Long-Term Care Products

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Longevity and Long-Term Care Risks and Products

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Agenda

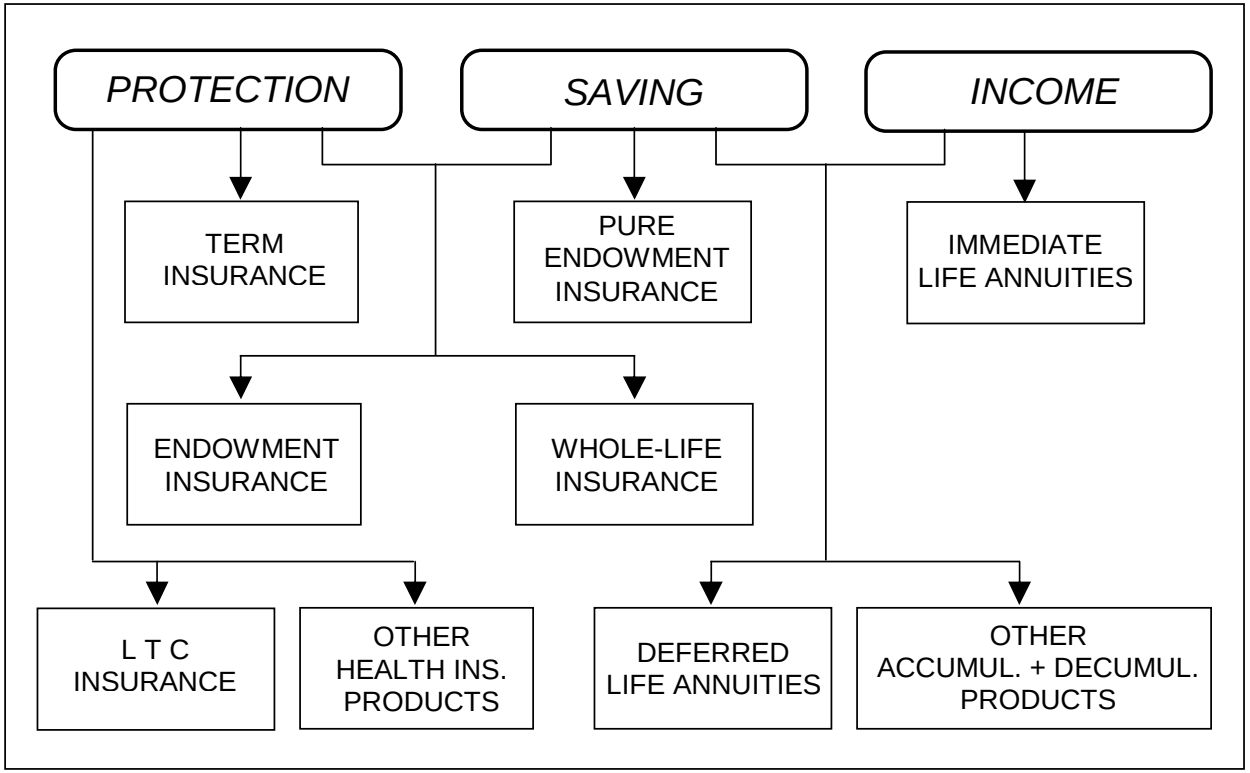
- Introduction & motivation
- A general framework: health-linked life annuities
- The LTC risk
- LTCI products
- Purchasing LTCI: reverse mortgage
- Concluding remarks

INTRODUCTION & MOTIVATION

In the area of life & health insurance products, immediate standard life annuities, and stand-alone LTCI products implement two “extreme” product designs, both with significant difficulties, from the client’s as well as the insurer’s perspective:

- life annuities: the *annuity puzzle* !
- stand alone LTCI: high premium for a *pure protection* product

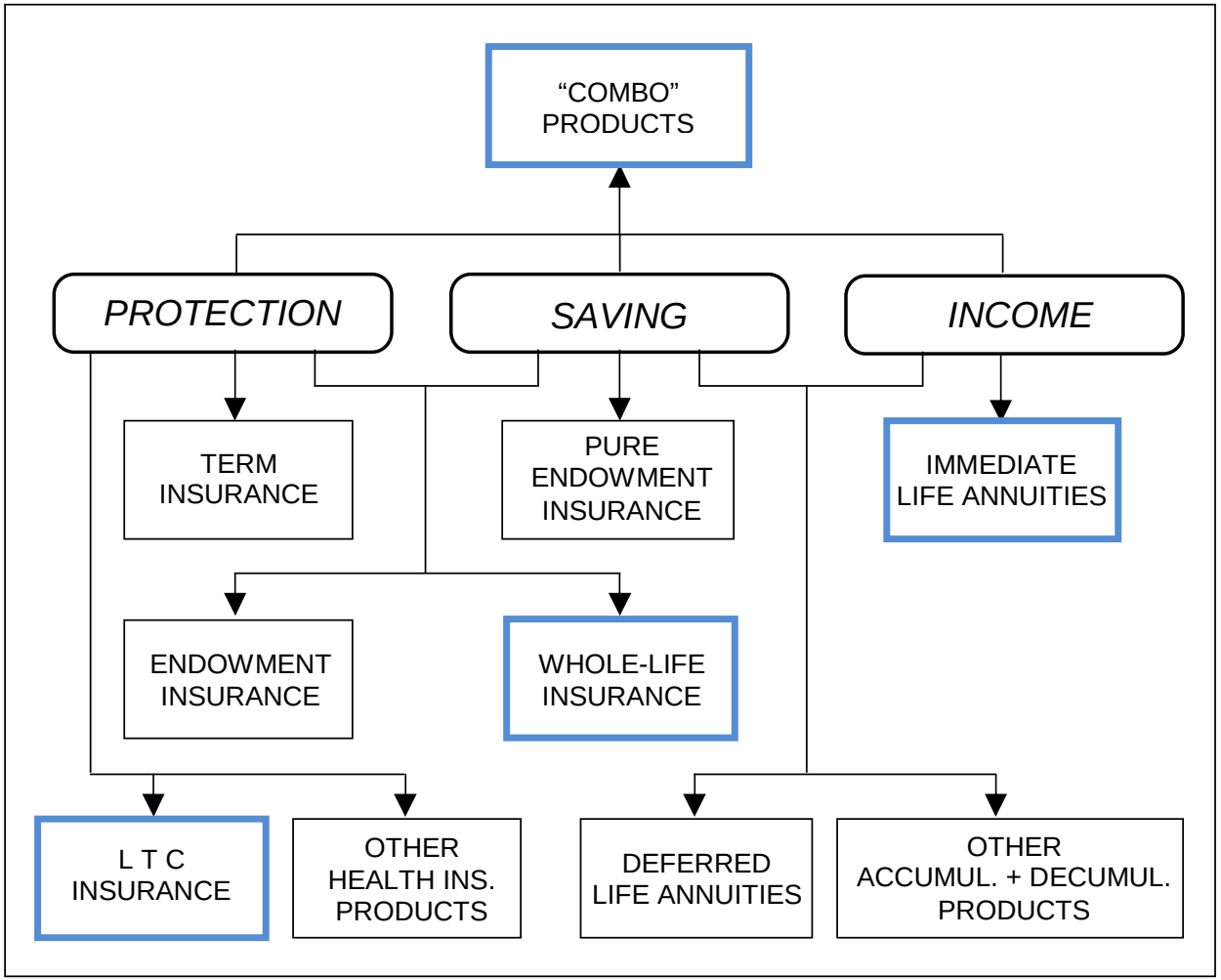
Look at a traditional classification of insurance products in the life & health area, according to the their purpose . . .



