Guarantees and product design in Life & Health Insurance

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Agenda

- Introduction & Motivation
- Weakening the guarantees in life annuity products
- Participation mechanisms in endowment policies
- Packaging life and LTC insurance benefits
- Concluding remarks

INTRODUCTION & MOTIVATION

Nineteenth century: a large variety of policies, to some extent tailored on the personal needs of the insured, customary in several European insurance markets

Later: a *standardization* process started $\Rightarrow$ a progressive shift to a very small set of standard products, basically:

- ▷ endowment insurance
- ▷ term insurance
- ▷ immediate life annuity
- ▷ deferred life annuity

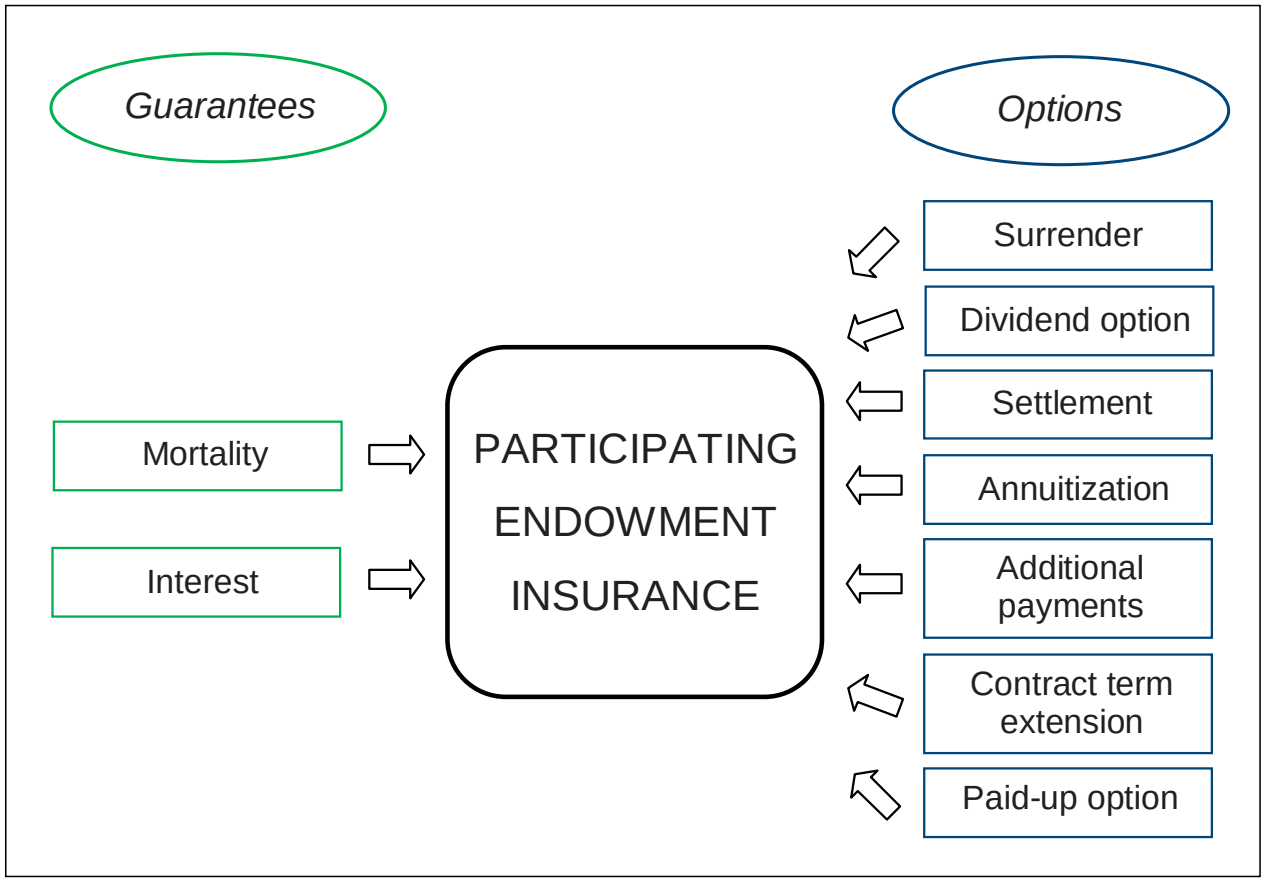
Recently, an inverse process is developing $\Rightarrow$ many modern insurance and pension products designed as *packages*, whose items may be either included or not in the product actually purchased by the client

Interesting examples provided by:

- endowment insurance which can include various rider benefits and options
- Universal Life insurance
- Variable Annuities
- other insurance or financial products which eventually aim at constructing a post-retirement income
- presence of possible Long Term Care benefits in pension products (e.g. uplift of the annuity benefit)
- . . . . . .

Benefits provided imply a wide range of "guarantees" $\Rightarrow$ risks borne by the insurance company (or the pension fund)

An example:



Endowment policy: guarantees and options

Guarantees and inherent risks are clearly perceived in recent scenarios, in particular because of

