburg et al. (2015)
- decisions:
  - consumption $C_t \rightarrow$ after consumption wealth $\overline{W}_t$
  - allocation to the risky asset $\alpha_t \rightarrow$ risk-free, $1 - \alpha_t$

Health dynamics

Heath states: Brown and Warshawsky (2013)

- 11 health states (H_t) by
  - self-reported health
  - history of illness
  - cognitive impairment and **ADL**
- roughly
  - 1-4: 0-1 ADLs, **eligible** for LCA
  - 5-7: 2-3 ADLs
  - 8-10: 4-5 ADLs
  - 11: death
- estimated to the U.S. Health and Retirement Study (HRS) data from 1998 to 2008

Out-of-pocket healthcare expenditure

For each gender and health state: a mixture distribution with

- bottom: no HCE

$$M_t = \begin{cases} 0, & \text{if } I_t = 1; \\ m_t, & \text{if } I_t = 0, \end{cases}$$

  where $I_t \sim \text{Bernoulli}(p)$ an indicator for zero HCE
- main: truncated lognormal distribution
- tail: exponential distribution

$$\begin{cases} m_t \sim \text{Truncated LN}\,(\mu, \sigma, a), & \text{if } m_t < a; \\ (m_t - a) \sim \text{Exp}\,(\lambda), & \text{if } m_t \geq a. \end{cases}$$

- **'The cost of dying':** different parameters for survivors and the deceased

Reasons:

- bottom: cluster of zero health costs
- main: LN fits body well, in line with the literature (De Nardi et al., 2010)
- tail: LN does not fit the tail well: a fat tail at very large percentiles

Calibration

Moments	Health state					
	1	2	3	4	5 to 7	8 to 10
Panel A: HCE from HRS ('000 $)						
Mean	2.8	4.5	4.2	4.1	8.7	16.9
Std	7.0	11.0	12.1	10.6	24.5	43.9
90th percentile	7.9	14.1	11.0	11.9	17.9	48.9
95th percentile	14.5	17.1	20.9	22.0	46.8	96.4
99.9th percentile	59.6	94.0	138.7	102.6	199.6	427.5
99.99th percentile	65.9	98.6	139.5	113.9	206.8	504.6
Panel B: Lognormal fit						
Mean	2.8	4.5	4.2	4.1	8.7	16.9
Std	7.0	11.0	12.1	10.6	24.5	43.9
90th percentile	**6.3***	**10.3***	9.4	**9.3***	19.4	38.0
95th percentile	**10.6***	17.0	16.1	**15.6***	33.3	63.9
99.9th percentile	**80.2***	**126.1***	138.9	122.5	**281.6***	505.8
99.99th percentile	**193.7***	**301.5***	**354.7***	**300.3***	**713.3***	**1244.6***
Panel C: Mixture distribution						
Mean	2.7	4.4	4.1	4.0	8.5	16.9
Std	6.5	**8.9***	**10.5***	**9.7***	23.8	41.0
90th percentile	7.9	14.1	11.0	11.9	17.9	48.9
99.5th percentile	40.6	51.8	65.1	60.8	155.2	257.6
99.99th percentile	**83.4***	101.0	135.7	124.8	334.5	530.0

* outside 95% CI

Financial assets

At retirement: Brown and Warshawsky (2013)

- conventional life annuities: adverse selection – the most healthy group ($H_0 = 1$)
- LCA: pooling transition probabilities of eligible health groups ($H_t \in [1, 4]$)
  - \$1 lifetime income
  - \$2 **additional** income when need aged care ($H_t \in [5, 10]$)

In each period: Pang and Warshawsky (2010)

- a bond: $R^f = 1 + r_f$ with $r_f = 3\%$ risk-free rate;
- a stock: gross return $\widetilde{R}_{t+1} \sim \text{LN}\,(\mu_S, \sigma_S)$ with $\mu_S = 0.065$ and $\sigma_S = 0.161$.
- portfolio return: $R_{t+1} = (1 - \alpha_t)R^f + \alpha_t \widetilde{R}_{t+1}$

The optimization problem

Objective function:

$$V(W,H_0) = \max_{\{x,C_t,\alpha_t\}_{t=0}^{T}} \left\{ \mathbb{E}_0 \left[\sum_{t=0}^{T-1} \sum_{j=1}^{10} \pi_0^t(H_0,j) \cdot \beta^t \cdot [u(C_t,H_t) + \beta \cdot \pi_t(j,11) \cdot v(W_{t+1})] \right] \right\},$$

