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Actuarial models and biometric assumptions for disability and long-term care

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PART 1

THE INSURANCE PRODUCTS

1 INTRODUCTION

Disability Insurance (providing disability annuities, i.e. Income Protection, IP) and Long-Term Care Insurance (LTCI) belong to the area of *Health Insurance*

Health Insurance belongs to the broader area of *Insurances of the Person* (see following Figure)

Benefit amount in Health Insurance can be:

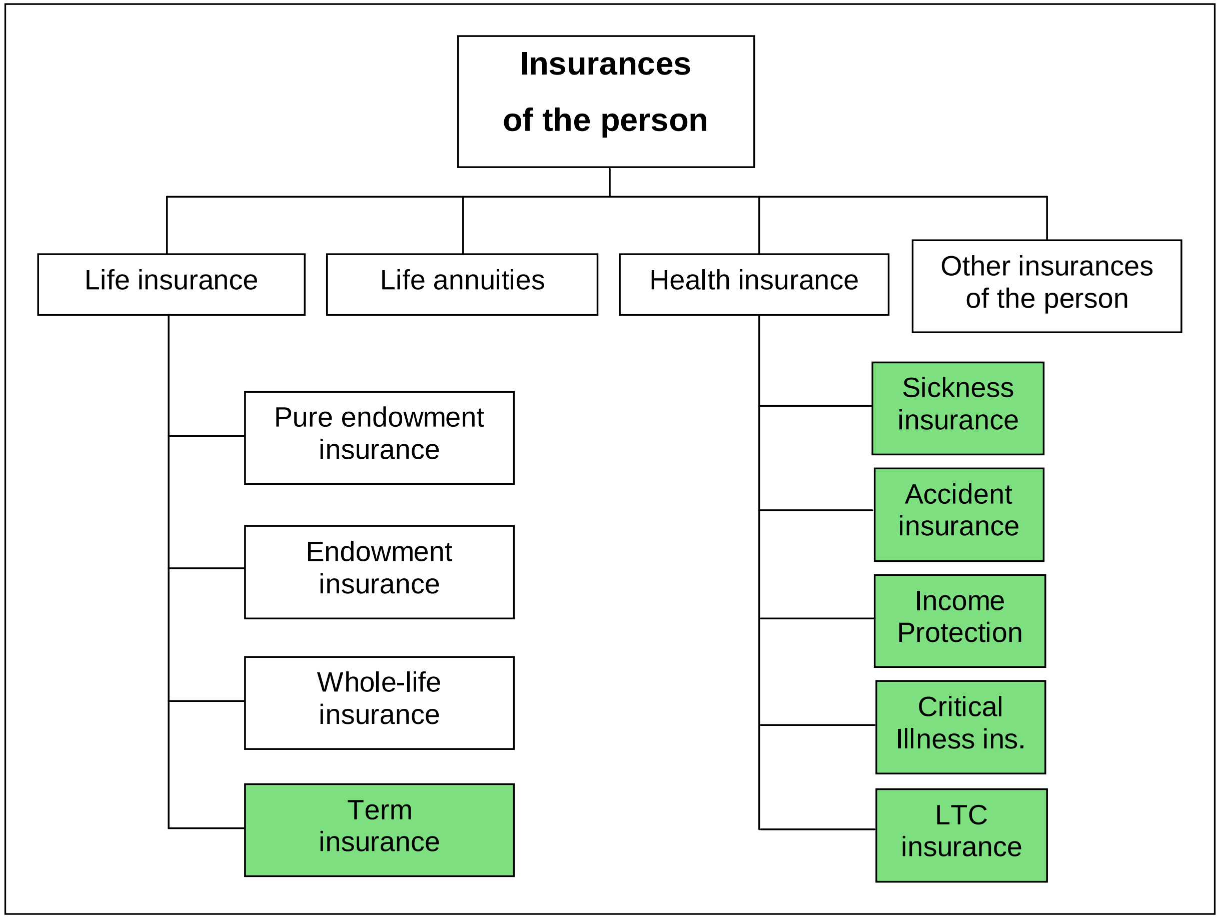
- fixed
- degree-related (i.e. depending on the severity of the disability or the LTC state)
- expense-related (i.e. reimbursement of health care expenses)

(see Figure)

For more information on health insurance products, see:

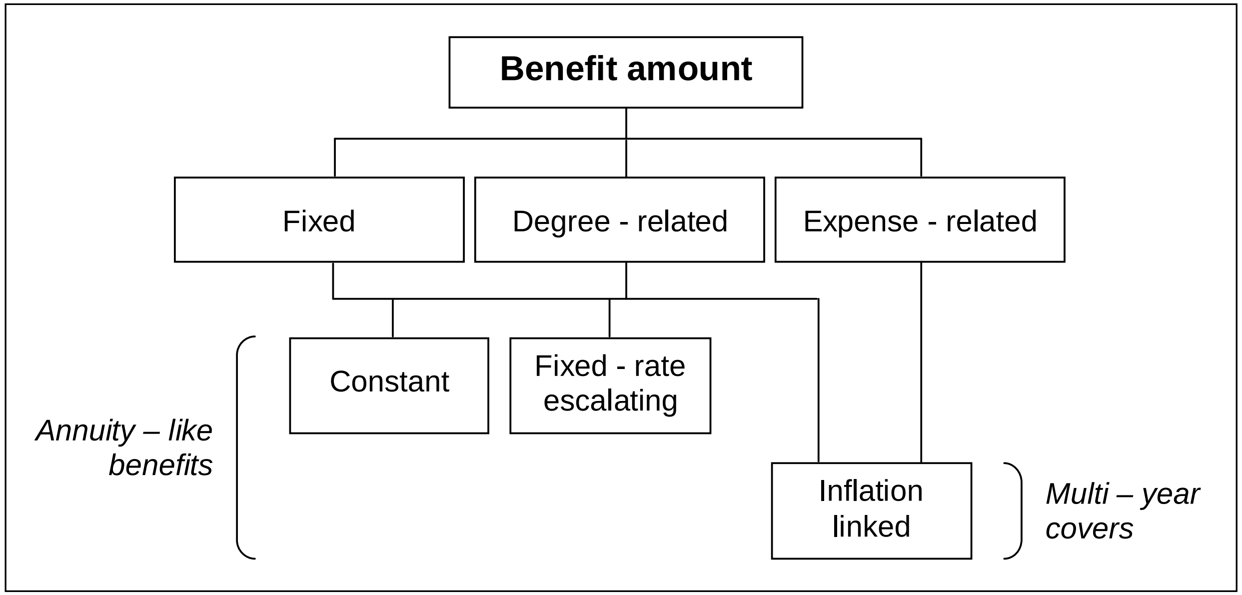
Bartleson [1968], Black and Skipper [2000], O'Grady [1988]

Introduction *(cont'd)*



Insurances of the person: basic products

Introduction *(cont'd)*



Defining the benefit amount: a classification

2 DISABILITY ANNUITIES (INCOME PROTECTION)

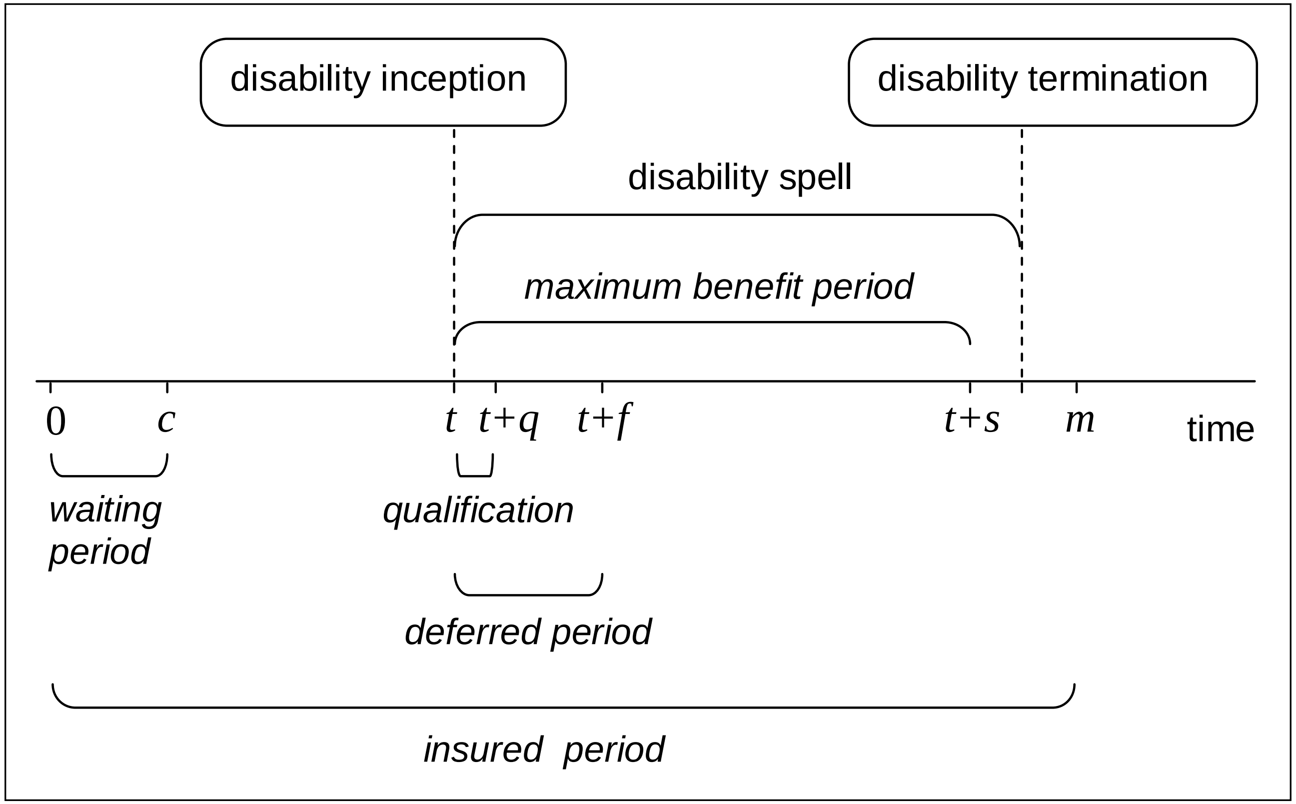
Benefit: an annuity paid while the insured is prevented from working because of either accident or sickness