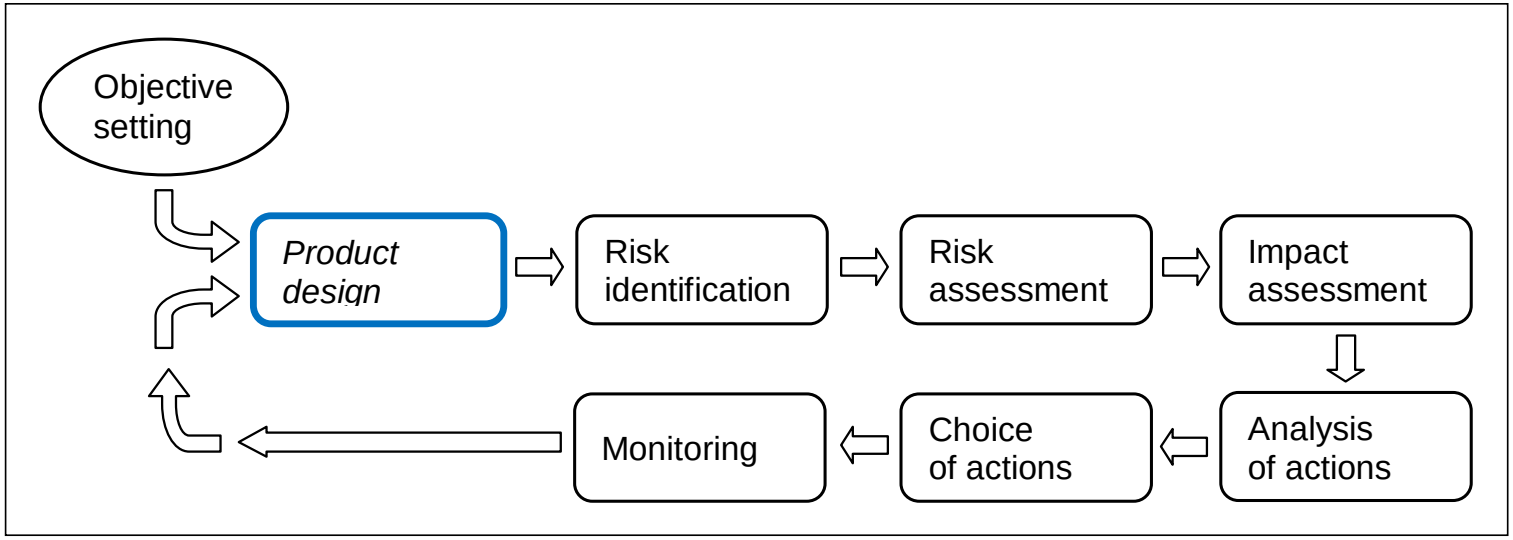
- ▷ volatility in financial markets
- ▷ trends in mortality / longevity and related uncertainty

Appropriate modeling tools are then needed for pricing and reserving
$\Rightarrow$ logical and technical shift from expected present values, and their prominent role in life insurance and pension calculations, to more modern and complex approaches, explicitly allowing for risk

Drawbacks (consequences of the shift):

- complexity is often an obstacle on the way towards sound pricing and reserving principles
- if sound pricing leads to very high premiums, the insurer's market share could become smaller

Possible suggestions from the Risk Management process:



Risk Management process: phases

Focus on the *product design* (or *re-design*)

- new products
- adjustment of features of existing products

See:

E. Pitacco. From "benefits" to "guarantees": looking at life insurance products in a new framework. CEPAR Working Paper 2012/26, 2012. Available at:
`http://www.cepar.edu.au/media/103403/lecturetext_pitacco.pdf`

and references therein

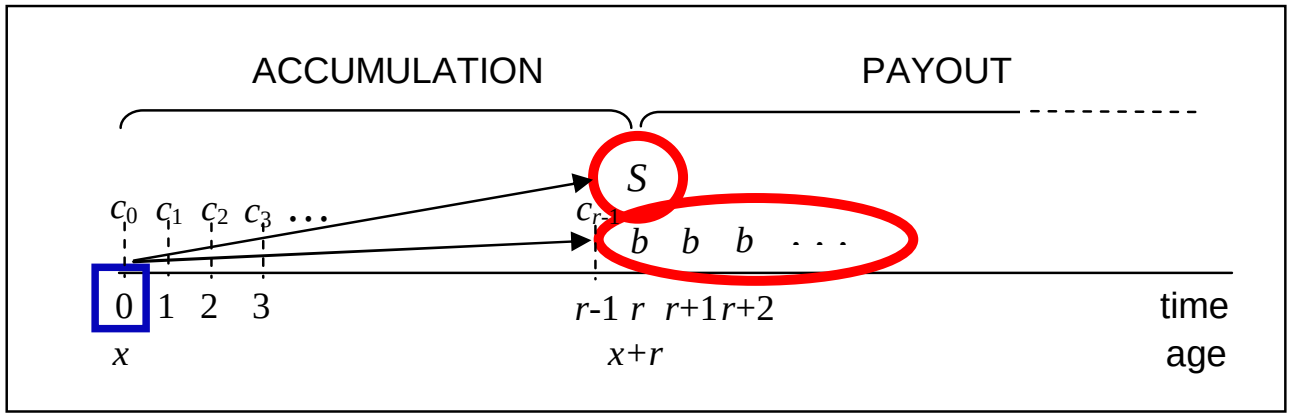
Following examples:

- Weakening the scope of guarantees in life annuities
- Participation mechanisms in endowment policies: shift to weaker financial guarantees
- Long-term care insurance: packaging benefits to lower the impact of uncertainty risk (choice of biometric bases)

WEAKENING THE GUARANTEES IN LIFE ANNUITY PRODUCTS

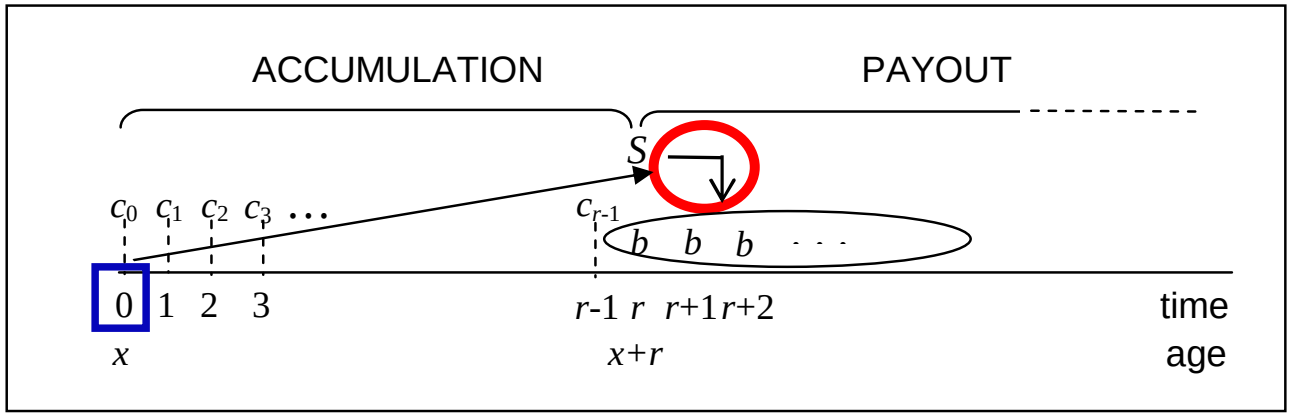
Traditional deferred life annuity

- Guarantees, stated at policy issue, involve both accumulation phase and payout phase
- Risks borne by the annuity provider, from policy issue onwards:
  - ▷ interest rate risk
  - ▷ (aggregate) longevity risk