. . . we can:

- realize that some interesting products ("combo", or "hybrid" products, already existing) are not captured by the scheme
- develop new combo product designs by generalizing some features

Introduction & motivation *(cont'd)*



Looking at recent trends:

1. Life annuities:
   (a) from "investment" to "longevity insurance" $\Rightarrow$ *old-age life annuities*
   (b) extension of the rating principles $\Rightarrow$ *special-rate*, or *underwritten life annuities*
2. LTCI: from stand-alone to *combo products*, e.g. including lifetime-related benefits

Note that:

- approach 1(a) $\Rightarrow$ restriction of the insurance coverage
- approach 2 $\Rightarrow$ extension of the insurance coverage
- approaches 1(b) and (2) $\Rightarrow$ possible implementation via *health-linked life annuities*

Our next steps:

- to define a general framework, including LTCI traditional products, LTCI combo products, underwritten life annuities, etc.
- to focus on LTC risks, and related need for insurance coverage
- to describe LTCI products, and relevant risk profile
- to focus on LTCI product purchase
  - ▷ premium arrangements
  - ▷ reverse mortgage solutions

A GENERAL FRAMEWORK: HEALTH-LINKED LIFE ANNUITIES

Our target:

- to recognize existing products and analyze their relevant features
- to provide hints for (possible) new products

Basic feature of a health-linked life annuity:

for a given (single) premium, the amount of benefits (either constant or varying throughout the policy duration) depends on the annuitant's health status (either at policy issue or throughout his/her lifetime)

A general framework: health-linked life annuities *(cont'd)*

In formal terms, the annuitant's health status can be represented by a stochastic process

$$\{H(t); t \geq 0\}$$

to be defined in terms of:

- *values*, for example:
  - ▷ state (active, disabled)
  - ▷ degree of disability
  - ▷ ADL's or IADL's scoring in LTCI
- *probabilistic structure* (e.g. Markov or semi-Markov)

INSURANCE PRODUCTS: EXAMPLES

Standard life annuity (flat profile)

$$B(t) = B = \frac{\Pi}{\ddot{a}_x} = f(\Pi); \quad t = 1, 2, \ldots$$

where Π = single premium

Health status not explicitly considered, but assumed very good (annuitants' self-selection)

Annuities with static health-linking

$$B(t) = B = \phi(\Pi, H(0)); \quad t = 1, 2, \ldots$$

Example: underwritten (or special-rate) life annuity (flat profile)

- ▷ lifestyle annuities
- ▷ enhanced annuities
- ▷ impaired annuities
- ▷ care annuities (LTC)

with assumed decreasing life expectancy

- The health status at policy issue is accounted for via underwriting
- Purpose:

$$\phi(\Pi, H(0)) > f(\Pi)$$

that is, better annuity rate in the case of non-optimal health conditions

Annuities with dynamic health-linking

$$B(t) = \psi(\Pi, H(t)); \quad t = 1, 2, \ldots$$

Several examples, with related definitions of the health status:

- LTC products
  - stand-alone
  - combo products
- Disability annuities (e.g. Income Protection), possibly degree-related
- ...

Bibliographic suggestions

Life annuities: general issues

E. Pitacco. Life Annuities. Products, guarantees, basic actuarial models. CEPAR Working Paper 2017/6, 2017. Available at: `http://cepar.edu.au/sites/default/files/Life_Annuities_Products_Guarantees_Basic_Actuarial_Models_Revised.pdf`

Underwritten life annuities

R. Ainslie. Annuity and insurance products for impaired lives. The Staple Inn Actuarial Society, London, 2000

M. Drinkwater, J. E. Montminy, E. T. Sondergeld, C. G. Raham, and C. R. Runchey. Substandard Annuities. Technical report, LIMRA International Inc. and the Society of Actuaries, in collaboration with Ernst & Young LLP, 2006. Available at: `https://www.soa.org/Files/Research/007289-Substandard-annuities-full-rpt-REV-8-21.pdf`

A general framework: health-linked life annuities *(cont'd)*

B. Ridsdale. Annuity underwriting in the United Kingdom. Note for the International Actuarial Association Mortality Working Group, 2012. Available at: `http://www.actuaries.org/mortality/Item10_Annuity_underwriting.pdf`

C. R. Rinke. The variability of life reflected in annuity products. Hannover Re's Perspectives - Current Topics of International Life Insurance. Issue No. 8, 2002

THE LTC RISK

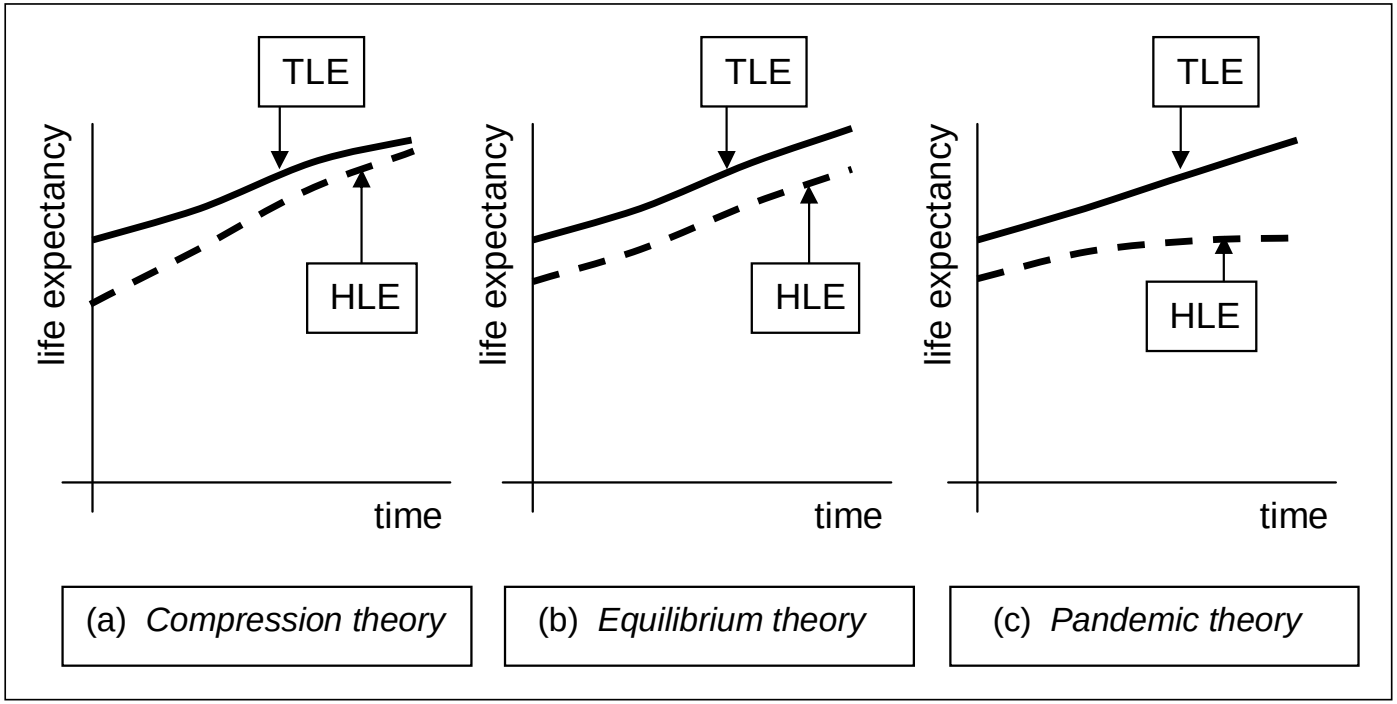
LTCI insurance provides the insured with financial support, while he/she needs nursing and/or medical care because of chronic (or long-lasting) conditions or ailments ($\Rightarrow$ implying dependence)

Remark

Interest in analyzing LTCI products:

- In many countries, elderly population rapidly growing because of increasing life expectancy and low fertility rates
- Spread between TLE (total life expectancy) and HLE (healthy life expectancy, or disability-free life expectancy) $\Rightarrow$ LTC need
- Household size is progressively reducing $\Rightarrow$ lack of assistance and care services provided to old family members of the family
- LTCI products are rather recent (compared to other health insurance products, e.g. sickness insurance) $\Rightarrow$ senescent disability data are scanty $\Rightarrow$ pricing difficulties
- High premiums (viz because of a significant safety loading) $\Rightarrow$ obstacle to the diffusion of these products
- Stand-alone LTCI product: only “protection” $\Rightarrow$ packaging of LTCI benefits with lifetime-related benefits can enhance propensity to LTCI