Various possible definition of disability; in particular:

- the insured is unable to engage in his/her own occupation
- the insured is unable to engage in his/her own occupation or carry out another activity consistent with his/her training and experience
- the insured is unable to engage in any gainful occupation

Several policy conditions, in particular regarding the insured period (or cover period) and the benefit payment duration (see following Figure)

Disability annuities (IP) *(cont'd)*



Some policy conditions

3 LONG-TERM CARE INSURANCE

Long-Term Care 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 ($\Rightarrow$ disability implying dependence)

Severity of disability measured according to various scales (ADL, IADL) See: McDowell [2006], Martin and Elliot [1992]

Types of LTC benefit:

- benefits with *predefined amount* (usually, lifelong annuities)
  - ▷ *fixed-amount* benefits;
  - ▷ *degree-related* (or *graded*) benefits, i.e. amount graded according to the degree of dependence (e.g. according to ADL)
- reimbursement (usually partial) of nursery and medical expenses, i.e. *expense-related* benefits
- *care service* benefits (for example provided by the Continuing Care Retirement Communities, CCRCs)

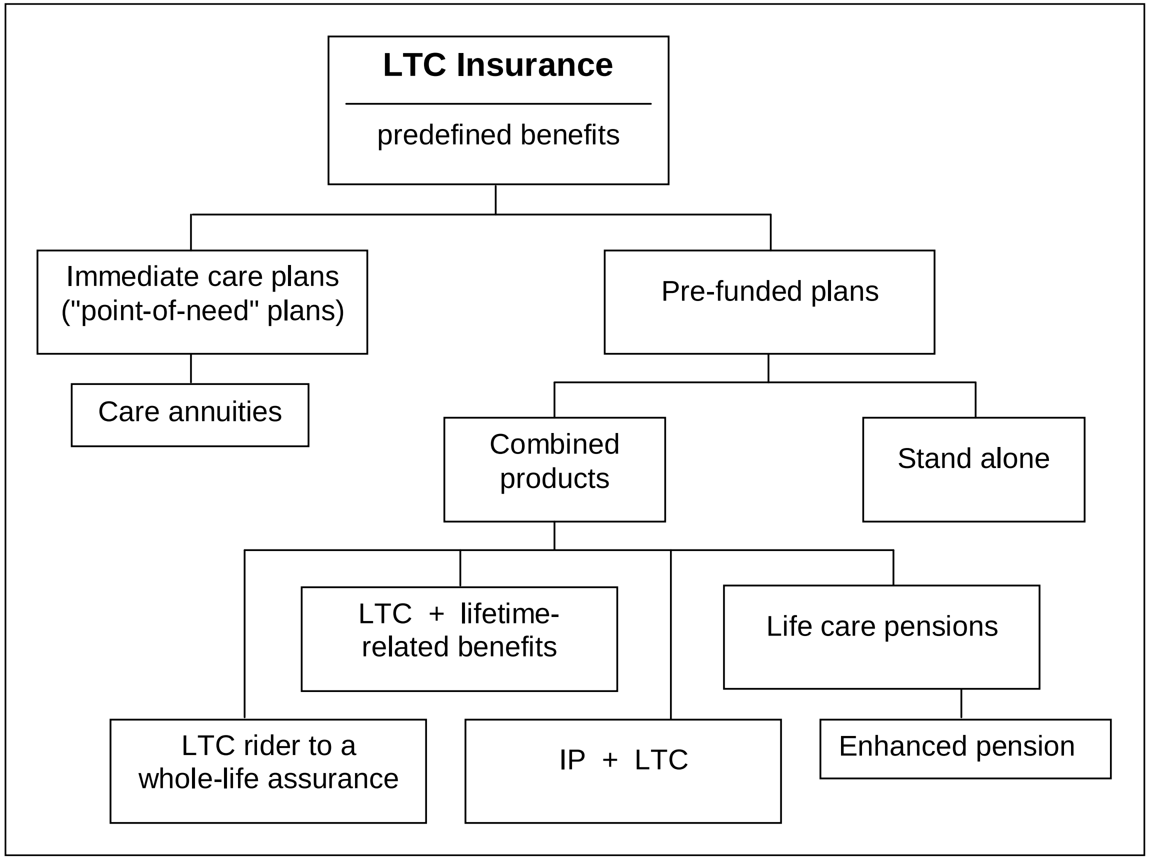
Long-term care insurance *(cont'd)*

Classification of LTCI products which pay out benefits with predefined amount (see following Figure)

- *immediate care plans* relate to individuals already affected by disability
- *pre-funded plans*, i.e. relying on an accumulation phase
  - ▷ stand-alone
  - ▷ combined products

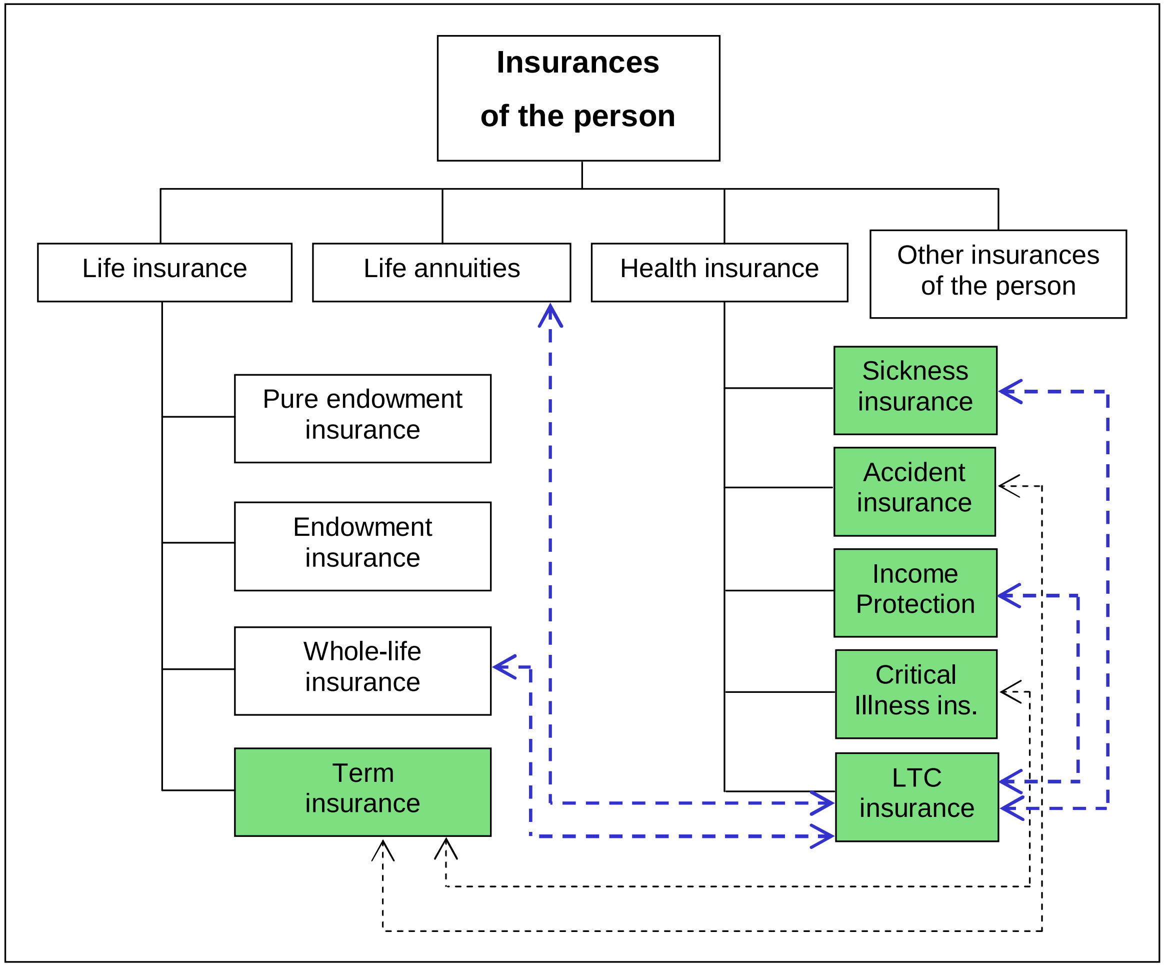
Several examples of insurance packages in which health-related benefits are combined with lifetime-related benefits (see Figure)