Accumulation and GAO

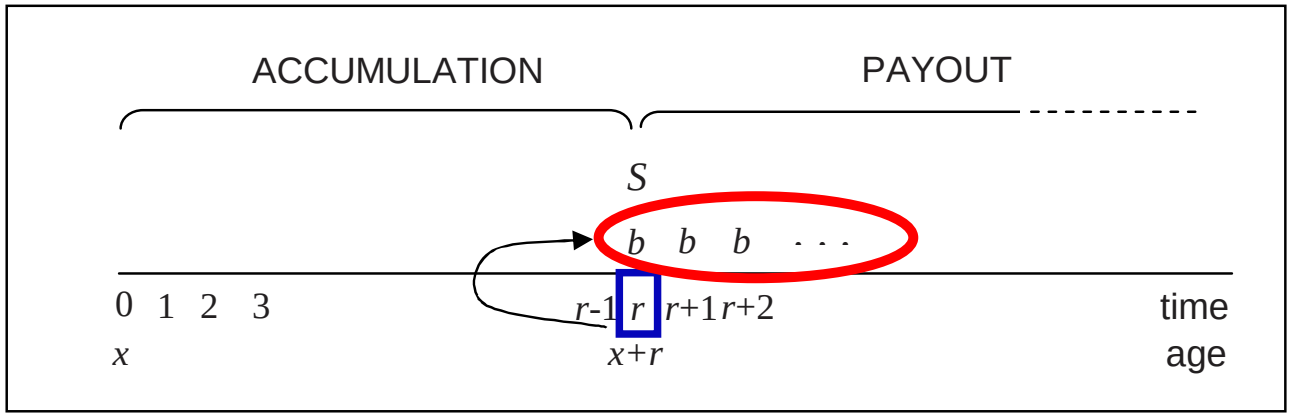
- No specific guarantees for the accumulation phase
- Guaranteed Annuity Option (GAO) $\Rightarrow$ possibility of annuitizing the accumulated amount according to GAR, i.e. guaranteed annuity rate stated at policy issue
- Risks borne by the annuity provider:
  - ▷ interest rate risk, from annuitization time onwards
  - ▷ (aggregate) longevity risk, from policy issue onwards



Weakening the guarantees in life annuity products *(cont'd)*

Accumulation and CAR

- No specific guarantees for the accumulation phase
- Possible annuitization at CAR, i.e. current annuity rate
- Risks borne by the annuity provider, from annuitization time onwards:
  - ▷ interest rate risk
  - ▷ (aggregate) longevity risk



Weakening the guarantees in life annuity products *(cont'd)*

From (traditional) deferred life annuity to accumulation + CAR
$\Rightarrow$ reduction of the scope of implied guarantees

For more information, see:

E. Pitacco. Guarantee structures in life annuities: A comparative analysis. *The Geneva Papers on Risk and Insurance - Issues and Practice*, 41(1):78–97, 2016a

and references therein

PARTICIPATION MECHANISMS IN ENDOWMENT POLICIES

BASIC IDEAS

We assume that:

- participation only relies on insurer's investment (segregated fund) yield
  - ▷ η = participation share (e.g. $\eta = 0.90$)
- participation $\Rightarrow$ increase in the policy reserve (revaluation) $\Rightarrow$ increase in the benefits

Traditional participating mechanism $\Rightarrow$ *lock-in guarantee*

- ▷ annual interest guarantee
- ▷ increment in the reserve and the benefits annually locked-in
- ▷ cliquet option ($\Rightarrow$ *embedded financial option*)
- ▷ relevant cost not explicitly charged to the policyholder

Possible approach aiming to mitigate the market risk borne by the insurer: weakening the interest rate guarantee

MATURITY GUARANTEE

Accumulation factor applied to saving premium paid at time t not lower than $(1+i)^{m-t}$ where:

i = annual interest rate (technical interest rate)

m = policy maturity

Hence, interest rate i:

- ▷ not annually guaranteed (no lock-in)
- ▷ guaranteed on a $(m-t)$-year basis

Similar guarantee can be applied to the death benefit

STOCHASTIC ANALYSIS

To capture the risk involved by different participation mechanisms and relevant guarantees:

- ▷ stochastic simulation of the investment yields
- ▷ calculation of the net present value of insurer's future profits, PVFP

In particular:

- mortality assumed deterministic (according to a given life table), no surrenders
- investment mix defined as:

  Assets = (risk-free bonds, other bonds, equities)

  in terms of % shares

Simulation results, in terms of distribution of random PVFP:
see following figures

Participation mechanisms in endowment policies *(cont'd)*

Participation mechanisms considered for the endowment policy:

- no participation; interest rate $i = 0.02$
- participation with lock-in guarantee
  - ▷ $i = 0.02$, no minimum reserve revaluation
  - ▷ $i = 0$, minimum reserve revaluation = 0.02
- participation with maturity guarantee

Two different investment mix

Various participation shares η

For more details, see:

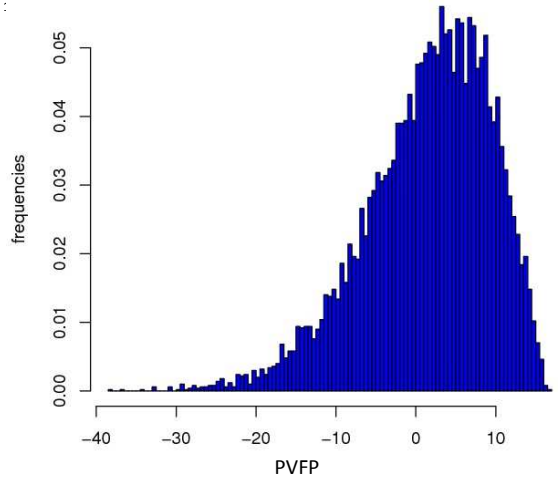
L. Brighenti. Assicurazioni miste rivalutabili: Analisi di garanzie alternative di rendimento. Master's thesis, DEAMS - Università di Trieste, 2015