The LTC risk *(cont'd)*

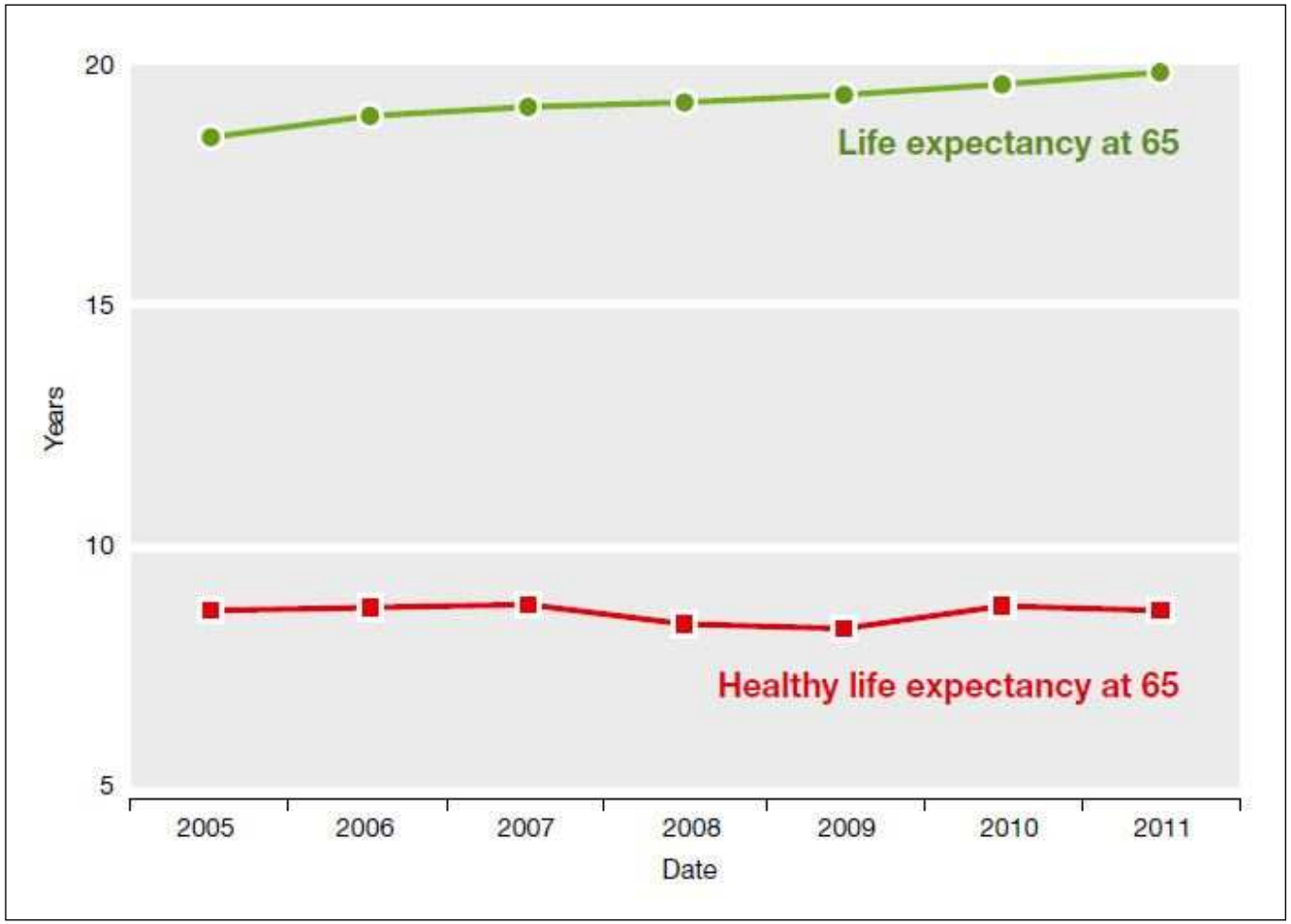


TLE and HLE: projected trends according to different theories

Observed average trend in 25 EU countries $\Rightarrow$ TLE increasing, but HLE approx constant over recent years

See following figure

The LTC risk *(cont'd)*



Average life expectancy and healthy life expectancy at age 65 in 25 EU countries (Source: Brown [2015])

Bibliographic suggestions

G. C. Brown. Living too long. *EMBO Reports*, 16(2), 2015

J. F. Fries. Aging, natural death, and the compression of morbidity. *The New England Journal of Medicine*, 303(3):130–135, 1980

E. M. Gruenberg. The failure of success. *The Milbank Memorial Fund Quarterly. Health Society*, 55(1):3–24, 1977

IFOA. Focus on: Healthy life expectancy. *Longevity Bulletin*, 4:5–10, 2012. Available at: `http://www.actuaries.org/index.cfm?lang=EN&DSP=CTTEES_TFM&ACT=INFO`

M. Kramer. The rising pandemic of mental disorders and associated chronic diseases and disabilities. *Acta Psychiatrica Scandinavica*, 62(S285):382–397, 1980

K. G. Manton. Changing concepts of morbidity and mortality in the elderly population. *The Milbank Memorial Fund Quarterly. Health Society*, 60(2):183–244, 1982

I. M. Majer, R. Stevens, W. J. Nusselder, J. P. Mackenbach, and P. H. M. van Baal. Modeling and forecasting health expectancy: Theoretical framework and application. *Demography*, 50:673–697, 2013

J-M. Robin and C. Jagger. The relationship between increasing life expectancy and healthy life expectancy. *Ageing Horizons*, 3:14–21, 2005

E. Stallard. Compression of morbidity and mortality: New perspectives. *North American Actuarial Journal*, 20(4):341–354, 2016

References on Healthy life expectancy: Information Base of the IAA - MWG (Mortality Working Group)

Link to the MWG:
`www.actuaries.org/mortalityevents`

- $\Rightarrow$ Information Base
- $\Rightarrow$ Healthy Longevity

or direct hyperlink:
`https://www.actuaries.org/iaa/IAA/Committees/Scientific/Mortality/IAA/Committees/Scientific/Mortality_Working_Group.aspx`

