



Product Pricing and Solvency Capital Requirements for Long-Term Care Insurance

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Research (CEPAR)

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- LTC costs are increasingly higher and the increasing trend is projected to continue (Congressional Budget Office, 2004; Shi and Zhang, 2013; Productivity Commission of Australia, 2013)
- LTC costs funding scheme
 - Australia: lifetime stop-loss mechanism
 - U.S.: Medicaid and Medicare + private insurance + personal payment
- The private LTC insurance market is an important supplement for the public funding source (Productivity Commission of Australia, 2011; Glendinning *et al.*, 2004; Colombo *et al.*, 2011)

Pays benefits when the insured becomes **functionally disabled**

- Based on number of Activities of Daily Livings (ADLs) that individuals cannot perform independently and cognitive impairment
- Six ADLs in the U.S. Health and Retirement Studies data: dressing, walking, bathing, eating, transferring in/out of bed, and toileting
- Typically two or three out of six ADLs
- Australian Bureau of Statistics data: Core Activity Restrictions
- Five ADLs in Australian Institute of Health and Welfare (AIHW) data: self-care, movement activities, moving around places, communication, and health-care tasks.

Four different types based on benefits

- Fixed benefit policies sold to healthy individuals
- Fixed benefit policies sold to the elderly entering or already staying in long-term care facilities
- Indemnity-based benefit policies
- Policies that allow the insured to choose between fixed benefit and long-term care service

Can also be categorised into:

- Base policies
- With an elimination period (3 months to 2 years) and a maximum benefit period (3 to 5 years)

Most typical and widely used is the fixed benefit policy

- Stand-alone policies
- Included as a rider benefit in whole life insurance
 - fixed death benefit
 - draw-down death benefit
- Life care annuities
 - long-term care insurance combined with life annuity
 - reduces adverse selection by pooling longevity risk and disability risk
 - potential for reduced LTC insurance premiums

This paper

- Derives premiums and best-estimate reserves for a broad range of fixed benefit LTC insurance policies
- Calculates solvency capital requirements for product providers
- Investigates the effectiveness of typical product features, such as the elimination period and the maximum benefit period
- Investigates capital requirements for different types of products sold to different cohorts

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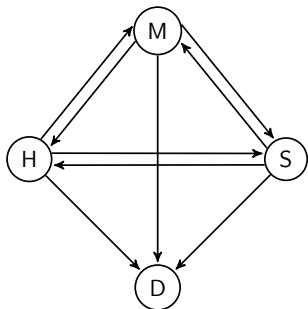


Figure. Four-state Markov transition diagram.

- H - Healthy, difficulty in no ADLs
- M - Mildly disabled, difficulty in 1-2 ADLs
- S - Severely disabled, difficulty in 3-6 ADLs
- D - Dead

Health and Retirement Study (HRS) data: nationally representative survey of Americans over the age of 50

- 12-year observation with 7 biannual waves, 1998 - 2010
- Longitudinal data on self-reported health status: ADLs and CI
- Cognition is evaluated by episodic memory and mental status: 7- out of 35 points is CI
- Sample: 19,547 individuals (56.5% females) without considering CI
- Sample: 18,781 individuals (57.4% females) respond to cognition scores

Base products:

- Thiele's differential equation
- A conventional actuarial valuation model

Products with flexible features:

- Benefits depend on seniority in disabled states: not Markovian
- Hard to use Thiele's differential equation
- Simulation-based approach: health paths for 40,000 males and 40,000 females
 - Allow for best-estimate reserves and VaR
 - Allow for calculating demographic characteristics

$$\begin{aligned} SCR_t &= \arg \min_x \left\{ \Pr (NAV_{t+1} > 0 \mid NAV_t = x) \geq 99.5\% \right\} \\ &= \arg \min_x \left\{ \Pr (NAV_t - NAV_{t+1} e^{-\delta_{t+1}} > x) \leq 0.5\% \right\} \end{aligned}$$