and

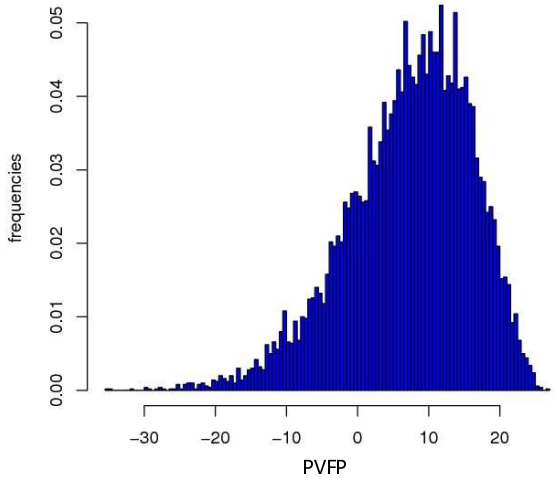
E. Pitacco. ERM and QRM in Life Insurance, 2016c. In preparation

Participation mechanisms in endowment policies *(cont'd)*

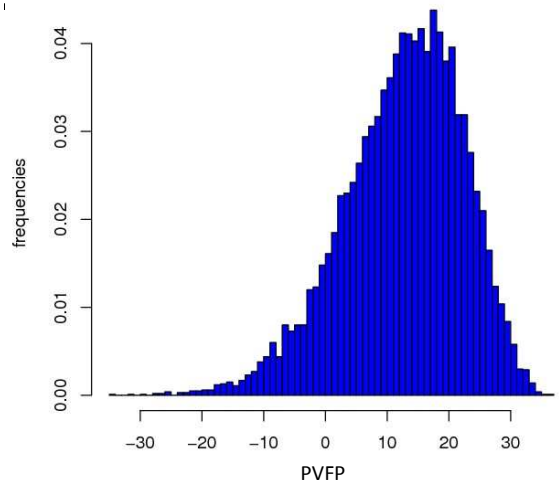
Assets = $(10, 80, 10)$; lock-in guarantee