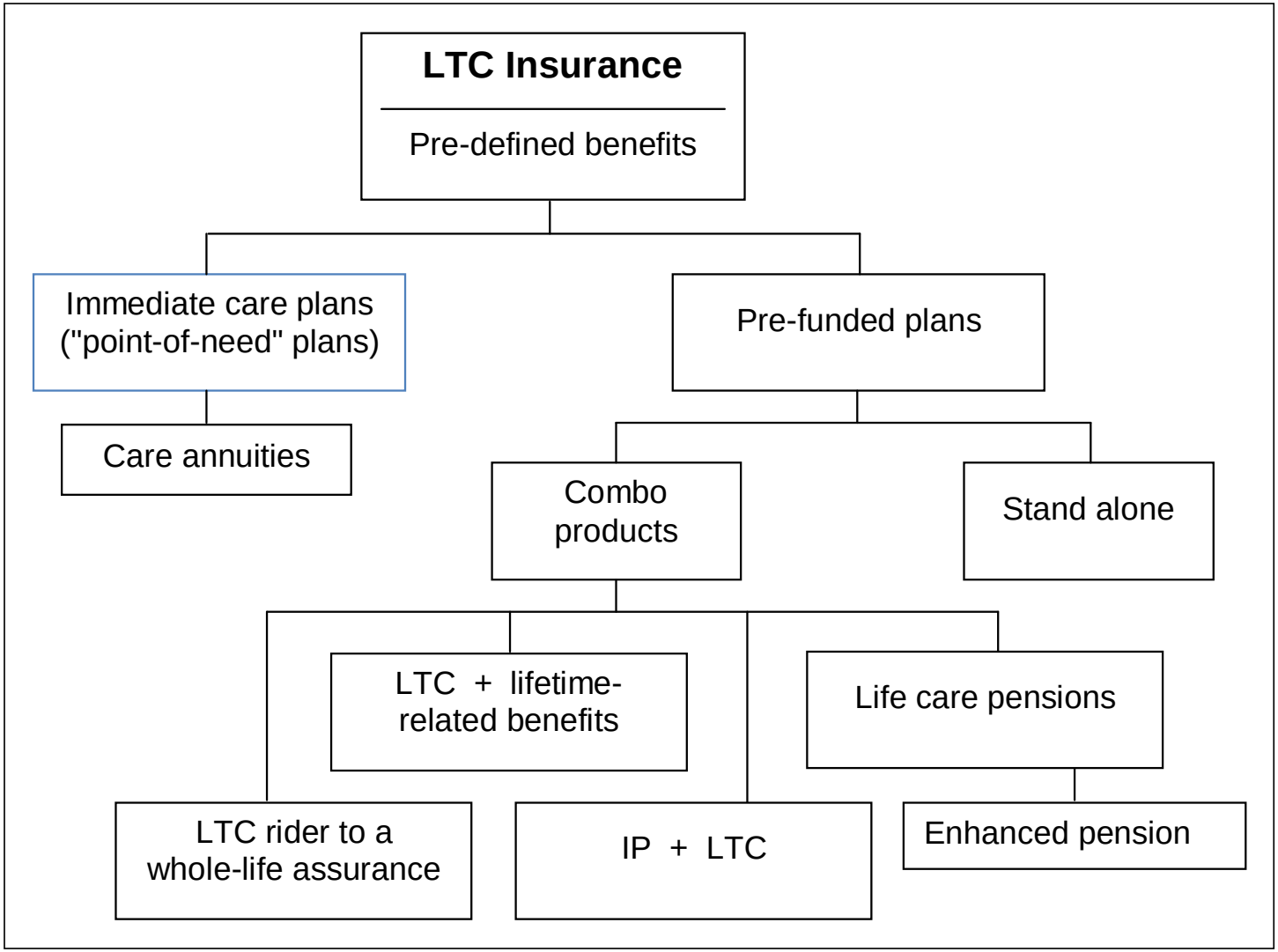
LTCI PRODUCTS

A CLASSIFICATION

- Benefits with *pre-defined amount* (usually, a lifelong annuity benefit); in particular:
  - *fixed-amount* benefit
  - *degree-related* (or *graded*) benefit, i.e. graded according to the severity of the disability itself
- Reimbursement (usually partial) of nursery and medical expenses, i.e. *expense-related* benefits
- *Care service* benefits; for example provided in the US by Continuous Care Retirement Communities (CCRCs)

Focus on pre-defined benefits

LTCI products *(cont'd)*



LTC products providing pre-defined benefits

BENEFITS

Stand-alone LTC degree-related annuity

$$B(t) = \begin{cases} 0 & \text{if } H(t) = \text{good} \\ b^{(1)} & \text{if } H(t) = \text{bad} \\ b^{(2)} & \text{if } H(t) = \text{very bad} \end{cases}$$

(with $b^{(2)} > b^{(1)}$)

- Health status expressed in terms of ADL's or IADL's
- Problem: high sensitivity of actuarial values (premiums and reserves) w.r.t. biometric assumptions (disablement, mortality of disabled people)
- High premium for a "pure protection" product

Life care pension (or Enhanced pension)

$$B(t) = \begin{cases} b' & \text{if } H(t) = \text{good} \\ b'' & \text{if } H(t) = \text{bad} \end{cases}$$

(with $b'' > b'$)

- The uplift $b'' - b'$ can be financed by a reduction w.r.t. the basic pension b'
- Advantage: lower sensitivity w.r.t. biometric assumptions

LTC annuity combined with old-age life annuity

$$B(t) = \begin{cases} 0 & \text{if } (H(t) = \text{good}) \wedge (t < t^*) \\ b & \text{if } (H(t) = \text{good}) \wedge (t \geq t^*) \\ b' & \text{if } H(t) = \text{bad} \end{cases}$$

(e.g. with $t^* = 80$)

- An example of combo product, providing longevity insurance
- The disability state is assumed permanent $\Rightarrow$ the two benefits are mutually exclusive
- A death benefit can be added ($\Rightarrow$ bequest motivation)

LTC rider to a whole-life assurance (acceleration benefit)

$$B(t) = \begin{cases} 0 & \text{if } H(t) = \text{good} \\ C/s & \text{if } (H(t) = \text{bad}) \wedge (t \leq \min\{s, K\}) \\ 0 & \text{if } (H(t) = \text{bad}) \wedge (t > \min\{s, K\}) \end{cases}$$

where:

- C = sum assured
- s = max number of annual LTC benefits
- K = curtate lifetime from policy issue
- death benefit reduced accordingly

- Another example of combo product
- Very low sensitivity w.r.t. biometric assumptions

Double enhanced annuity

Proposed by Colin Davis (seminar at Cass Business School, City University, London, 2017)

Defined by combining:

- ▷ rating model $\Rightarrow$ underwritten annuity
- ▷ benefit structure $\Rightarrow$ LTC benefits

Formally:

$$B(t) = \Phi(\Pi, \underbrace{H(0)}_{\Uparrow}, \underbrace{H(t))}_{\Uparrow}$$

initial status — current status

BIBLIOGRAPHIC SUGGESTIONS

LTCI products & markets

J. Brown and M. Warshawsky. The Life Care annuity: a new empirical examination of an insurance innovation that addresses problems in the markets for life annuity and Long-Term Care insurance. *The Journal of Risk and Insurance*, 8(3):677–703, 2013

F. Colombo, A. Llena-Nozal, J. Mercier, and F. Tjadens. *Help Wanted? Providing and Paying for Long-Term Care*. OECD Health Policy Studies, OECD Publishing, 2011. Available at: `http://dx.doi.org/10.1787/9789264097759-en`

M. P. Freiman. Can 1+1=3? A look at hybrid insurance products with long-term care insurance. AARP Public Policy Institute, 2007. Available at: `https://assets.aarp.org/rgcenter/il/2007_11_hybrid.pdf`

D. Kessler. The Long-term Care insurance market. *The Geneva Papers on Risk and Insurance. Issues and Practice*, 33(1):33–40, 2008

E. Pitacco. *Health Insurance. Basic actuarial models*. EAA Series. Springer, 2014

Population Issues Working Group - IAA. Long-Term Care. An actuarial perspective on societal and personal challenges. International Actuarial Association, 2017

ADL & IADL

M. P. Lawton and E. M. Brody. Assessment of older people: self-maintaining and instrumental activities of daily living. *Gerontologist*, 9:179–186, 1969

J. Martin and D. Elliot. Creating an overall measure of severity of disability for the Office of Population Censuses and Surveys disability survey. *Journal of the Royal Statistical Society. Series A (Statistics in Society)*, 155(1):121–140, 1992

I. McDowell. *Measuring Health. A Guide to Rating Scales and Questionnaires*. Oxford University Press, 2006

Actuarial models

G. Biessy. Long-term care insurance: a multi-state semi-Markov model to describe the dependency process for elderly people. *Bulletin Français d'Actuariat*, 15(29):41–73, 2015

M. C. Christiansen. Multistate models in health insurance. *AStA Advances in Statistical Analysis*, 96:155–186, 2012

J. H. Fong, A. W. Shao, and M. Sherris. Multistate actuarial models of functional disability. *North American Actuarial Journal*, 19(1):41–59, 2015

S. Haberman and E. Pitacco. *Actuarial Models for Disability Insurance*. Chapman & Hall / CRC, 1999

D. J. Pritchard. Modeling disability in long-term care insurance. *North American Actuarial Journal*, 10(4):48–75, 2006

BIOMETRIC ASSUMPTIONS: A SENSITIVITY ANALYSIS

LTCI products are rather recent $\Rightarrow$ senescent disability data are scanty $\Rightarrow$ uncertainty in technical bases $\Rightarrow$ pricing difficulties

High premiums, in particular because of safety loading $\Rightarrow$ obstacle to the diffusion of these products (especially stand-alone LTC covers only providing "protection")

Uncertainty in technical bases, in particular biometric assumptions:

- probability of disablement, i.e. entering LTC state
- probability of recovery, i.e. back to healthy state
- mortality of disabled people, i.e. lives in LTC state

Need for:

- ▷ accurate *sensitivity analysis*
- ▷ focus on *product design* $\Rightarrow$ single out products whose premiums (and reserves) are not too heavily affected by the choice of the biometric assumptions