- NAV_t : net asset value at time t
- δ_{t+1} : interest rate from t to $t + 1$
- Horizon: one year
- Interpretation: capital required to cover extreme losses

- For each risk (European Insurance and Occupational Pension Authority, 2011)

$$SCR_t^{Shock} = NAV_t - NAV_t^{Shock}$$

- NAV_t : net asset value at time t
- NAV_t^{Shock} : net asset value with the one-off permanent shock
- We consider two **uncorrelated** risks: longevity and disability
- Longevity risk: a permanent 20% decrease in mortality rates at all ages
- Disability risk:
 - an increase of 35% in disability rates at all ages for the next year
 - a permanent increase of 25% at all ages for the following years
 - a permanent decrease of 20% in recovery rates at all ages
- Aggregate

$$SCR_t^S = \sqrt{\left(SCR_t^{Longevity}\right)^2 + \left(SCR_t^{Disability}\right)^2}$$

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No. of Disabled

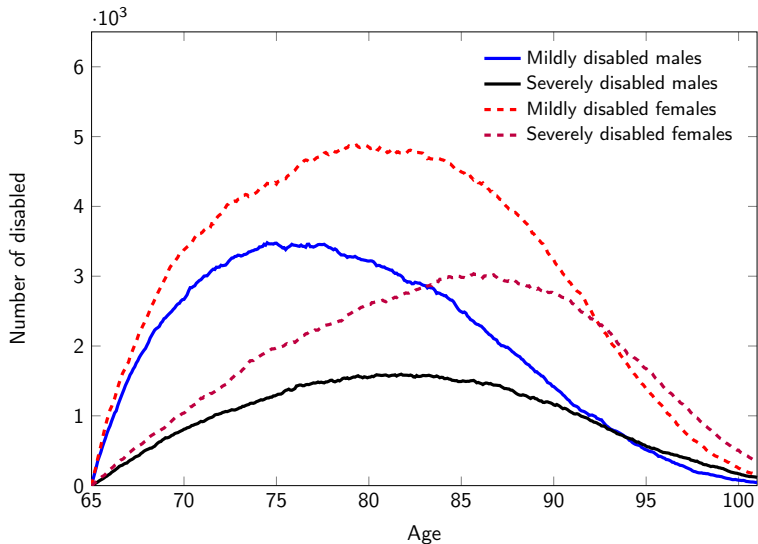


Figure. Number of disabled in the simulated cohorts: 65-year-old healthy individuals of 40,000 males and 40,000 females.

Table. Demographic characteristics of the simulated cohorts (40,000 males and 40,000 females, 65-year-old), based on HRS data.

Demographic Characteristics	Males	Females
Mean years of life after age 65	16.3	19.4
Mean years with mild disability	1.8	2.8
Mean years with severe disability	0.9	1.7
Share with disability	56%	73%
Share with mild disability	48%	63%
Share with severe disability	27%	42%
Average age of first disability, conditional on becoming disabled	76.2	76.5
Average age of first mild disability, conditional on becoming mildly disabled	75.8	76.4
Average age of first severe disability, conditional on becoming severely disabled	80.5	81.7

- The LTC insurance pays \$100 per day while the insured is severely disabled - \$36k p.a. assumed average care costs in residential care
- Interest rate 4% continuous compounding

Table. Premiums for base stand-alone LTC insurance.

Age	Males				Females			
	Lump sum	Continuous	Annual	Monthly	Lump sum	Continuous	Annual	Monthly
<i>Sold to the healthy</i>								
55	15,923	1,138	1,126	95	27,526	1,825	1,806	152
65	17,448	1,619	1,596	135	30,313	2,535	2,501	211
70	17,915	1,964	1,933	163	31,469	3,084	3,036	257
<i>Sold to the mildly disabled</i>								
55	28,694	2,326	2,295	194	48,865	3,647	3,607	304
65	32,622	3,639	3,581	303	47,391	4,550	4,482	379
70	32,590	4,417	4,340	368	47,163	5,412	5,318	450
<i>Sold to the severely disabled</i>								
55	130,655	-	-	-	157,337	-	-	-
65	136,771	-	-	-	159,412	-	-	-
70	131,552	-	-	-	154,487	-	-	-