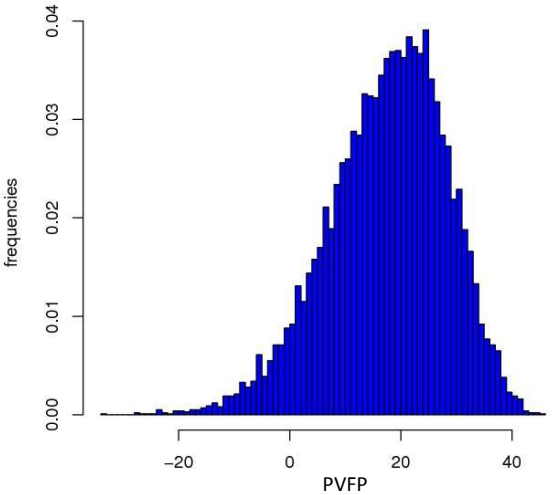
$\eta = 0.95$



$\eta = 0.90$



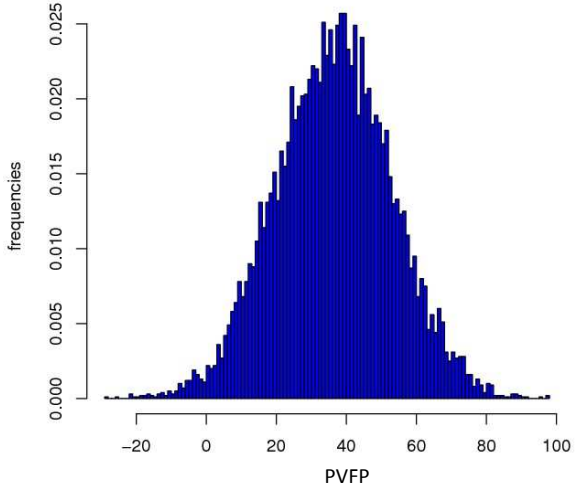
$\eta = 0.85$



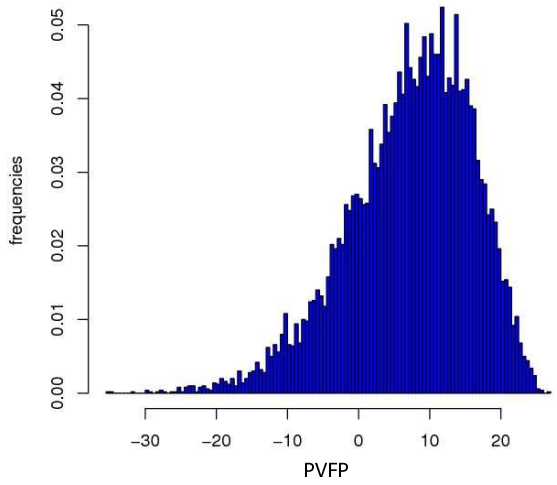
$\eta = 0.80$

Participation mechanisms in endowment policies *(cont'd)*

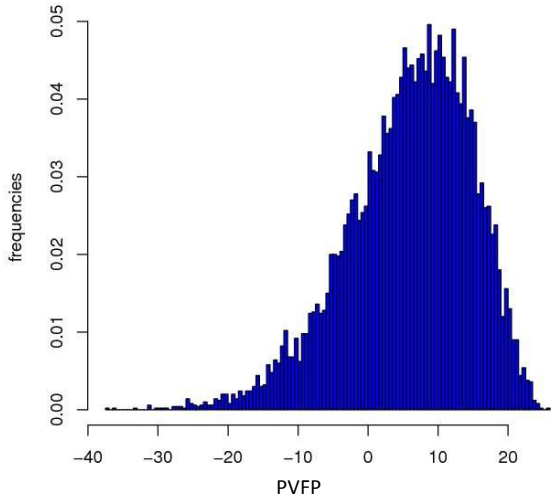
Assets = $(10, 80, 10)$; $\eta = 0.90$



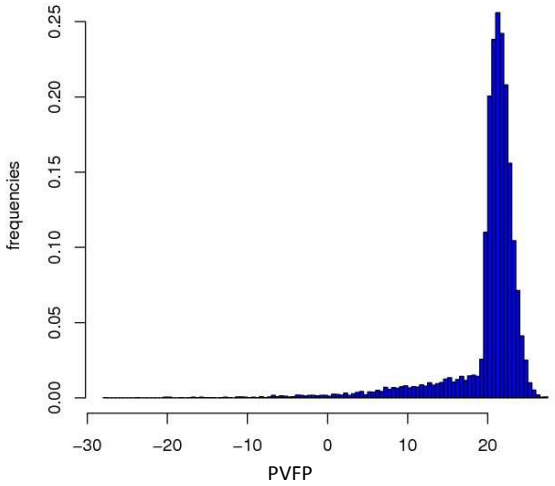
no participation



lock-in guarantee



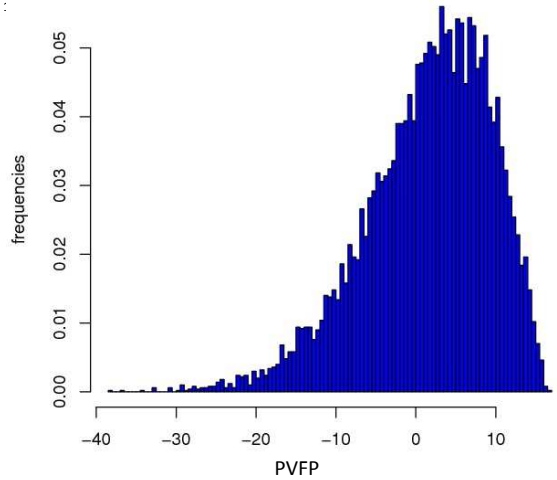
min + lock-in guarantee



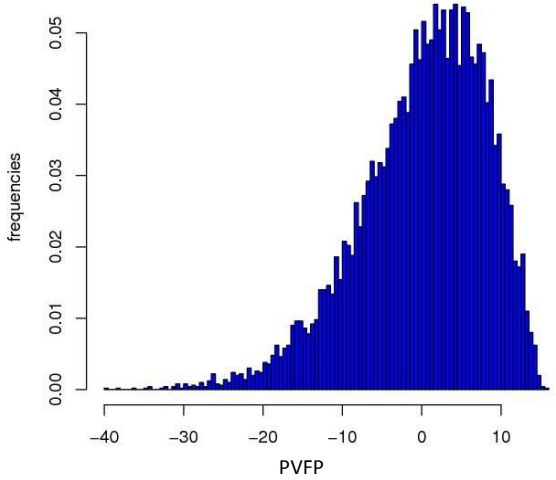
maturity guarantee

Participation mechanisms in endowment policies *(cont'd)*

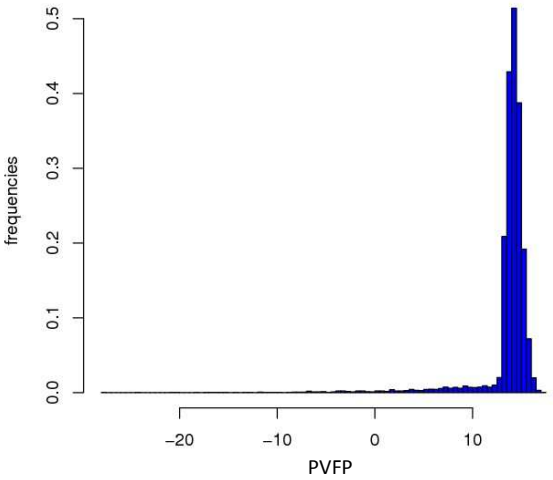
Assets = $(10, 80, 10)$; $\eta = 0.95$



lock-in guarantee

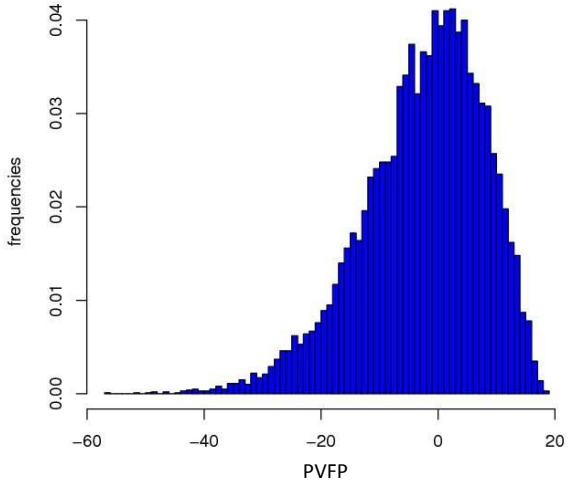


min + lock-in guarantee

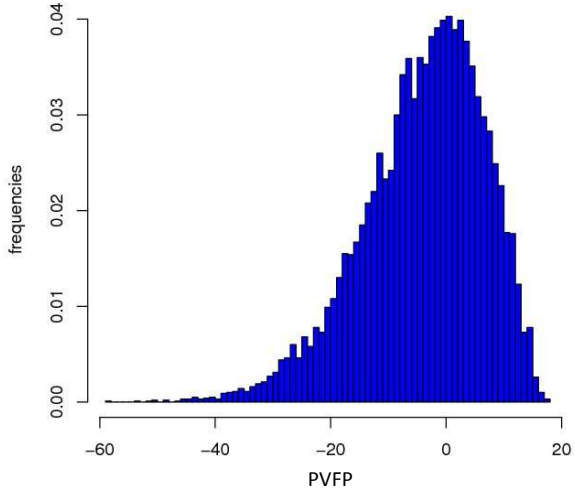


maturity guarantee

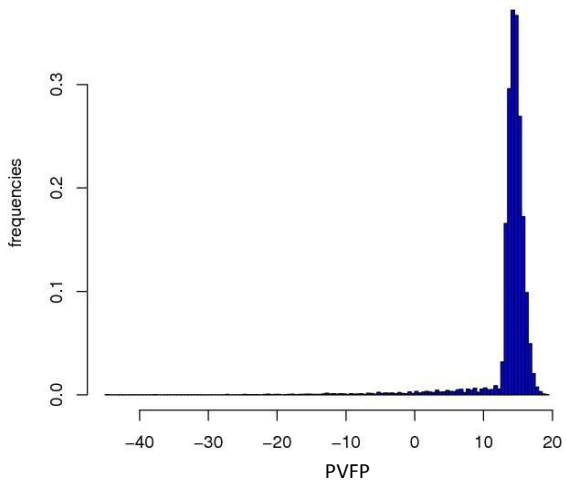
Assets = $(10, 70, 20)$; $\eta = 0.95$



lock-in guarantee



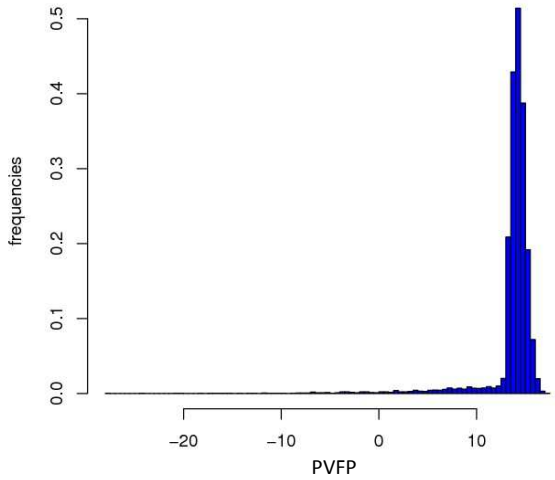
min + lock-in guarantee



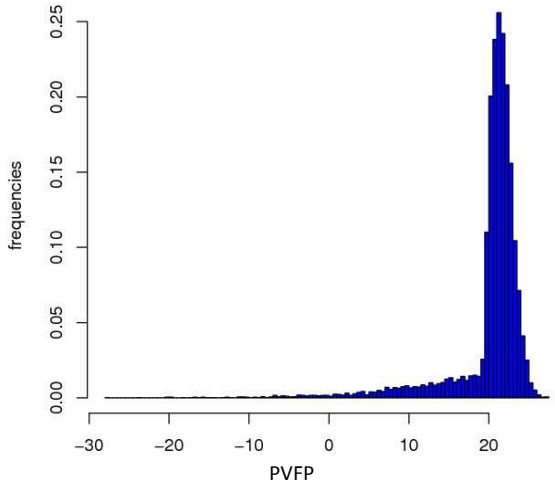
maturity guarantee

Participation mechanisms in endowment policies *(cont'd)*