Products addressed in the sensitivity analysis

Stand-alone LTCI
(Product P1)

LTCI as an acceleration benefit in a whole-life assurance
(Product P2(s))

Package including LTC benefits, old-age life annuity, death benefit
(Products P3a($x+n$) and P3b($x+n$))

Enhanced pension (Life care pension)
(Product P4(b', b''))

The multistate model

States:

$a =$ active = healthy

$i =$ invalid = in LTC state

$d =$ died

Transitions:

$a \rightarrow i$

$a \rightarrow d$

$i \rightarrow d$

Transition probabilities according to the Markov assumption

Biometric functions (needed)

For an active (healthy) individual age x:

$q_x^{aa} =$ prob. of dying before age $x+1$ from state a

$w_x =$ prob. of becoming invalid (disablement, i.e. LTC claim) before $x+1$

For an invalid age x:

$q_x^{i} =$ prob. of dying before age $x+1$

Assumptions

q_x^{aa}: life table (first Heligman-Pollard law)

w_x: a specific parametric law

$q_x^{i} = q_x^{aa} +$ extra-mortality (i.e. additive extra-mortality model)

Life table

First Heligman-Pollard law:

$$\frac{q_x^{aa}}{1-q_x^{aa}} = a^{(x+b)^c} + d\,\mathrm{e}^{-e\,(\ln x - \ln f)^2} + g\,h^x$$

a	b	c	d	e	f	g	h
0.00054	0.01700	0.10100	0.00014	10.72	18.67	$2.00532\,\mathrm{E}-06$	1.13025

The first Heligman-Pollard law: parameters

$\overset{\circ}{e}_0$	$\overset{\circ}{e}_{40}$	$\overset{\circ}{e}_{65}$	Lexis	q_0^{aa}	q_{40}^{aa}	q_{80}^{aa}
85.128	46.133	22.350	90	0.00682	0.00029	0.03475

The first Heligman-Pollard law: some markers

Disablement (LTC claim)

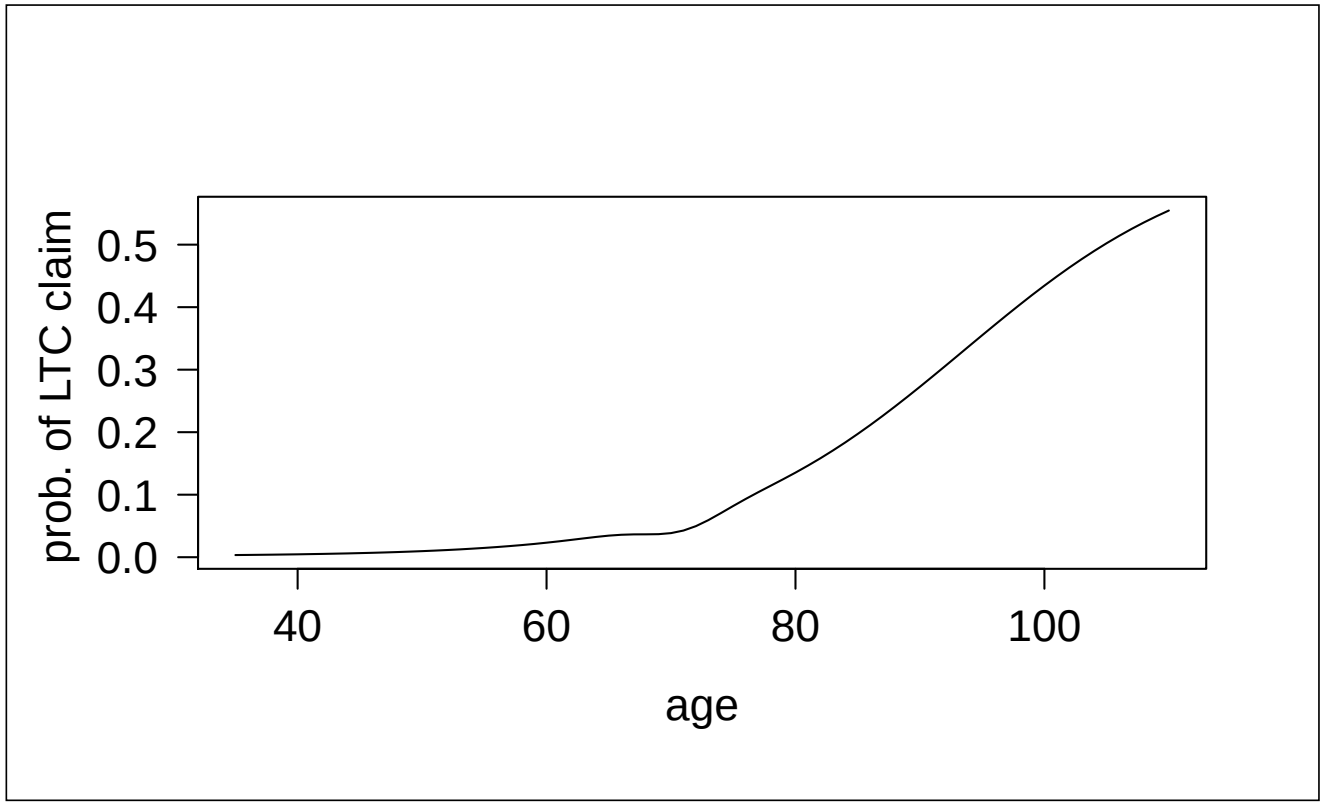
Assumption by Rickayzen and Walsh [2002]

$$w_x = \begin{cases} A + \dfrac{D-A}{1+B^{C-x}} & \text{for females} \\ \left(A + \dfrac{D-A}{1+B^{C-x}}\right)\left(1 - \dfrac{1}{3}\exp\left(-\left(\dfrac{x-E}{4}\right)^2\right)\right) & \text{for males} \end{cases}$$

Parameter	Females	Males
A	0.0017	0.0017
B	1.0934	1.1063
C	103.6000	93.5111
D	0.9567	0.6591
E	n.a.	70.3002

Parameters Rickayzen-Walsh

LTCI products *(cont'd)*



Probability of disablement (Males)

Extra-mortality

Assumption by Rickayzen and Walsh [2002]

$$q_x^{i^{(k)}} = q_x^{[\text{standard}]} + \Delta(x, \alpha, k)$$

with:

$$\Delta(x, \alpha, k) = \frac{\alpha}{1 + 1.1^{50-x}} \frac{\max\{k-5, 0\}}{5}$$