Long-term care insurance *(cont'd)*



A classification of LTCI products providing predefined benefits

Long-term care insurance *(cont'd)*



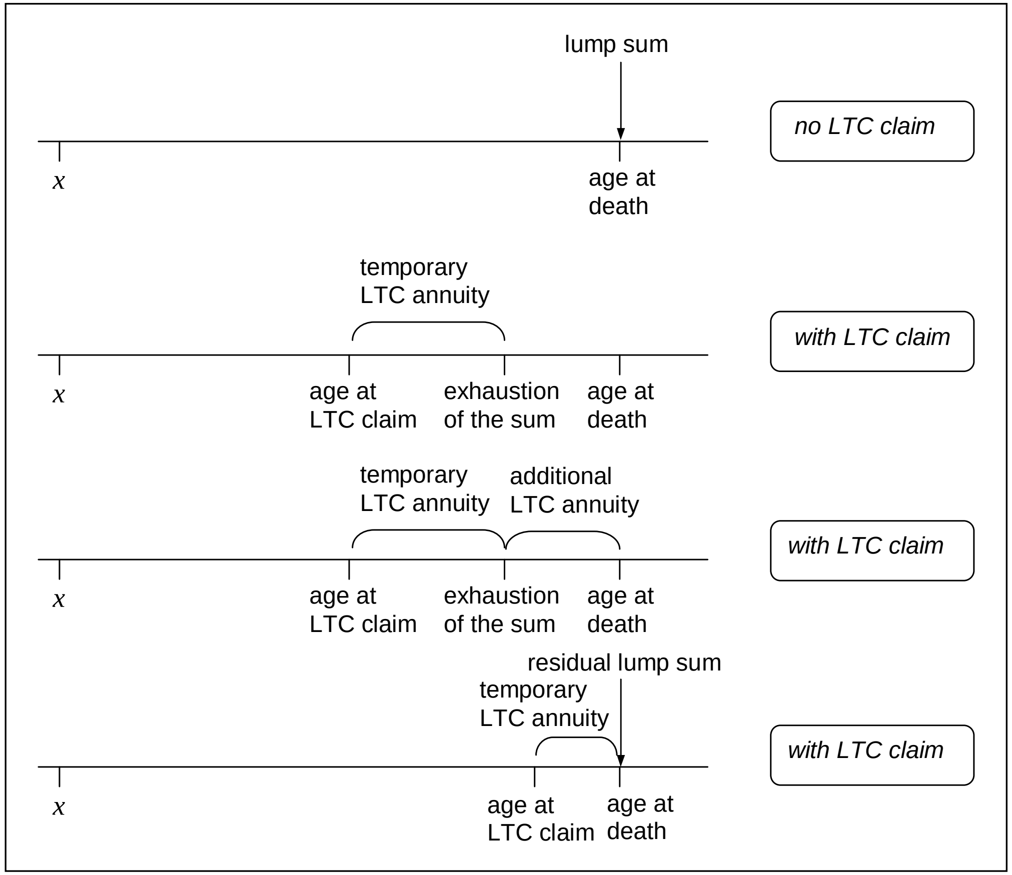
Combining health and life benefits

Long-term care insurance *(cont'd)*

Examples

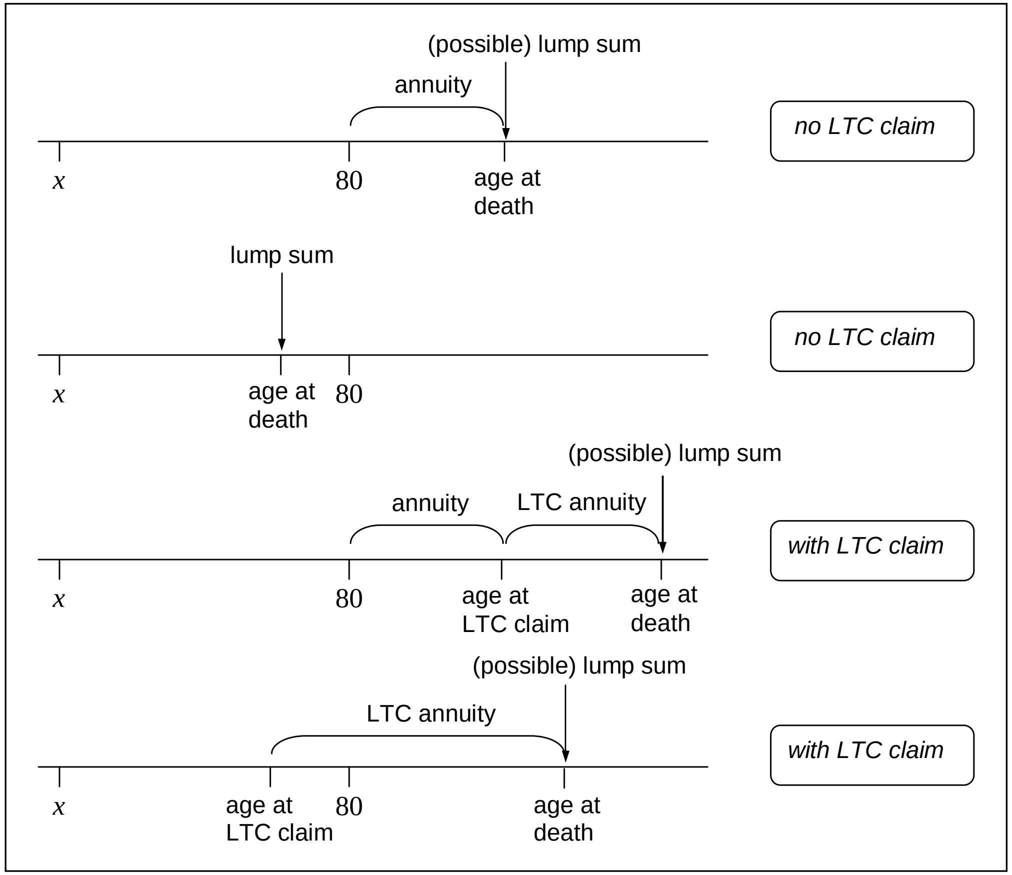
1. *Whole-life assurance with LTCI as an acceleration benefit*: annual benefit = $\dfrac{\text{sum assured}}{r}$ paid for r years at most
2. LTC benefits combined with *lifetime-related benefits*
   (a) a lifelong LTC annuity (from the LTC claim on)
   (b) a deferred life annuity (e.g. from age 80), while the insured is not in LTC disability state
   (c) a lump sum benefit on death, alternatively given by
      i. a fixed amount, stated in the policy
      ii. the difference (if positive) between a stated amount and the amount paid as benefit 1 and/or benefit 2

Long-term care insurance *(cont'd)*



Whole-life assurance with LTCI as an acceleration benefit: possible outcomes

Long-term care insurance *(cont'd)*



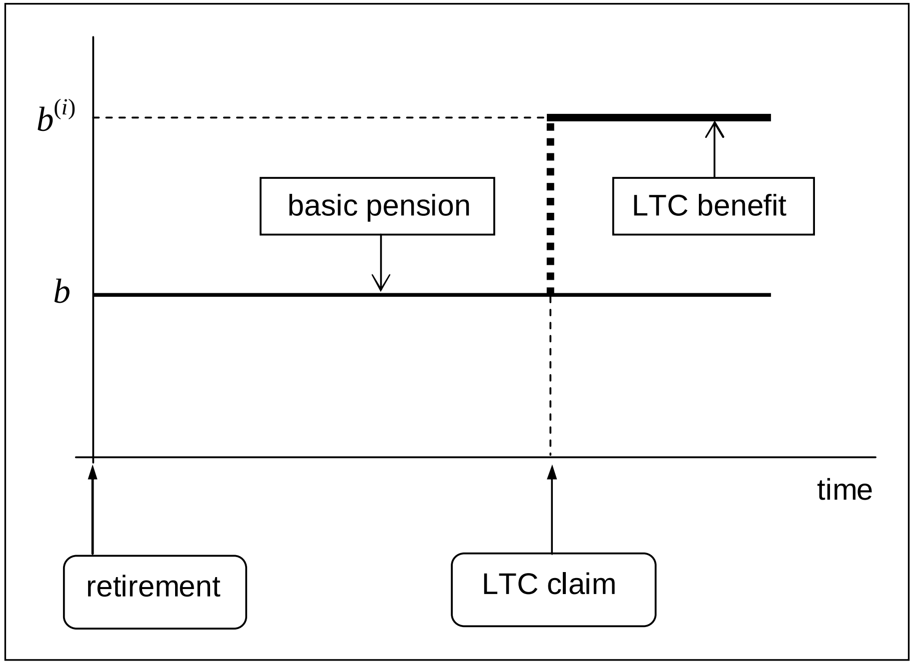
Insurance package including LTC annuity: possible outcomes

Long-term care insurance *(cont'd)*

3. *Life care pensions* (or *life care annuities*): LTC benefit defined as uplift with respect to the basic pension; basic pension b paid from retirement onwards, and replaced by $b^{(i)}$ ($b^{(i)} > b$) in the case of LTC claim. See Figure. Uplift can be financed during the whole accumulation period by premiums higher than those needed to purchase the basic pension b
   - *enhanced pension*: a particular life care pension with uplift financed by a reduction (with respect to the basic pension b) of the benefit paid while the policyholder is healthy $\Rightarrow$ reduced benefit $b^{(a)}$ paid as long as the retiree is healthy, uplifted benefit $b^{(i)}$ paid in the case of LTC claim (of course, $b^{(a)} < b < b^{(i)}$)