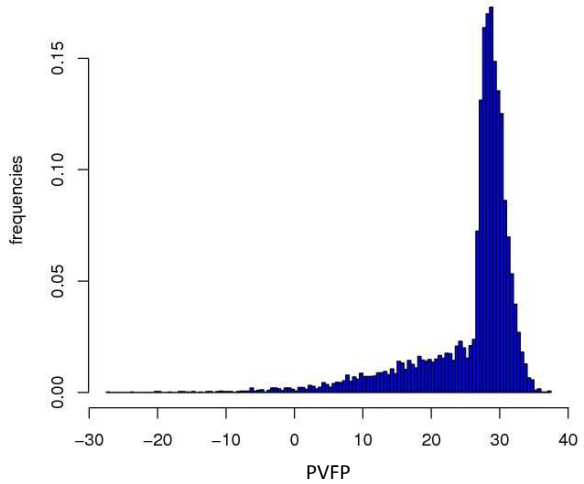
Assets = $(10, 80, 10)$; Maturity guarantee



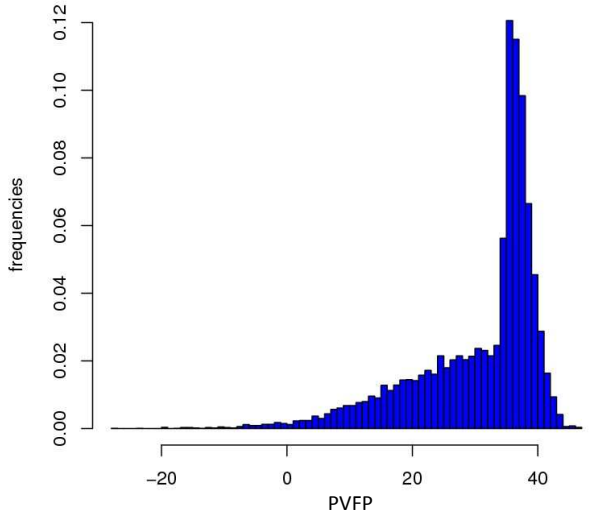
$\eta = 0.95$



$\eta = 0.90$



$\eta = 0.85$



$\eta = 0.80$

PACKAGING LIFE AND LTC INSURANCE BENEFITS

LONG-TERM CARE INSURANCE (LTCI)

We consider the following LTCI products:

- Stand-alone LTCI
- LTCI as an acceleration benefit in a whole-life assurance
- Package including LTC benefits and lifetime-related benefits
- Enhanced pension

See, for example:
E. Pitacco. *Health Insurance. Basic actuarial models*. EAA Series. Springer, 2014
and references therein

Whatever the product, we consider:

- ▷ pre-defined amount (not expense reimbursement)
- ▷ single disability level for benefit eligibility (not graded benefit)
- ▷ no recovery allowed for

Stand-alone LTCI

(Product P1)

LTCI benefit: a lifelong annuity with predefined annual amount

LTCI as an acceleration benefit in a whole-life assurance

(Product P2(s))

Annual LTC benefit = $\dfrac{\text{sum assured}}{s}$ paid for s years at most

(Critical point: no surrendering !)