- The rider benefit policy pays \$100 per day while the insured is severely disabled and pays a death benefit of \$500,000 when the insured dies
- The life care annuity pays \$50 per day while the insured is alive and additional \$50 per day while the insured is severely disabled (\$18k p.a. assumed residential accommodation charges)

Table. Premiums of base rider benefit policies and life care annuities (LCA)

Age	Males				Females			
	Rider benefit	LCA H	LCA M	LCA S	Rider benefit	LCA H	LCA M	LCA S
55	226,927	267,773	250,787	270,261	209,708	298,983	290,061	323,363
60	258,649	240,319	222,786	239,606	239,785	273,634	263,741	292,932
65	291,614	211,479	194,002	208,682	272,847	245,530	234,859	259,514
70	324,797	182,067	165,388	178,927	307,940	215,110	204,025	224,654
75	357,067	153,053	137,878	151,417	343,570	183,191	172,404	190,228
80	387,212	125,472	112,263	126,759	377,597	150,957	141,551	157,930

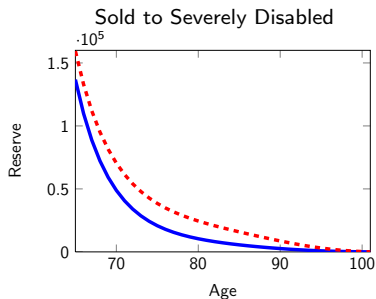
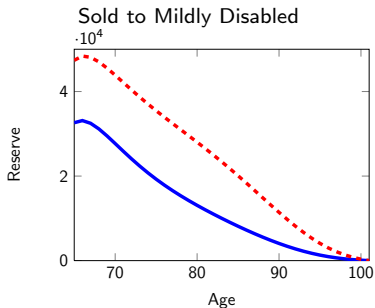
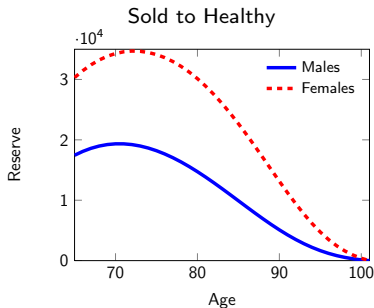
Table. Impact of elimination period and maximum benefit period.

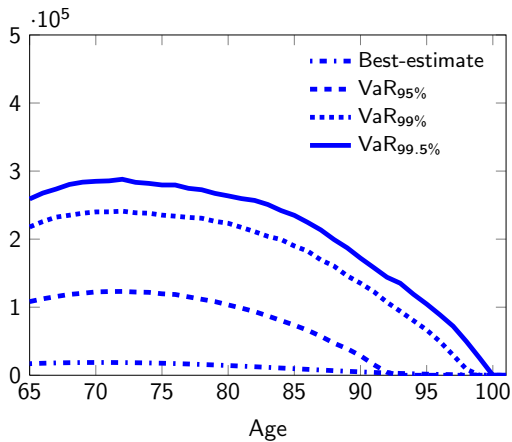
Elimination Period	Males			Females		
	<i>Lump sum</i>	<i>Annual</i>	<i>Monthly</i>	<i>Lump sum</i>	<i>Annual</i>	<i>Monthly</i>
<i>Unlimited benefit period</i>						
0-day	17,018 (219)	1,510 (31)	131 (5)	29,843 (287)	2,392 (35)	207 (6)
30-day	16,561 (216)	1,470 (30)	128 (5)	29,155 (284)	2,337 (35)	202 (6)
60-day	16,116 (213)	1,430 (30)	124 (5)	28,479 (281)	2,283 (34)	198 (6)
90-day	15,680 (210)	1,391 (29)	121 (5)	27,817 (278)	2,230 (34)	193 (6)
<i>3-year maximum benefit period</i>						
0-day	10,700 (111)	950 (16)	83 (3)	17,237 (128)	1,382 (17)	120 (3)
30-day	10,418 (109)	924 (16)	80 (3)	16,854 (127)	1,351 (17)	117 (3)
60-day	10,142 (108)	900 (16)	78 (3)	16,476 (126)	1,321 (17)	114 (3)
90-day	9,873 (107)	876 (16)	76 (3)	16,106 (125)	1,291 (16)	112 (3)