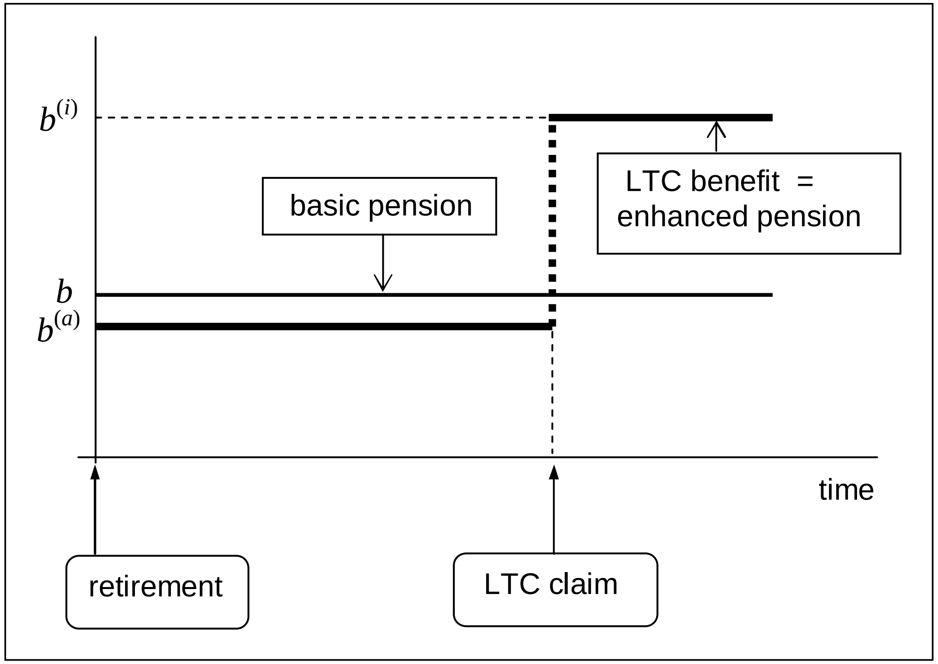
   See following Figures

Long-term care insurance *(cont'd)*



Benefits provided by a life care pension product

Long-term care insurance *(cont'd)*



Benefits provided by an enhanced pension product

Long-term care insurance *(cont'd)*

For more information on LTCI products see:

Ainslie [2000], American Academy of Actuaries [1999], Brown and Warshawsky [2013], Dullaway and Elliott [1998], Elliott et al. [2012], Jones [2004], Merlis [2004], Murtaugh et al. [2001], Nuttall et al. [1994], Warshawsky [2007], Whynes [1996], Zhou-Richter and Gründl [2011], Zweifel [1996]

PART 2

MODELS AND ASSUMPTIONS

4 INTRODUCTION

Actuarial models for Health Insurance products $\Rightarrow$ a mix of non-life insurance and life insurance features

Disability insurance (IP annuities) and LTCI:

- long-term contracts
- annuity-like benefits (lifelong in LTCI)

Hence, need for:

▷ biometric assumptions (in particular, lifetime probability distribution)

▷ financial aspects (investment, interest rate guarantee)

Biometric assumptions other than those required for life insurance and life annuities:

- probability of entering a disability state
- probability of leaving a disability state (mortality, recovery)

Introduction *(cont'd)*

Further:

- statistical experience shows the impact of time spent in disability state on probabilities of leaving that state $\Rightarrow$ *inception-select* probabilities
- non-Markov models should be used to express the probabilistic structure

Data scarcity $\Rightarrow$ various approx calculation methods, in several cases disregarding the disability past-duration effect

See actuarial models for disability annuities

5 ACTUARIAL MODELS FOR DISABILITY ANNUITIES

Assume statistical data of a given type available according to a given format $\Rightarrow$ (approximate) calculation procedures often chosen consistently with type and format

Following Figure: a classification of actuarial methods for disability annuities (IP), including methods adopted in actuarial practice

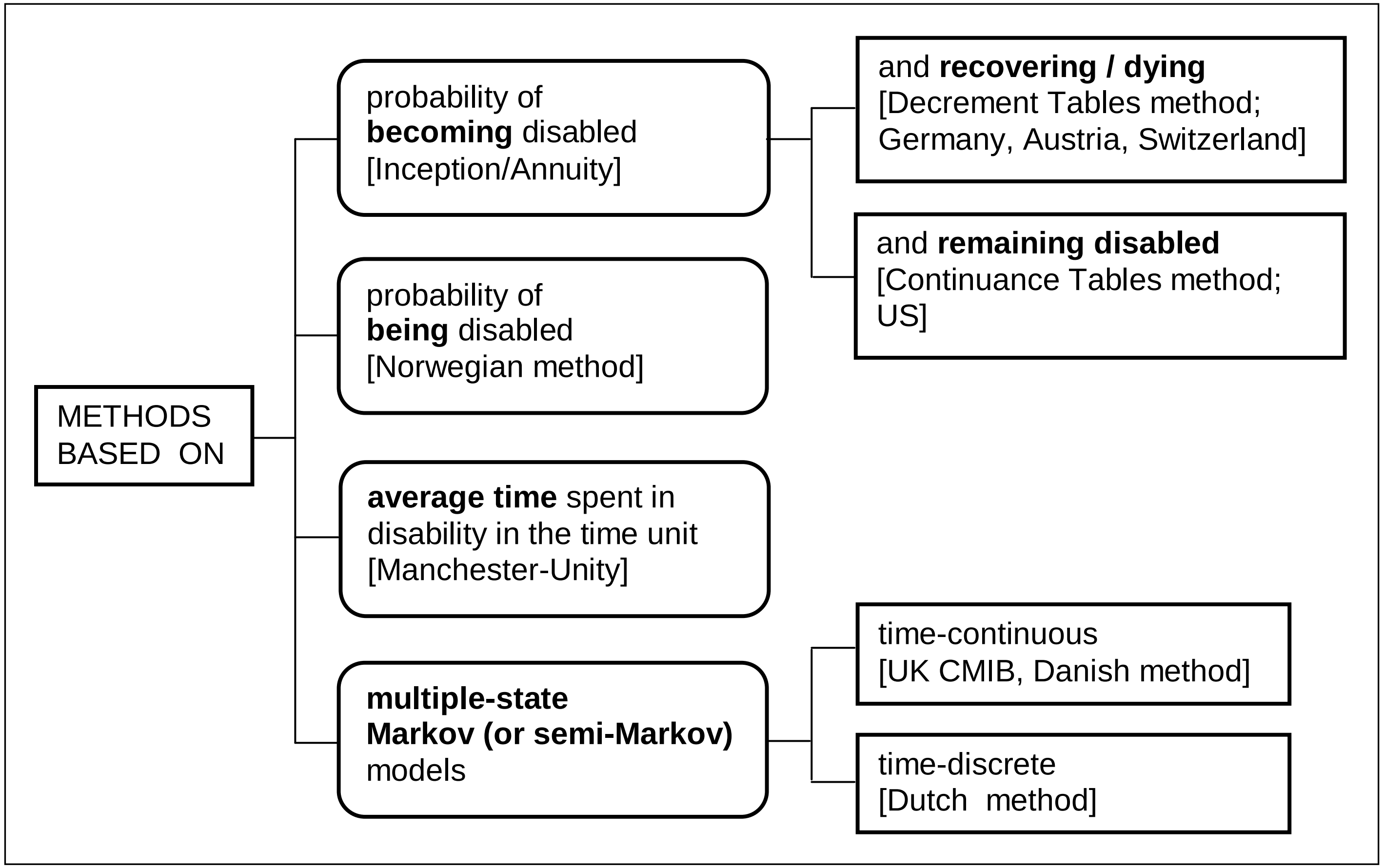
See: Haberman and Pitacco [1999] and references therein

Methods adopted in actuarial practice are *deterministic*: although relying on probabilities, only expected values are usually considered for pricing an reserving

Stochastic methods, relying on MonteCarlo simulation procedures, allow assessment of risks inherent in managing an IP portfolio

A stochastic approach to the evaluation of a disability insurance portfolio is proposed in: Haberman et al. [2004]

Actuarial models for disability annuities *(cont'd)*



A classification of approaches to actuarial calculations for disability annuities

6 CONVERTING DATA

Assume that disability data are available as *prevalence rates*:

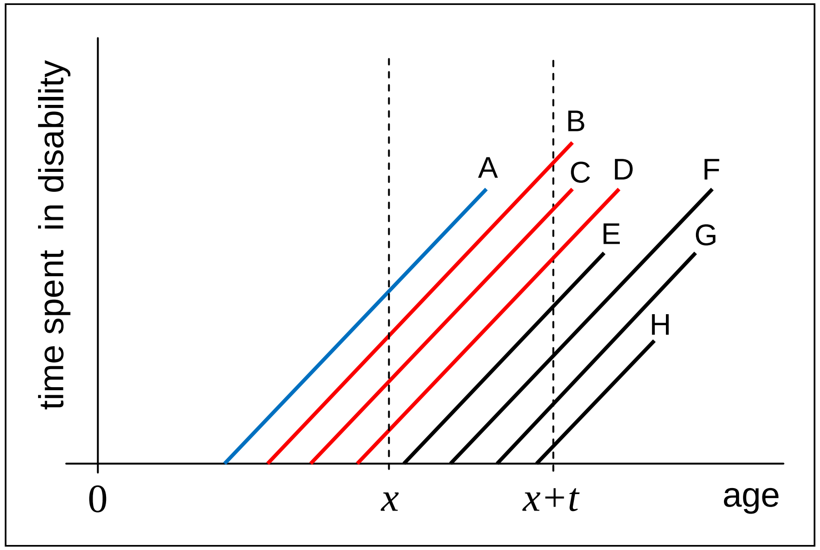
$$\frac{\text{number of people disabled at age } y}{\text{number of people alive at age } y}$$

Data available e.g. from social security database, or public health system database

These date cannot be directly used for insurance purposes, e.g. to assess the probability of *being disabled*, as they do not assume the individual was healthy at a given age, viz the age at policy issue