Possibly complemented by a (deferred) lifelong LTC annuity in the case of sum exhaustion

Package including LTC benefits and lifetime-related benefits

(Products P3a($x+n$) and P3b($x+n$))

Benefits:

1. a lifelong LTC annuity (from the LTC claim on)
2. a deferred life annuity from age $x+n$ (e.g. $x+n=80$), while the insured is not in LTC disability state
3. a lump sum benefit on death, alternatively given by
   - 3a. a fixed amount, stated in the policy
   - 3b. the difference (if positive) between a fixed amount and the total amount paid as benefit 1 and/or benefit 2

Benefits 1 and 2 are mutually exclusive

Enhanced pension (Life care pension)

(Product P4(b', b''))

LTC annuity benefit defined as an uplift with respect to the basic pension b

Uplift financed by a reduction (with respect to the basic pension b) of the benefit paid while the policyholder is healthy

- ▷ reduced benefit b' paid as long as the retiree is healthy
- ▷ uplifted lifelong benefit b'' paid in the case of LTC claim (of course, $b' < b < b''$)

BIOMETRIC ASSUMPTIONS AND SENSITIVITY ANALYSIS

For more information, see:

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

Biometric functions

For a healthy individual age x:

$q_x^{aa} =$ probability of dying before age $x+1$ (from healthy state)

$w_x =$ probability of becoming LTC invalid before age $x+1$

For an LTC invalid individual age x:

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

Assumptions

q_x^{aa}: first Heligman-Pollard law

w_x: a specific parametric law

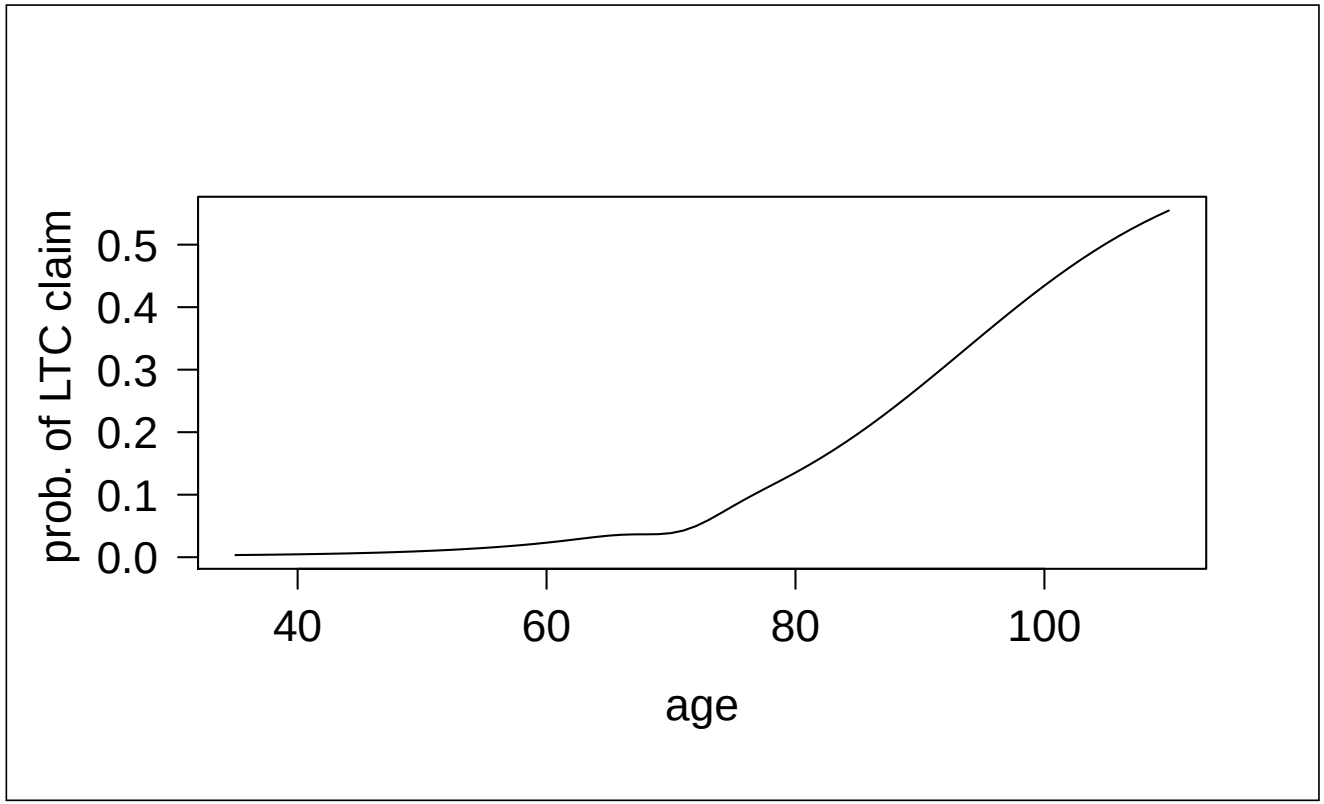
assumption by B. D. Rickayzen and D. E. P. Walsh. A multi-state model of disability for the United Kingdom: Implications for future need for Long-Term Care for the elderly. *British Actuarial Journal*, 8:341–393, 2002