- Allowing each spouse to access his/her partner's benefits
- Example: 3-year shared LTCI, each spouse has potential to claim 6 years' benefits
- For a couple of a male and a female both aged 65:

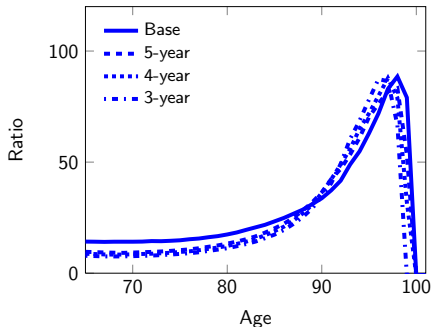
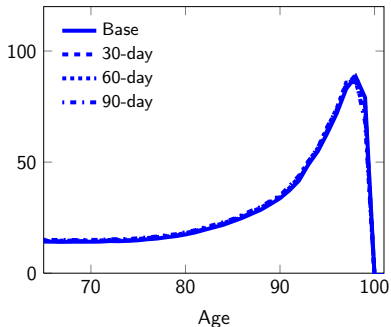
Product	3-year, separate	3-year, shared	6-year, separate
Premium	27,937	37,450	39,507
s.e.	(239)	(240)	(375)

Product	2-year, separate	2-year, shared	4-year, separate
Premium	21,171	30,569	32,982
s.e.	(173)	(182)	(294)



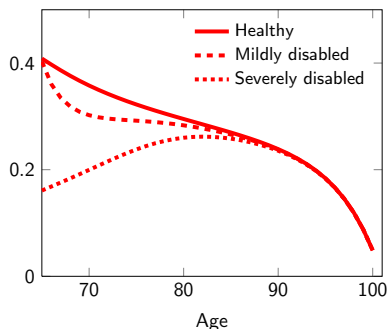
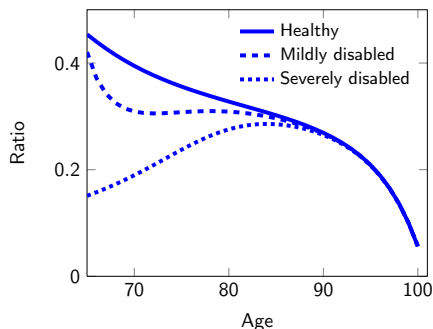


$$\frac{VaR_{99.5\%} - \text{Best-Estimate Reserve}}{\text{Best-Estimate Reserve}}$$



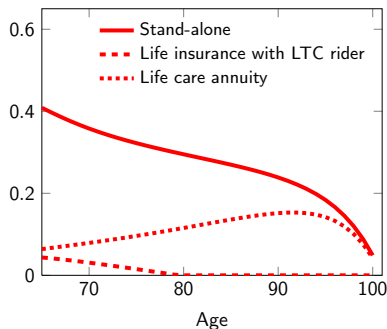
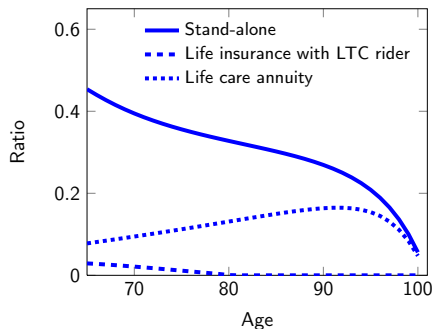
Stand-alone LTCI sold to 65-year-old healthy individuals.

$$\eta_k(t) = \frac{SCR_t^S}{V(t, T | \chi(0) = k)}, \quad k \in \{H, M, S\}$$



Base stand-alone LTCI sold to 65-year-old individuals.