See following Figure

Converting data *(cont'd)*



Some individual disability stories in a population

Refer to a portfolio consisting of a cohort entering insurance at age x

Individuals B, C and D (in the population), disabled at age $x+t$, should not be accounted for when determining the disability prevalence rate at age $x+t$, because entered the disability state before age x

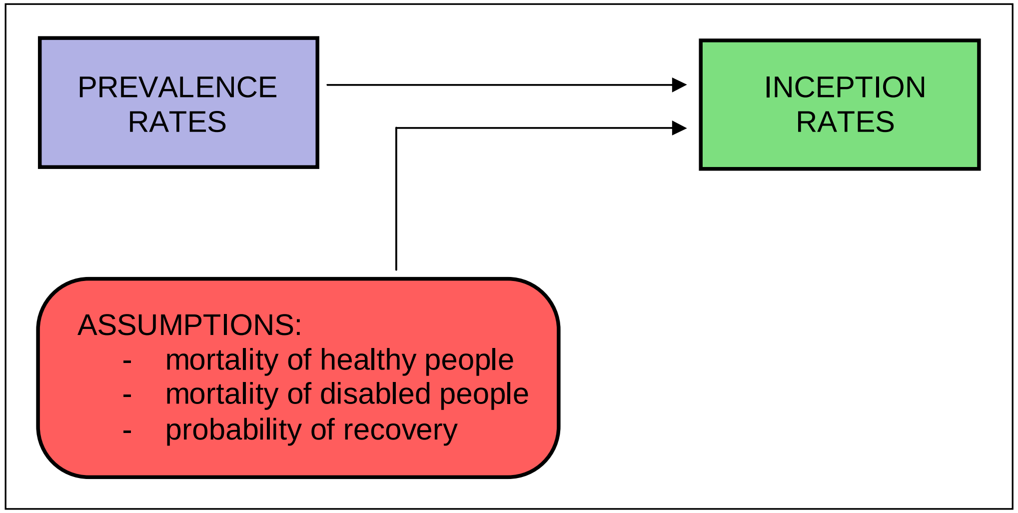
Converting data *(cont'd)*

Two basic approaches available

- Adjustment of the prevalence rates
  - ▷ j_{x+t} = prevalence rate at age $x + t$ (smoothed frequency)
  - ▷ define: $j_{(x)+t} = j_{x+t}\,\alpha(t)$ ($\alpha(t)$ = adjustment coefficient)
  - ▷ take $j_{(x)+t}$ as the probability of an individual healthy at age x being disabled at age $x + t$
  - ▷ method implemented in Norway
- Converting prevalence rates into *inception rates* $\Rightarrow$ probabilities of *becoming disabled*
  - ▷ set of (critical) assumptions needed

  See following Figure

Converting data *(cont'd)*



Converting disability data

A procedure for converting prevalence data into inception data proposed by:
Gatenby [1991] referring to LTCI, with two severity-related disability states

7 ACTUARIAL MODELS FOR LTCI

Actuarial models for LTCI are basically similar to actuarial models for IP, but:

- ▷ more complicated because more than one disability state must be involved in the case of degree-related benefits (e.g. according to ADL or IADL)
- ▷ simpler because possibility or recovery is usually disregarded (the related probability is very small because of the usually chronic character of the disability)

Prevalence data are usually available

To implement an inception/annuity approach (see actuarial models for disability annuities) prevalence data must be converted into inception data

See: Gatenby [1991] for a procedure applicable to LTCI insurance with 2 disability states

Actuarial models for LTCI *(cont'd)*

Actuarial methods for LTCI are also dealt with in:

American Academy of Actuaries [1999], Dullaway and Elliott [1998], Gatenby [1991], Haberman and Pitacco [1999], Leung [2004], Pitacco [1994], Society of Actuaries Long-Term Care Insurance Valuation Methods Task Force [1995]

For longevity risk in LTCI see: Olivieri and Ferri [2003], Olivieri and Pitacco [2002]

8 LTCI: SOME NUMERICAL RESULTS

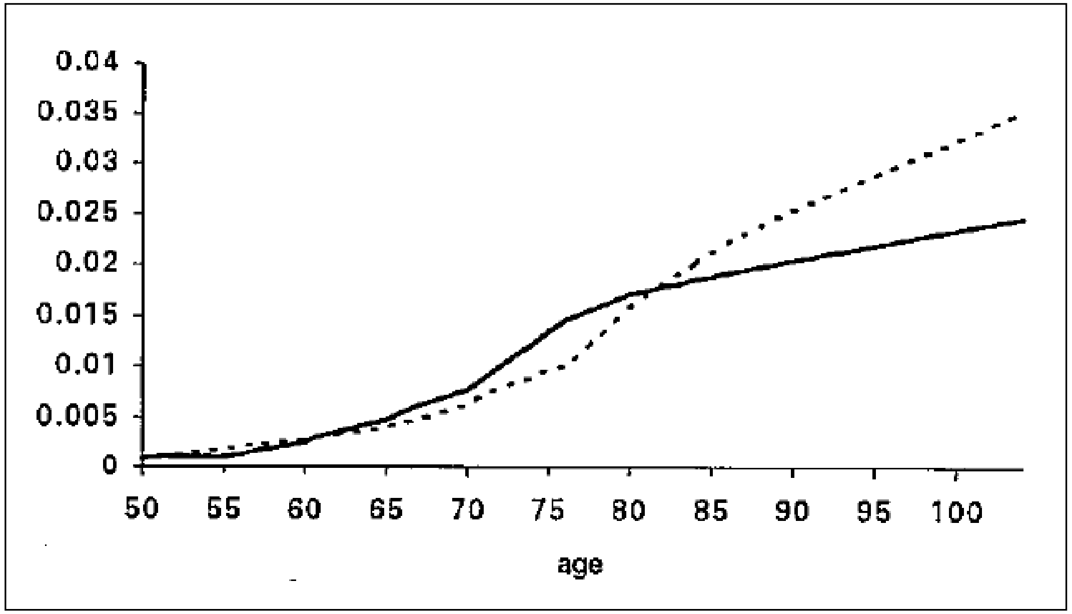
Consider two LTC disability states i', i''

Probabilities of entering (from the healthy state) state i' and i'' have been derived from OPCS prevalence data according to Gatenby's procedure
See Figure

- solid line: healthy $\rightarrow$ i'
- dotted line: healthy $\rightarrow$ i''

Mortality of disabled people have been obtained by increasing the mortality observed in the population according to the multiplicative model, with parameters η_1, η_2

LTCI: some numerical results *(cont'd)*



Probabilities of becoming disabled from OPCS data

LTCI: some numerical results *(cont'd)*

Refer to a LTC *stand-alone cover*, allowing for two disability states i', i''

Benefits:

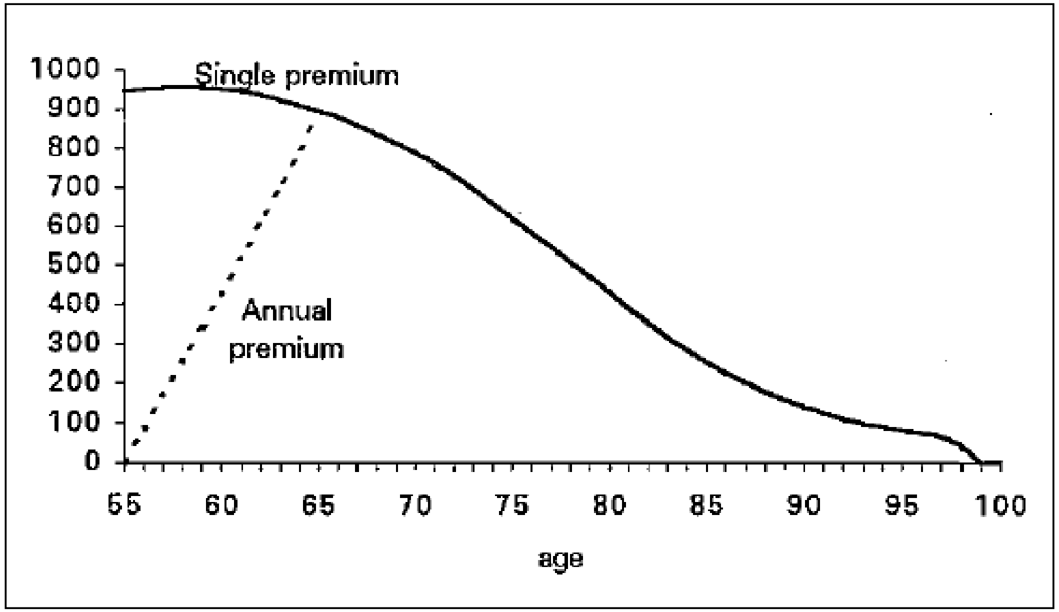
- ▷ b' if disability state = i'
- ▷ b'' if disability state = i''

Following Figures:

- active reserve
- disabled reserves
  - LTC state i' reserve
  - LTC state i'' reserve

Note the different reserve amounts for any given age $\Rightarrow$ jump in the reserve profile when shifting from healthy state to state i' or to state i'' (jump = "sum at risk" in the life insurance language)