Subject to:

$$\overline{W}_t = W_t + Y_t - M_t + G_t - C_t \geq 0 \qquad \text{(budget constraint);}$$

$$0 \leq \alpha_t \leq 1 \qquad \text{(no short selling);}$$

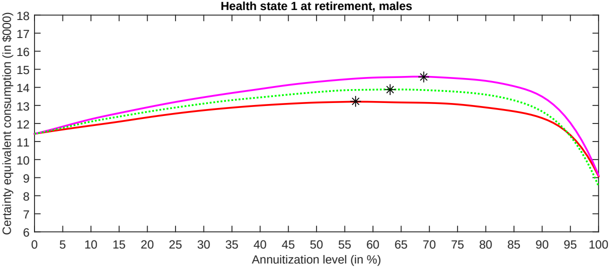
$$W_{t+1} = \overline{W}_t \cdot R_{t+1} \qquad \text{(wealth dynamics).}$$

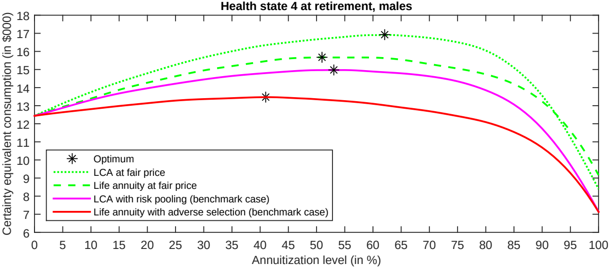
for all $t \in [0, T-1]$**.**

Sensitivity analysis: for most parameters (see paper).

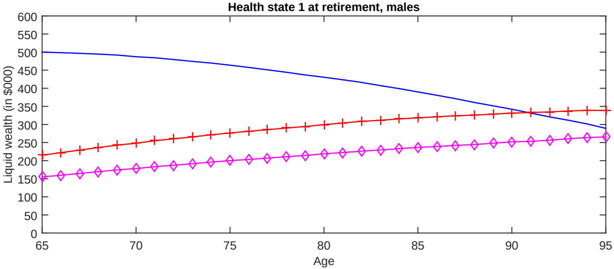
Outline

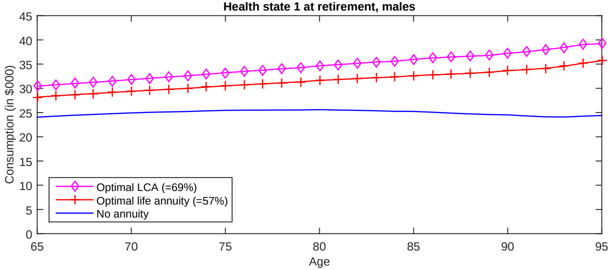
Effect of LCA on optimal annuitization choice



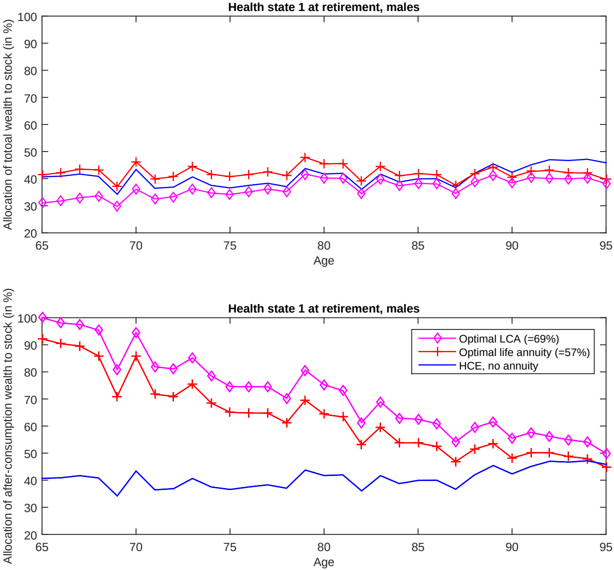


On optimal wealth and consumption paths





On optimal asset allocations



On individual welfare

Life annuity → LCA: Higher consumption in retirement

Willingness to pay for LCA: at retirement, an individual

- with \$550,000 & standard life annuities $\overset{\text{utility}}{=}$ with \$500,000 & LCAs
- retirees in health state 1 (4) is willing to pay a loading up to 16% (21%) for LCAs $\overset{\text{utility}}{=}$ with \$500,000 with standard life annuities