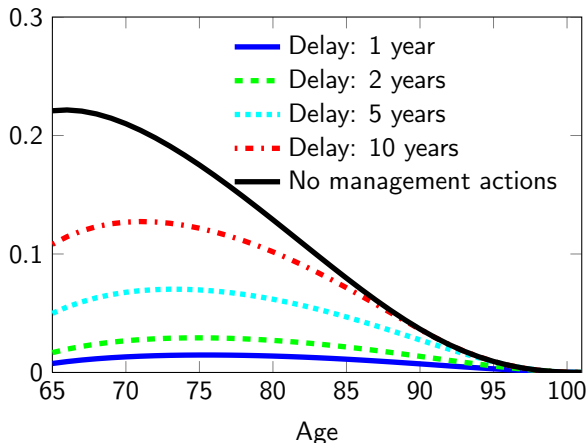
$$\eta_H(t) = \frac{SCR_t^S}{V(t, T | \chi(0) = H)}$$



Base products sold to 65-year-old healthy individuals.

- Management can take actions in the presence of adverse situations
- Delay in management actions
- Base annual premium LTCI policies sold to 65-year-old healthy males

Solvency capital requirements per dollar provision



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- LTCI product design: use of fixed benefits, elimination period, maximum benefit period, combining with life insurance or annuities, inflation protection, shared LTCI
- Potential market to underwrite disabled individuals, in terms of premium and capital
- Maximum benefit period is effective in making LTCI more affordable and reducing idiosyncratic risk
- Quick management actions can effectively reduce SCRs.

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Appendix B - Inflation Protection

Table. Premiums for base LTC insurance sold to 65-year-old.

	Males			Females		
	Without Inflation	With Inflation	Increase	Without Inflation	With Inflation	Increase
<i>1. Stand-alone policies sold to the healthy</i>						
	17,448	27,930	60%	30,313	50,946	68%
<i>2. Stand-alone policies sold to the mildly disabled</i>						
	32,622	44,992	38%	47,391	69,990	48%
<i>3. Stand-alone policies sold to the severely disabled</i>						
	136,771	157,321	15%	159,412	191,237	20%
<i>4. Rider benefit policies sold to the healthy</i>						
	291,614	302,097	4%	272,847	293,480	8%
<i>5. Life care annuities sold to the healthy</i>						
	211,479	280,065	32%	245,530	337,567	37%
<i>6. Life care annuities sold to the mildly disabled</i>						
	194,002	252,675	30%	234,859	318,576	36%
<i>7. Life care annuities sold to the severely disabled</i>						
	208,682	255,889	23%	259,514	332,848	28%

- Interest rate 4% continuous compounding
- Inflation rate 3% continuous compounding

Appendix B - Varying LTC Disability Definitions

Table. Premiums for base LTC insurance sold to 65-year-old.

Males			Females		
3+ ADLs	2+ ADLs	Difference	3+ ADLs	2+ ADLs	Difference
<i>1. Stand-alone policies sold to the healthy</i>					
17,448	28,059	61%	30,313	47,473	57%
<i>2. Stand-alone policies sold to the mildly disabled</i>					
32,622	48,756	49%	47,391	68,184	44%
<i>3. Stand-alone policies sold to the severely disabled</i>					
136,771	148,445	9%	159,412	175,380	10%
<i>4. Rider benefit policies sold to the healthy</i>					
291,614	302,290	4%	272,847	290,170	6%
<i>5. Life care annuities sold to the healthy</i>					
211,479	216,727	2%	245,530	253,939	3%
<i>6. Life care annuities sold to the mildly disabled</i>					
194,002	205,040	6%	234,859	247,994	6%
<i>7. Life care annuities sold to the severely disabled</i>					
208,682	227,793	9%	259,514	279,606	8%

- 3+ ADLs: Inured receive LTC benefits when having difficulties with 3 or more ADLs
- 2+ ADLs: Inured receive LTC benefits when having difficulties with 2 or more ADLs