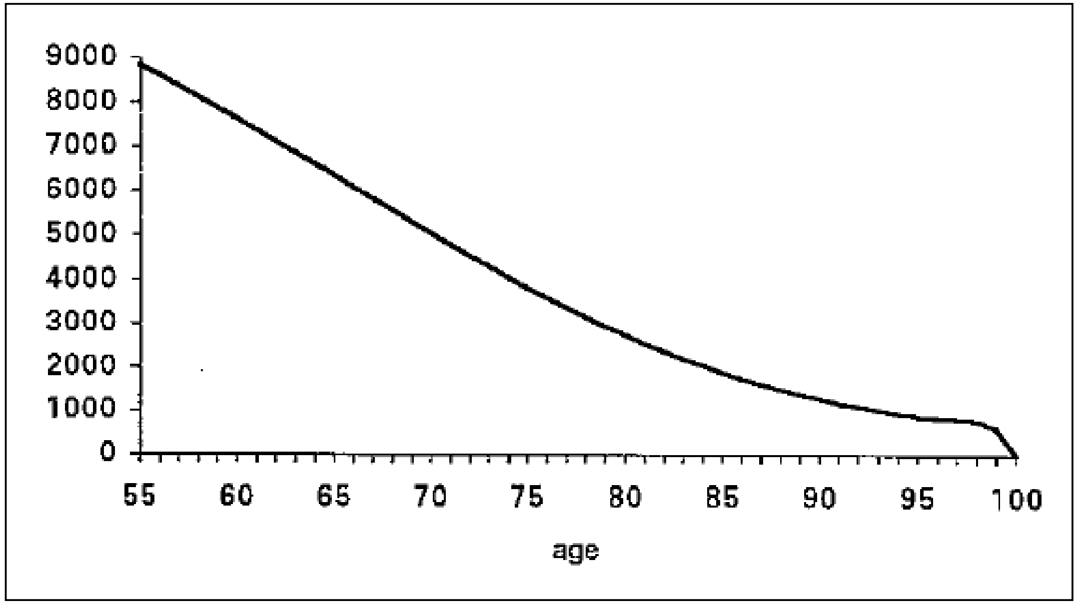
LTCI: some numerical results *(cont'd)*



Reserve for the healthy state

Age at entry $x = 55$; $b' = 600$, $b'' = 100$; $\eta_1 = 0.05$, $\eta_2 = 0.10$

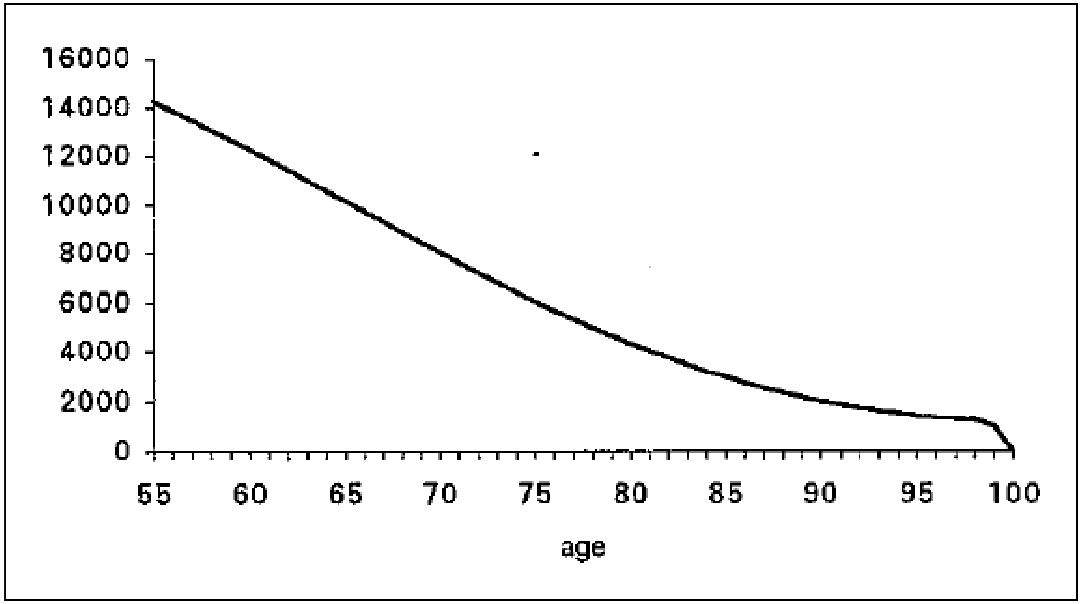
LTCI: some numerical results *(cont'd)*



Reserve for the LTC state i'

Age at entry $x = 55$; $b' = 600$, $b'' = 100$; $\eta_1 = 0.05$, $\eta_2 = 0.10$

LTCI: some numerical results *(cont'd)*



Reserve for the LTC state i''

Age at entry $x = 55$*;* $b'' = 100$*;* $\eta_2 = 0.10$

LTCI: some numerical results *(cont'd)*

Premiums and reserves obviously depend on all the assumptions, in particular on mortality assumptions for

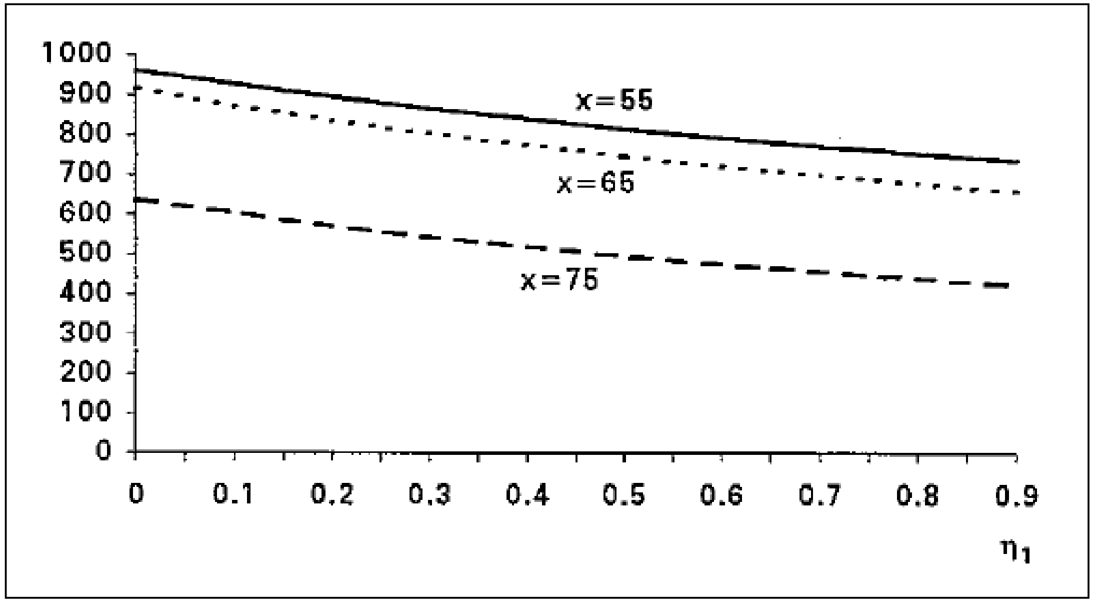
- healthy people
- disabled people in state i'
- disabled people in state i''

See following Figure

Higher mortality assumptions $\Rightarrow$ lower premiums

To be on the safe-side mortality should not be overestimated

LTCI: some numerical results *(cont'd)*



Single premium as a function of η_1, η_2*, with* $1 + \eta_2 = 1.05\,(1 + \eta_1)$*;*
various ages at entry; $b' = 600$, $b'' = 100$

LTCI: some numerical results *(cont'd)*

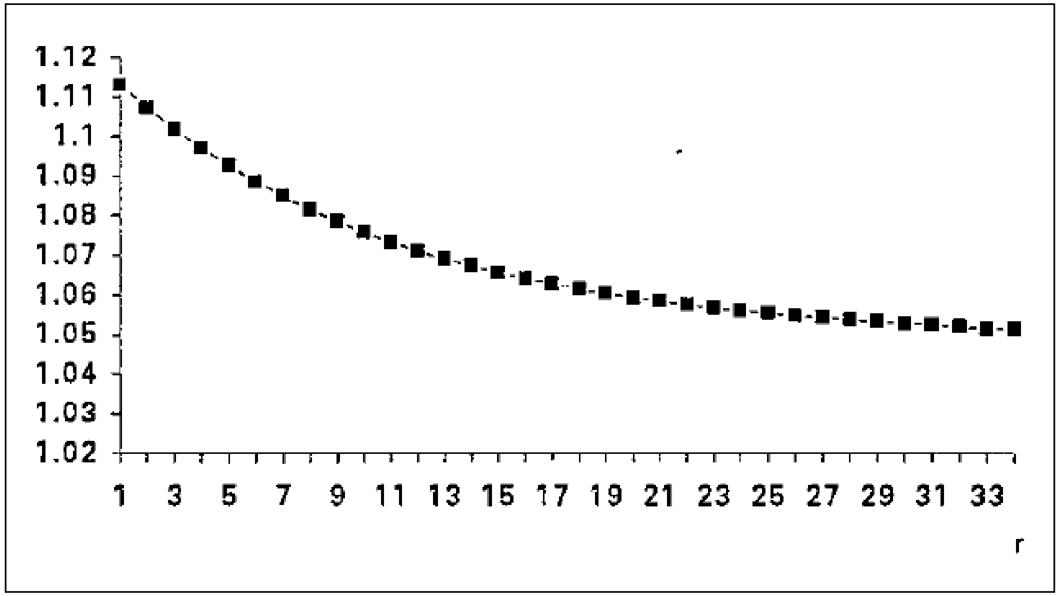
Refer to a *whole-life assurance with acceleration benefit* in the case of LTC claim

Assume: annual LTC benefit = $\frac{\text{sum assured}}{r}$, paid for r years at most