Effect of out-of-pocket HCE and end-of-life HCE

- On annuitization choice

Optimal annuitization level in percent

	H1	H4
Panel A: Standard life annuity		
Without HCE	66	53
HCE without costs of dying	70	53
HCE with costs of dying	57	41

- On consumption and saving behavior: additional precautionary savings & less consumption
- On allocation to the stock: increase proportion of total wealth in the risky asset

Outline

Conclusion

- life annuity $\rightarrow$ LCA
  - increases annuitization level for both health groups by around 12 percentage points
    - health group 1: due to both insurance feature and risk pooling
    - health group 4: mainly from insurance feature
  - less liquid wealth and higher consumption
  - more risk-averse allocation of total wealth; less risk-averse allocation of liquid wealth
  - substantially improves welfare

- uncertain out-of-pocket HCE, in particular the end-of-life HCE
  - reduces (increases) the demand of life annuities (LCA)
  - leads to precautionary savings and lower consumption
  - increases risky asset holding among total wealth

Implications & Future research

Implications:

- the potential of LCAs to provide at least partial protection against out-of-pocket HCE and the cost of long-term care
- design of retirement income products and public pension policy

Future research:

- incorporate monthly and new health transitions: Friedberg et al. (2014)
- household decision model
- laddered annuity purchase
- more specific institutional settings
- ...
- optimal LTCI product design: empirical evidence from stated preference data, next year Netspar Pension Workshop?

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The numerical solution method

Backward induction:

- grid points for
  - after-consumption wealth $\overline{W}_t$ (endogenous grid method, Carroll, 2006)
  - annuity income Y_t: $x = 0\%, 1\%, ..., 100\%$
-

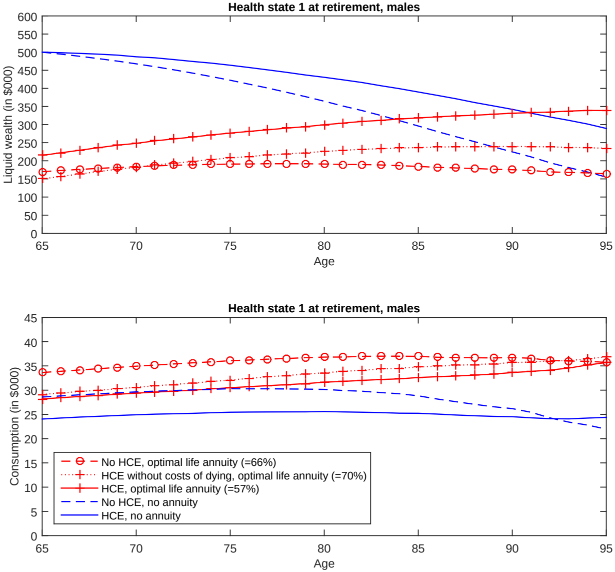
$$C_t^{*\,-\gamma} = \sum_{j=1}^{10} \pi_t(H_t, j) \cdot \beta \cdot \mathbb{E}_t \left\{ \frac{\partial V_{t+1}}{\partial W_{t+1}} \cdot R_{t+1}^* \right\} + \pi_t(H_t, 11) \cdot \beta \cdot b^{1-\gamma} \mathbb{E}_t \left\{ W_{t+1}^{-\gamma} R_{t+1}^* \right\}$$

where

$$\frac{\partial V_{t+1}}{\partial W_{t+1}} = \begin{cases} C_{t+1}^{*\,-\gamma}, & \text{if } W_{t+1} + Y^A - M_{t+1} \geq \underline{W}; \\ 0, & \text{if } W_{t+1} + Y^A - M_{t+1} < \underline{W}. \end{cases}$$

- Importance Sampling for out-of-pocket HCE (Rubinstein and Kroese, 2011)
- Monte Carlo method for calculating the expectation, 200,000 simulations
- linear (cubic spline) interpolation for consumption (allocation)

On optimal wealth and consumption paths



On optimal asset allocations