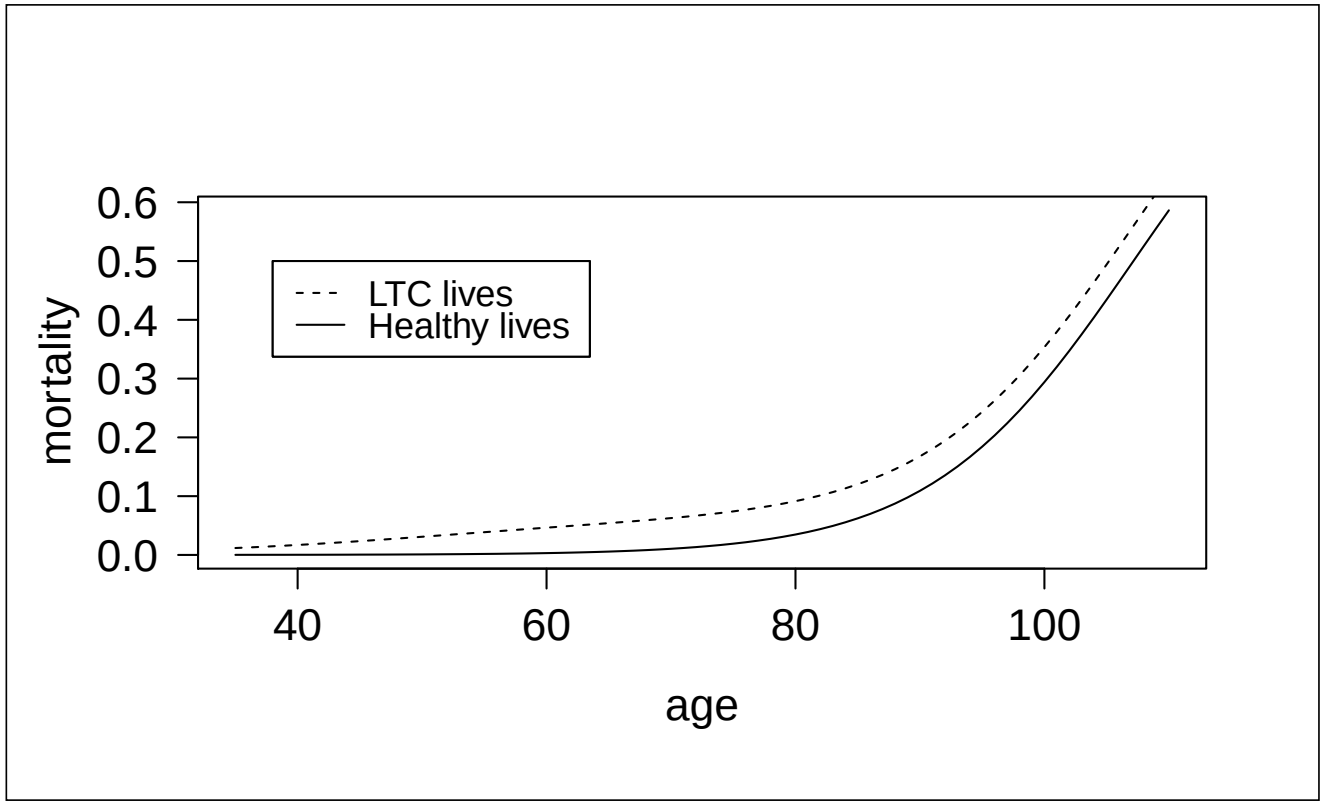
where:

- parameter k expresses LTC severity category
  - $0 \leq k \leq 5 \Rightarrow$ less severe $\Rightarrow$ no impact on mortality
  - $6 \leq k \leq 10 \Rightarrow$ more severe $\Rightarrow$ extra-mortality
- parameter α (assumption by Rickayzen [2007])

$$\alpha = 0.10 \quad \text{if } q_x^{[\text{standard}]} = q_x^{aa} \text{ (mortality of insured healthy people)}$$

Our (base) choice: $\alpha = 0.10$, $k = 8$; hence:

$$q_x^i = q_x^{aa} + \Delta(x, 0.10, 8) = q_x^{aa} + \frac{0.06}{1 + 1.1^{50-x}}$$



Mortality assumptions (Males)

Sensitivity analysis

- Probability of disablement (i.e. entering into LTC state)
- Extra-mortality of lives in LTC state

Notation:

$\Pi_x^{[\mathrm{PX}]}(\delta, \lambda)$ = actuarial value (single premium) of product PX, according to the following assumptions:

- $\delta \Rightarrow$ disablement

$$\bar{w}_x(\delta) = \delta\, w_x$$

  where w_x is given by the previous Eq. (assumption by Rickayzen and Walsh [2002])

- $\lambda \Rightarrow$ extra-mortality

$$\bar{\Delta}(x; \lambda) = \lambda\, \Delta(x, \alpha, k) = \Delta(x, \lambda\, 0.10, 8)$$

  and hence:

$$q_x^i(\lambda) = q_x^{aa} + \bar{\Delta}(x; \lambda)$$

For products P1, P2, P3, normalize and define the ratio:

$$\rho_x^{[\mathrm{PX}]}(\delta,\lambda) = \frac{\Pi_x^{[\mathrm{PX}]}(\delta,\lambda)}{\Pi_x^{[\mathrm{PX}]}(1,1)}$$

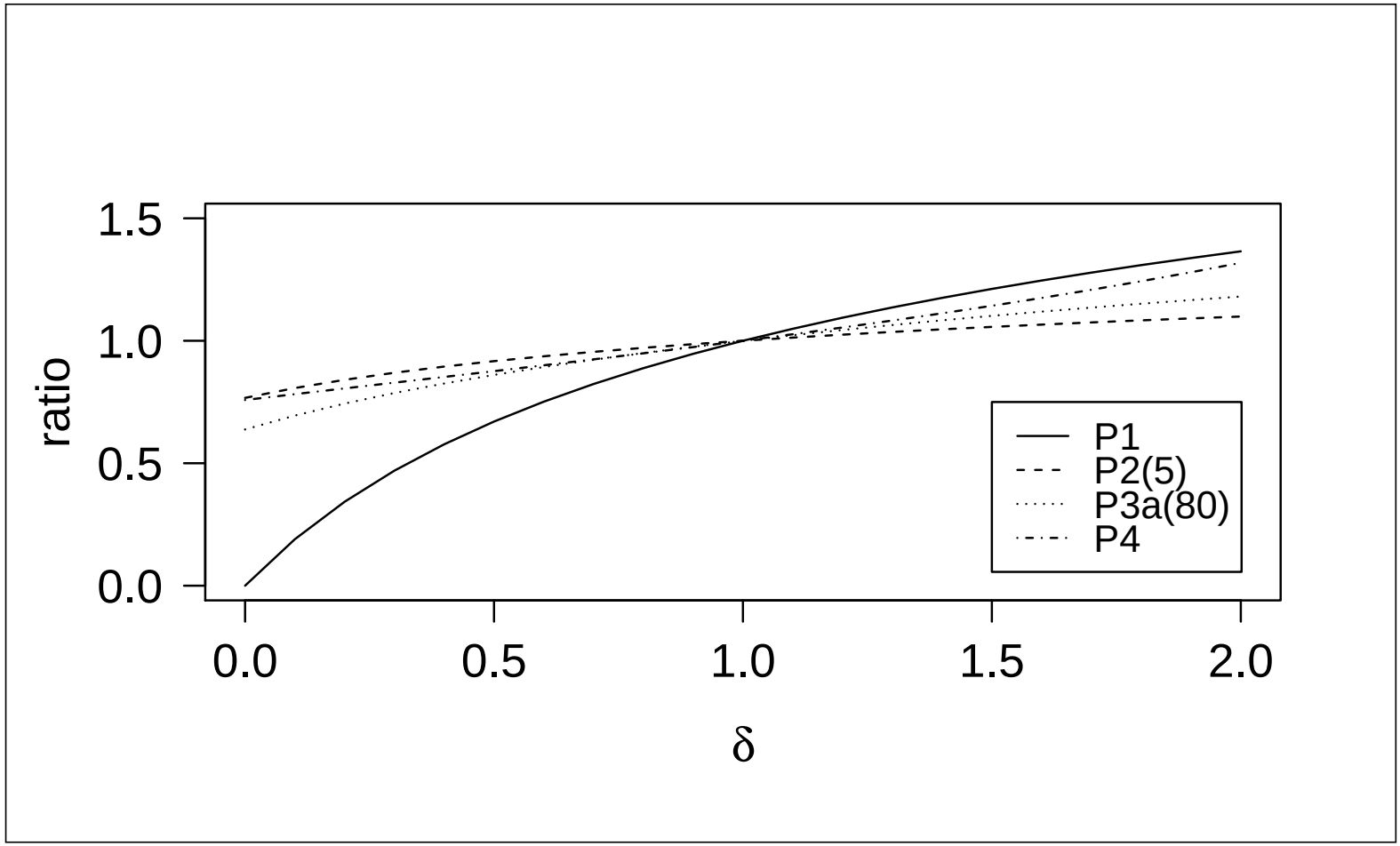
For product P4, with given b and b'', normalize and define the ratio:

$$\rho_x^{[\mathrm{P4}]}(\delta,\lambda) = \frac{b'(1,1)}{b'(\delta,\lambda)}$$

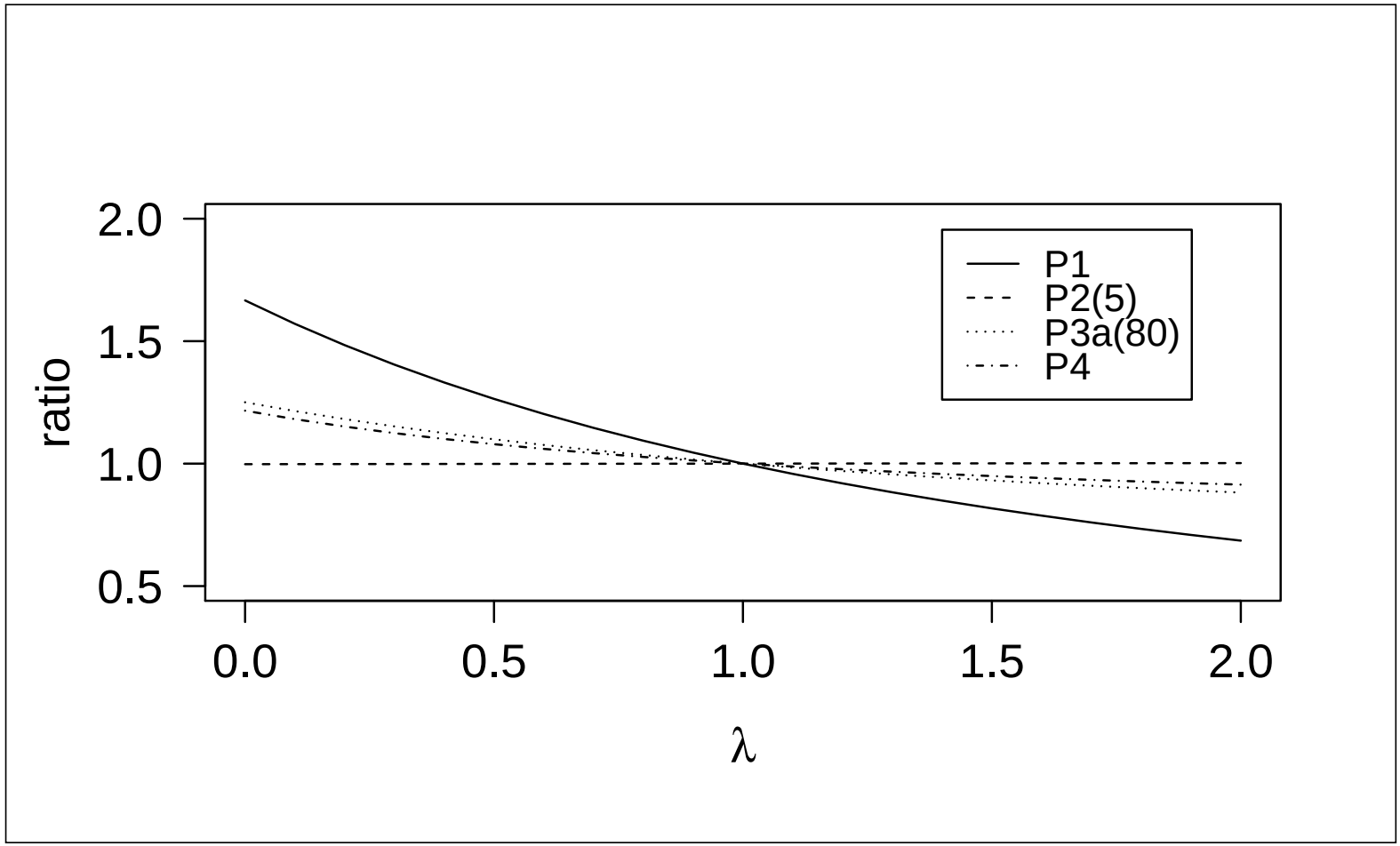
For all the products, we first perform *marginal* analysis, i.e. tabulating the functions:

$$\Pi_x^{[\mathrm{PX}]}(\delta,1),\ \rho_x^{[\mathrm{PX}]}(\delta,1);\quad \Pi_x^{[\mathrm{PX}]}(1,\lambda),\ \rho_x^{[\mathrm{PX}]}(1,\lambda)$$

Sensitivity analysis: disablement assumption (parameter δ)



Sensitivity analysis: extra-mortality assumption (parameter λ)



Joint sensitivity analysis (parameters δ, λ)

For the generic product PX, and a given age x, find (δ, λ) such that:

$$\rho_x^{[\mathrm{PX}]}(\delta, \lambda) = \rho_x^{[\mathrm{PX}]}(1, 1) = 1 \qquad (^*)$$

Eq. $(^*)$ implies

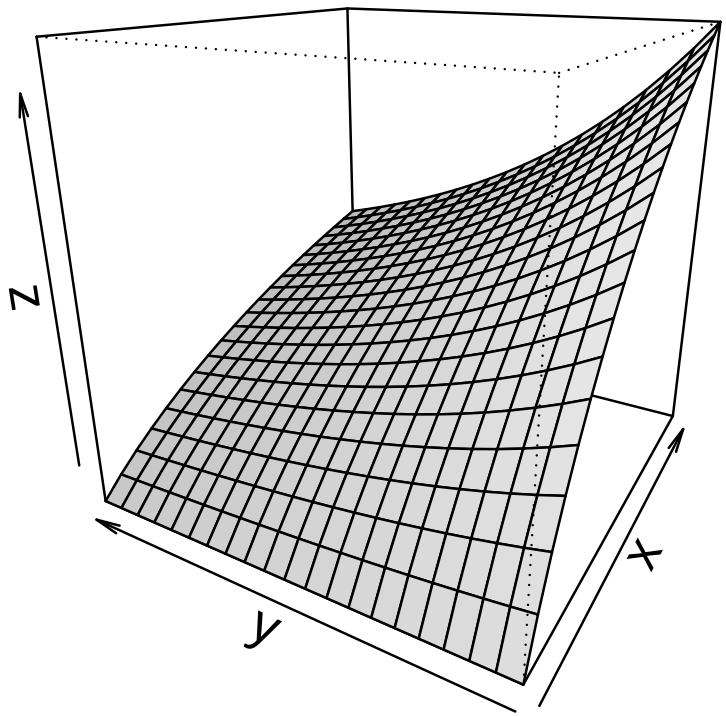
- for products P1, P2, P3:

$$\Pi_x^{[\mathrm{PX}]}(\delta, \lambda) = \Pi_x^{[\mathrm{PX}]}(1, 1)$$

- for product P4:

$$b'(\delta, \lambda) = b'(1, 1)$$

LTCI products *(cont'd)*

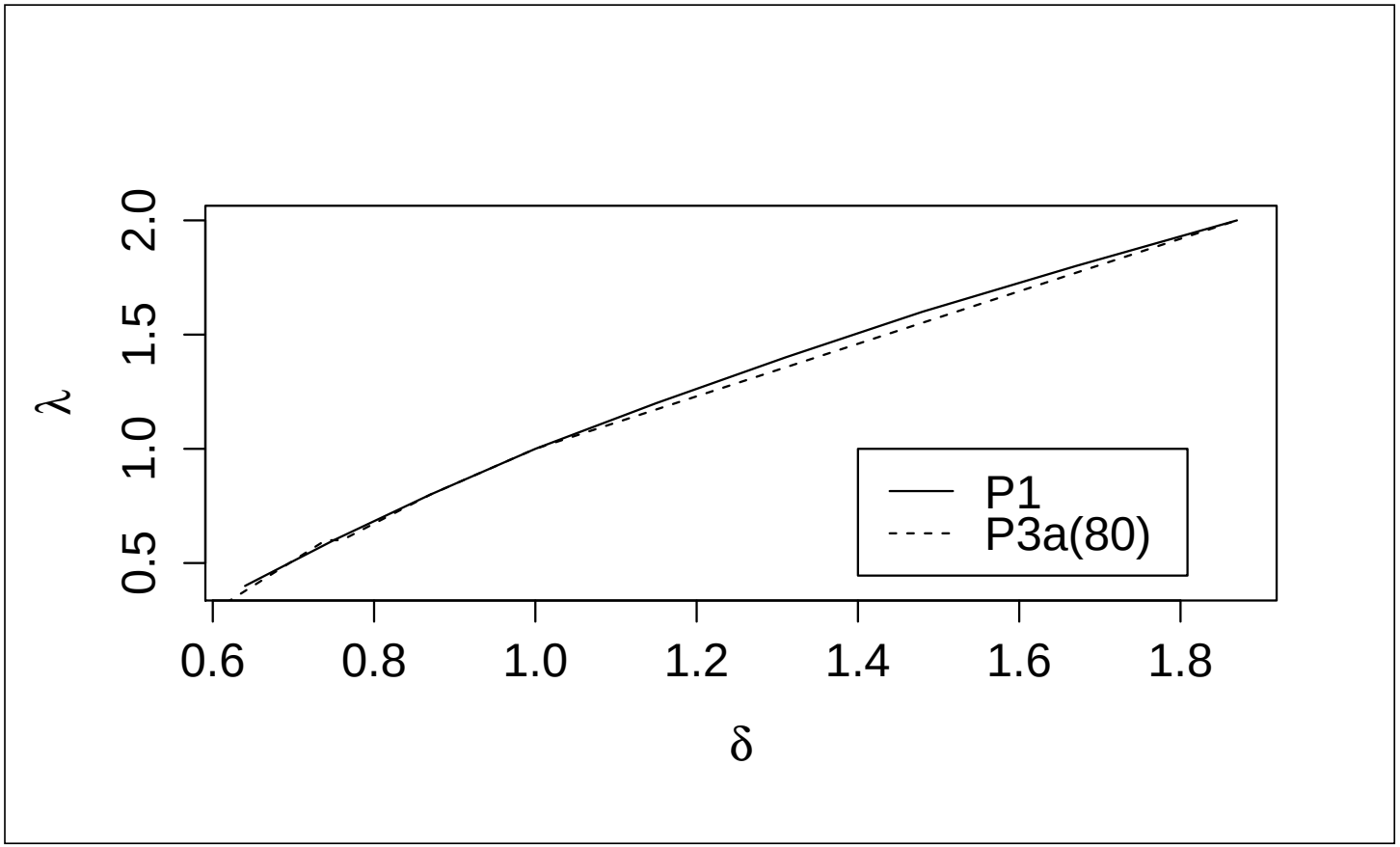


Product P3a(80)

$x = \delta \Rightarrow$ *disablement*

$y = \lambda \Rightarrow$ *extra-mortality*

$z = \Pi \Rightarrow$ *premium*



Offset effect: isopremium lines

Combo LTCI products: mainly aiming at reducing the relative weight of the risk component by introducing a "saving" component, or by adding the LTC benefits to an insurance product with an important saving component

Combined insurance products in the area of health insurance:

- Insurer's perspective
  - ▷ a combined product can result profitable even if one of its components is not profitable
  - ▷ a combined product can be less risky than one of its components (less exposed to the impact of uncertainty risk related to the choice of technical bases)
- Client's perspective $\Rightarrow$ purchasing a combined product can be less expensive than separately purchasing all the single components (in particular: reduction of acquisition costs charged to the policyholder)

Bibliographic suggestions

E. Pitacco. Premiums for long-term care insurance packages: Sensitivity with respect to biometric assumptions. *Risks*, 4(1), 2016. Available at: `http://www.mdpi.com/2227-9091/4/1/3`

B. D. Rickayzen. An analysis of disability-linked annuities. Actuarial Research Paper No. 180, Faculty of Actuarial Science & Insurance, City University, London, 2007. Available at: `http://openaccess.city.ac.uk/2312/1/180ARP.pdf`

B. D. Rickayzen and D. E. P. Walsh. A multi-state model of disability for the United Kingdom: Implications for future need for Long-Term Care for the elderly. *British Actuarial Journal*, 8:341–393, 2002

PURCHASING LTCI: REVERSE MORTGAGE

PREMIUM ARRANGEMENTS

Feasibility of various premium arrangements depends on the specific LTC product concerned

Some examples follow

Care annuities

"Point-of-need" plan: benefit structure as in the immediate life annuity
$\Rightarrow$ singe premium required

Stand alone product

Benefit structure: a (possible) deferred annuity with random deferment from policy issue

- ▷ single premium
- ▷ periodic premiums, while the insured is in the healthy state, in particular:
  - unlimited level premiums
  - temporary level premiums

LTC rider to a whole-life assurance

- single premium
- periodic premiums, while the insured is in the healthy state, in particular:
  - unlimited level premiums
  - temporary level premiums
- single recurrent premiums, while the insured is in the healthy state
  $\Rightarrow$ sum assured and hence LTC benefit progressively determined, according to premiums actually paid

REVERSE MORTGAGE SOLUTIONS

Purposes of reverse mortgage: to provide retirees with liquidity, by converting real estate assets into

- ▷ lump sum
- ▷ periodic income

$\Rightarrow$ additional funding to finance consumption, medical costs, nursing home costs (LTC costs)

Basic features of reverse mortgage

- Liquidity is provided against a mortgage charge on the borrower's real estate (house, in particular)
- Contract termination:
  - ▷ borrower's death
  - ▷ permanent move-out of borrower's house

  $\Rightarrow$ house is sold, to repay the outstanding loan amount

Provider's risks in reverse mortgage transaction

- Biometric risk
  - ▷ longevity risk $\Rightarrow$ delay in termination (more severe risk in income arrangement)
- Investment risks
  - ▷ interest rate risk
  - ▷ real estate depreciation

No-negative-equity guarantee

Protection for the plan holder:

- ensures that the debt never exceeds the value of the property
- no debt can be levied on borrower's beneficiaries

Securitization of provider's risks

Securitization:

$\Rightarrow$ transferring and financing risks related to reverse mortgage transactions

$\Rightarrow$ an interesting example of ART (Alternative Risk Transfers)

Securitization structures (similar to those applied in traditional insurance products)

- survivor bonds
- survivor swaps

BIBLIOGRAPHIC SUGGESTIONS

D. H. Alai, H. Chen, D. Cho, K. Hanewald, and M. Sherris. Developing equity release markets: Risk analysis for reverse mortgages and home reversions. UNSW Australian School of Business. Research Paper No. 2013ACTL01, 2013

H. Chen, S. H. Cox, and S. S. Wang. Is the home equity conversion mortgage in the United States sustainable? Evidence from pricing mortgage insurance premiums and non-recourse provisions using conditional Esscher transform. *Insurance: Mathematics and Economics*, 46(2):371–384, 2010

D. Cho, K. Hanewald, and M. Sherris. Risk management and payout design of reverse mortgages. In *Actuaries Summit*, Sydney, 2013. Actuaries Institute

P. Chinloy and I. F. Megbolugbe. Reverse mortgages: Contracting and crossover risk. *Real Estate Economics*, 22(2):367–386, 1994

G. M. Hosty, S. J. Groves, C. A. Murray, and M. Shah. Pricing and risk capital in the equity release market. *British Actuarial Journal*, 14(1):41–91, 2008

Purchasing LTCI: reverse mortgage *(cont'd)*

H. C. Huang, C. W. Wang, and Y. C. Miao. Securitisation of crossover risk in reverse mortgages. *The Geneva Papers on Risk and Insurance. Issues and Practice*, 36(4): 622–647, 2011

M. Ji. A semi-Markov multiple state model for reverse mortgage terminations. *Annals of Actuarial Science*, 1(1):1–23, 2011

Y. T. Lee, C. W. Wang, and H. C. Huang. On the valuation of reverse mortgages with regular tenure payments. *Insurance: Mathematics and Economics*, 51(2):430–441, 2012

A. Shao, M. Sherris, and K. Hanewald. On the valuation of reverse mortgages with regular tenure payments. In *Proceedings of the 11th Emerging Researchers in Ageing Conference*, 2012

Y. K. Tse. Modelling reverse mortgages. *Asia Pacific Journal of Management*, 12(2): 79–95, 1995

L. Wang, E. A. Valdez, and J. Piggott. Securitization of longevity risk in reverse mortgages. *North American Actuarial Journal*, 12(4):345–371, 2008

CONCLUDING REMARKS

Main issues:

- Shift from traditional products (“single benefit”) to combo products
  - ▷ insurer’s perspective $\Rightarrow$ better risk profile
  - ▷ insured’s perspective $\Rightarrow$ more attractive
- Purchasing insurance products
  - ▷ various premium arrangements
  - ▷ reverse mortgage solutions providing liquidity

Many thanks for your kind attention !