For example, $r = 5$ (i.e. 20% of the sum assured) $\Rightarrow$ 5 years covered

A small premium increment, since the benefit is certain (in terms of total amount)

LTCI: some numerical results *(cont'd)*



Single premium of a whole-life assurance with LTC acceleration benefit as a function of r compared to the single premium of a conventional whole-life insurance;
$c = 10\,000$; $x = 65$; $\eta = 0.05$

LTCI: some numerical results *(cont'd)*

Refer to an *enhanced pension*, allowing for one disability state

- annuity benefit $b^{(a)}$ while the annuitant is healthy
- annuity benefit $b^{(i)}$ while the annuitant is disabled

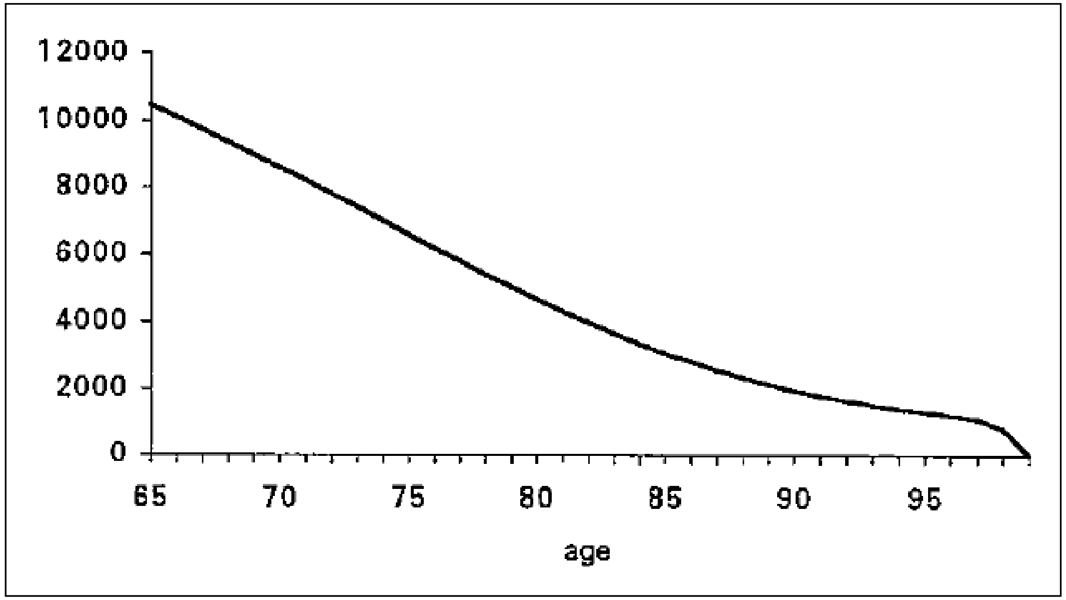
With $b = 1\,000$, we find:

$$b^{(a)} = 700$$

$$b^{(i)} = 3\,438$$

Following Figures: reserves for the healthy state and the LTC state

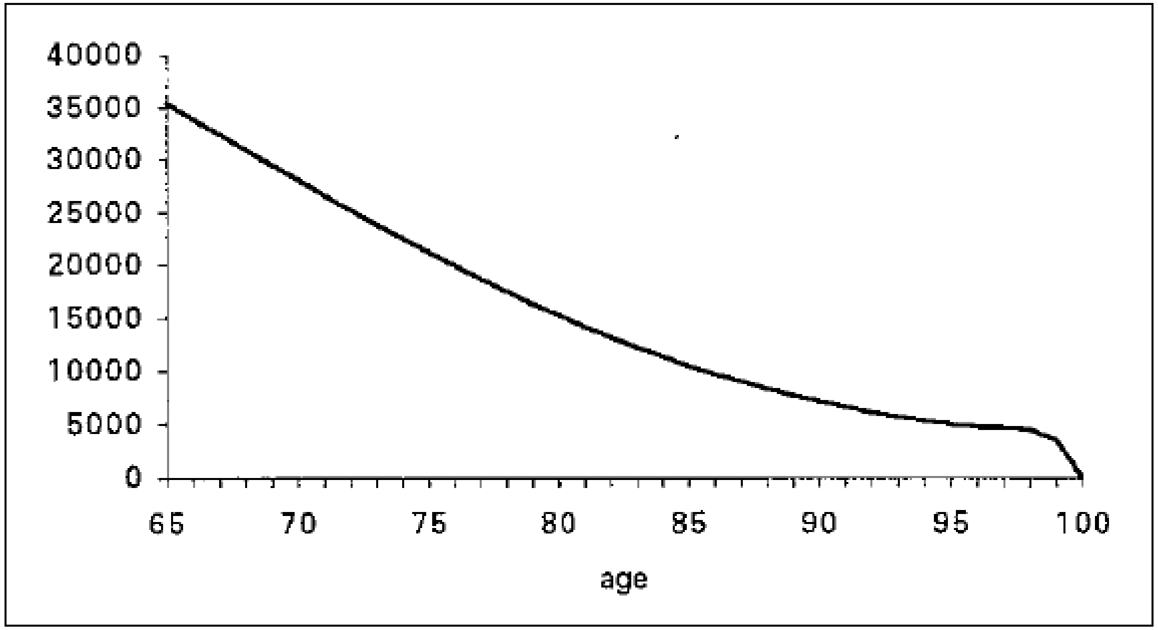
LTCI: some numerical results *(cont'd)*



Reserve for the healthy state

Age at entry $x = 65$; $b = 1\,000$, $b^{(a)} = 700$, $b^{(i)} = 3\,438$; $\eta = 0.05$

LTCI: some numerical results *(cont'd)*



Reserve for the LTC state

Age at entry $x = 65$; $b = 1\,000$, $b^{(a)} = 700$, $b^{(i)} = 3\,438$; $\eta = 0.05$

9 MORTALITY OF DISABLED PEOPLE

SOME PRELIMINARY IDEAS

- Inception-select data
  - ▷ Both frequencies of recovery and death of disabled people depend on past duration of disability
  - ▷ Assumptions about mortality of disabled people should rely on inception-select mortality data
- Mortality by causes
  - ▷ Mortality depends on the cause (in particular: accident vs sickness) and severity (partial vs total)
  - ▷ Eligibility to disability benefits (in IP and LTC products) varies according to legislation, policy conditions, market practice, etc.
  - ▷ Difficulties in grouping data, or interpreting grouped data

Mortality of disabled people *(cont'd)*

- Safe-side mortality assumption
  - ▷ Disability benefits are "living benefits", payable as long as the insured is alive and disabled
  - ▷ Safe-side assessment (in pricing and reserving)
    $\Rightarrow$ mortality of disabled people should not be overestimated

MODELING EXTRA-MORTALITY

Disabled people constitute substandard risks

Mortality of disabled people contains an "extra-mortality" term

Extra-mortality can be represented as:

- ▷ specific mortality (table, parametric mortality law)
- ▷ adjustments to the standard mortality pattern

Mortality of disabled people *(cont'd)*

If a law (or a family of laws) has been chosen, then:

$$q_{y,z}^{(k)} = \Psi(y, z; k)$$

where:

$q_{y,z}^{(k)}$ = one-year probability of death

y = current age

z = time elapsed since disability inception

k = category of disability, expressing in particular the severity, and entering Ψ via appropriate parameters

Mortality of disabled people *(cont'd)*

Alternative approach: express the mortality of disabled people in relation to standard mortality:

$$q_{y,z}^{(k)} = \Phi(q_y, z; k) \qquad (*)$$

where:

Φ = transform

q_y = one-year probability of death according to standard age-pattern of mortality

Mortality of disabled people *(cont'd)*

Examples

A rather general model of type $(^*)$ is as follows:

$$\Phi(q_y, z; k) = A_z^{(k)}\, q_{y+B^{(k)}} + C_z^{(k)} \qquad (^\circ)$$

Note that:

- parameters A, B and C are category-dependent
- in general, A and C are functions of time z $\Rightarrow$ disability duration effect on mortality
- B is a "years to age" addition, also called "age-shift" parameter

See: Ainslie [2000]

Mortality of disabled people *(cont'd)*

Several models adopted in actuarial practice constitute particular implementations of model $(^\circ)$

Assume:

$B^{(k)} = 0$, for any k

$A_z^{(k)} = \bar{A}^{(k)}$, for all z

$C_z^{(k)} = \bar{C}^{(k)}$, for all z

$\Rightarrow$ *linear model* (with flat parameters):

$$\Phi^{[\mathrm{L}]}(q_y; k) = \bar{A}^{(k)} \, q_y + \bar{C}^{(k)}$$

Note: duration effect is disregarded $\Rightarrow$ aggregate probabilities of death are adopted

Mortality of disabled people *(cont'd)*

In particular:

- setting $\bar{A}^{(k)} = 1$ for any $k \;\Rightarrow\;$ *additive model*:
$$\Phi^{[\mathrm{A}]}(q_y; k) = q_y + \bar{C}^{(k)}$$
$\Rightarrow$ constant extra-mortality
- setting $\bar{C}^{(k)} = 0$ for any $k \;\Rightarrow\;$ *multiplicative model*:
$$\Phi^{[\mathrm{M}]}(q_y; k) = \bar{A}^{(k)}\, q_y$$
$\Rightarrow$ increasing extra-mortality (given that q_y increases as age y increases)

Assume $A_z^{(k)} = 1$ and $C_z^{(k)} = 0$ for any k and all $z \;\Rightarrow\;$ *age-shift model*:
$$\Phi^{[\mathrm{S}]}(q_y; k) = q_{y+B^{(k)}}$$

$\Rightarrow$ approx to the multiplicative model if $q_y \approx$ exponential

Mortality of disabled people *(cont'd)*

Another particular model: take the general model $(^\circ)$ and assume:

k = category of disability according to the OPCS scale, where $k = 0 (=\text{healthy}), 1, \dots, 10$

$B^{(k)} = 0$, for any k

$A_z^{(k)} = 1$, for any k and all z

Define:

$$\Phi(q_y; k) = q_y + \frac{\alpha}{1 + 1.1^{50-y}} \, \frac{\max\{k-5, 0\}}{5}$$

See: Ellingsen [2010], Rickayzen [2007], Rickayzen and Walsh [2002], Pitacco [2012], Sanchez-Delgado et al. [2009]

For the OPCS scale, see: Martin and Elliot [1992]

Mortality of disabled people *(cont'd)*

SOME AVAILABLE MATERIAL

Group Long-term Disability Termination Study (Canada)

`http://www.cia-ica.ca/docs/default-source/2011/211103e.pdf?sfvrsn=2`

Actuarial Report (26th) on the Canada Pension Plan

`http://www.osfi-bsif.gc.ca/Eng/Docs/cpp26.pdf`

Social Security Disability Insurance Program Worker Experience (USA)

`http://www.ssa.gov/oact/NOTES/pdf_studies/study118.pdf`

Society of Actuaries (USA)

`http://www.soa.org/research/experience-study/pension/research-rp-2000-mortality-tables.aspx`

Mortality of disabled people *(cont'd)*

Institute and Faculty of Actuaries (UK)

`http://www.actuaries.org.uk/research-and-resources`

In particular:
CMI Working paper 23, *Analysis of individual income protection experience by cause of disability*

References

R. Ainslie. Annuity and insurance products for impaired lives. The Staple Inn Actuarial Society, London, 2000. Available at:
`http://www.sias.org.uk/siaspapers/search/view_paper?id=ImpairedLives`

American Academy of Actuaries. Long-term care. Actuarial issues in designing voluntary federal-private LTC insurance programs. Public Policy Monograph, Washington, 1999. Available at: `http://www.actuary.org/pdf/health/LTC.pdf`

E. L. Bartleson. *Health Insurance*. The Society of Actuaries, Illinois, USA, 1968

K. Black and H. D. Skipper. *Life & Health Insurance*. Prentice Hall, New Jersey, 2000

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

D. Dullaway and S. Elliott. Long-term care insurance: a guide to product design and pricing. The Staple Inn Actuarial Society, London, 1998. Available at:
`http://www.actuaries.org.uk/research-and-resources/documents/long-term-care-insurance-guide-product-design-and-pricing`

References *(cont'd)*

T. M. Ellingsen. Mortality among disability pensioners. In *Transactions of the 29th International Congress of Actuaries*, Cape Town, South Africa, 2010. Available at: `http://www.actuaries.org/EVENTS/Congresses/Cape_Town/Papers/`

S. Elliott, S. Golds, I. Sissons, and H. Wilson. Long Term Care - A review of global funding models. A background paper for discussion. Presented to The Institute and Faculty of Actuaries, London, 2012. Available at: `http://www.actuaries.org.uk/sites/all/files/`

P. Gatenby. Long Term Care. The Staple Inn Actuarial Society, London, 1991. Available at: `http://www.sias.org.uk/siaspapers/search/view_paper?id=ltc.pdf`

S. Haberman, Z. Butt, and B. Rickayzen. Measuring process risk in Income Protection insurance. *ASTIN Bulletin*, 34(1):199–227, 2004. doi: 10.2143/AST.34.1.504962

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

References *(cont'd)*

B. L. Jones. Long-term care insurance. In J. L. Teugels and B. Sundt, editors, *Encyclopedia of Actuarial Science*, volume 2, pages 1037–1041. John Wiley & Sons, 2004

E. Leung. A multiple state model for pricing and reserving private long term care insurance contracts in Australia, 2004. Available at: `http://www.actuaries.asn.au/Library/horizons_paper0604.pdf`

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

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

M. Merlis. Long Term Care financing: Models and issues. Working Paper. National Academy of Social Insurance. Washington, DC, 2004. Available at: `http://www.nasi.org/usr_doc/Merlis_LongTerm_Care_Financing.pdf`

References *(cont'd)*

C. M. Murtaugh, B. C. Spillman, and M. J. Warshawsky. In sickness and in health: An annuity approach to financing Long-Term Care and retirement income. *The Journal of Risk and Insurance*, 68(2):225–254, 2001

S. R. Nuttall, R. J. L. Blackwood, B. M. H. Bussell, J. P. Cliff, M. J. Cornall, A. Cowley, P. L. Gatenby, and J. M. Webber. Financing long-term care in Great Britain. *Journal of the Institute of Actuaries*, 121:1–68, 1994. Available at: `http://www.actuaries.org.uk/research-and-resources/documents/financing-long-term-care-great-britain`

F. T. O'Grady, editor. *Individual Health Insurance*, Illinois, USA, 1988. The Society of Actuaries

A. Olivieri and S. Ferri. Mortality and disability risks in Long Term Care insurance. *IAAHS Online Journal*, (1), 2003. Available at: `http://www.actuaries.org/IAAHS/OnlineJournal/2003-1/Mortality_and_Disability_Risks_in_Long_Term_Care_Insurance.pdf`

References *(cont'd)*

A. Olivieri and E. Pitacco. Managing demographic risks in Long Term Care insurance. *Rendiconti per gli Studi Economici Quantitativi*, 2(2):15–37, 2002

E. Pitacco. LTC insurance. From the multistate model to practical implementations. In *Proceedings of the 25th International ASTIN Colloquium*, pages 437–452, Cannes, France, 1994

E. Pitacco. Mortality of disabled people. Technical Report, 2012. Available at: `http://www.actuaries.org/CTTEES_TFM/Documents/Mortality_Disabled.pdf`

B. D. Rickayzen. An analysis of disability-linked annuities. Faculty of Actuarial Science and Insurance, Cass Business School, City University, London. Actuarial Research Paper No. 180, 2007. Available at: `http://www.cass.city.ac.uk/__data/assets/pdf_file/0018/37170/180ARP.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(36):341–393, 2002

References *(cont'd)*

E. Sanchez-Delgado, S. de Paz-Cobo, and J. M. Lopez-Zafra. Mortality rates of Spanish dependents: a joint correction approach. In J. Otamendi, A. Bargiela, J. L. Montes, and L. M. Doncel Pedrera, editors, *Proceedings of the 23rd European Conference on Modelling and Simulation*, Madrid, Spain, 2009. Available at: `http://www.scs-europe.net/conf/ecms2009/`

Society of Actuaries Long-Term Care Insurance Valuation Methods Task Force. Long-Term Care insurance valuation methods. *Transactions of the Society of Actuaries*, 47:599–773, 1995

M. J. Warshawsky. The life care annuity - A proposal for an insurance product innovation to simultaneously improve financing and benefit provision for long-term care and to insure the risk of outliving assets in retirement. Georgetown University - Long-Term Care Financing Project. Working Paper No. 2, 2007. Available at: `http://ltc.georgetown.edu/forum/2warshawsky061107.pdf`,

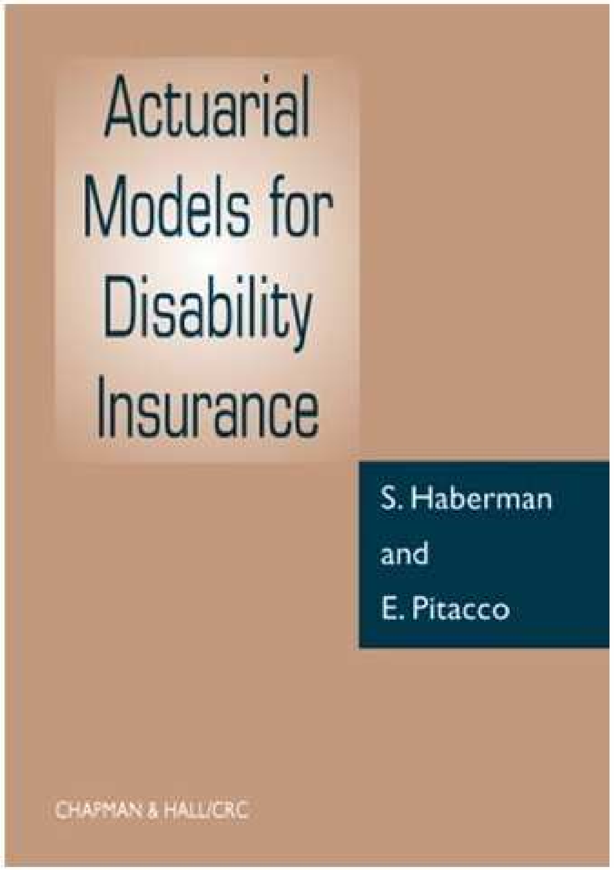
D. K. Whynes. The provision and finance of long-term care in the United Kingdom. *The Geneva Papers on Risk and Insurance*, 21(79):271–283, 1996

References *(cont'd)*

T. Zhou-Richter and H. Gründl. Life Care annuities - Trick or treat for insurance companies? Technical Report, 2011. Available at SSRN: `http://ssrn.com/abstract=1856994`

P. Zweifel. Providing for long-term care: Insurance vs. trust saving. *The Geneva Papers on Risk and Insurance*, 21(79):284–292, 1996

References *(cont'd)*



Something old . . .

References *(cont'd)*

. . . and something new:

(forthcoming)