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

assumption by 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

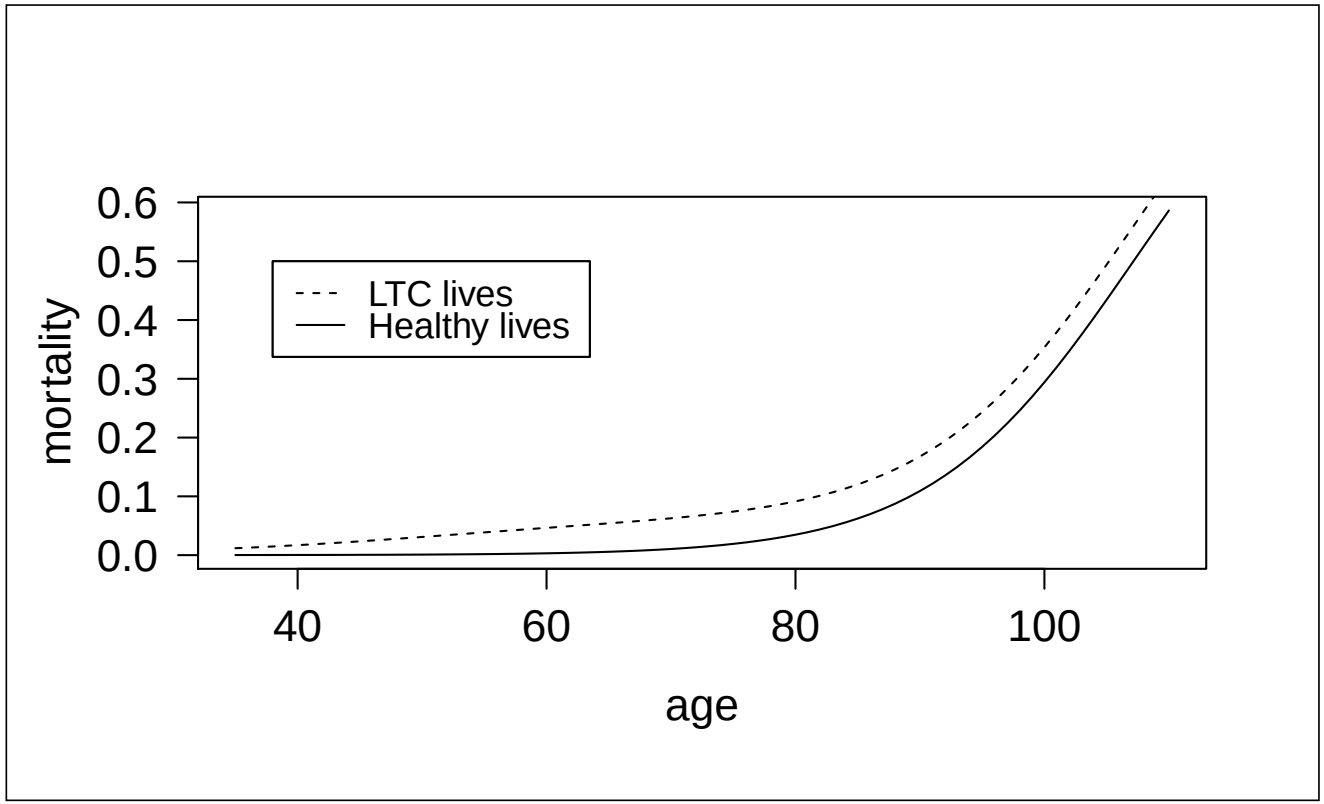
See following figures

Packaging life and LTC insurance benefits *(cont'd)*



Probability of disablement (Males)

Packaging life and LTC insurance benefits *(cont'd)*



Mortality assumptions (Males)

SENSITIVITY ANALYSIS

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

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

- $\delta \Rightarrow$ disablement

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

- $\lambda \Rightarrow$ extra-mortality

$$\bar{\Delta}_x(\lambda) = \lambda\, \Delta_x$$

and hence:

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

$\Pi_x^{[\mathrm{PX}]}(1, 1)$ = "base" actuarial value for product PX

Packaging life and LTC insurance benefits *(cont'd)*

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:

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

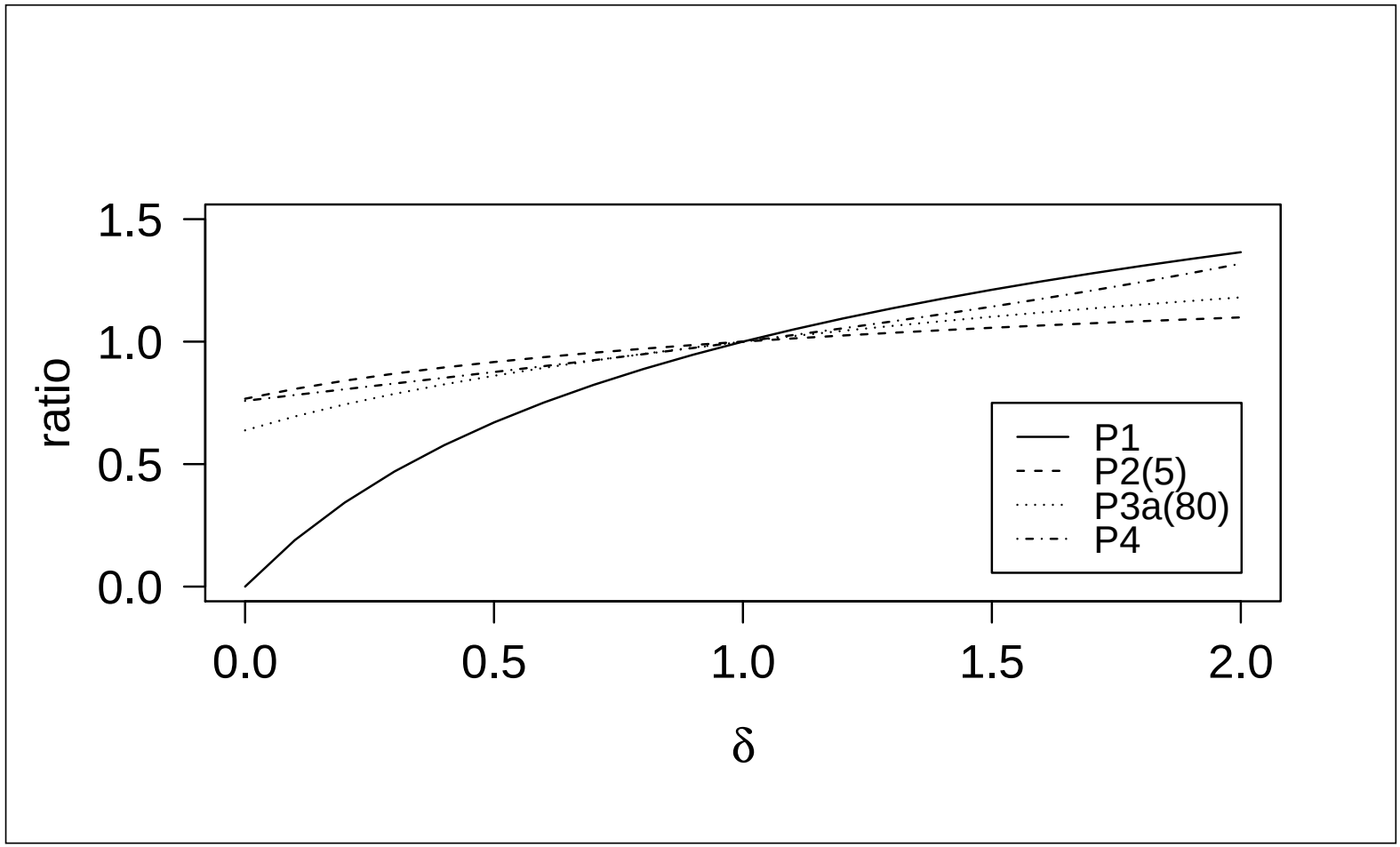
For all the products, we first perform *marginal* analysis, i.e. tabulating the functions:

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

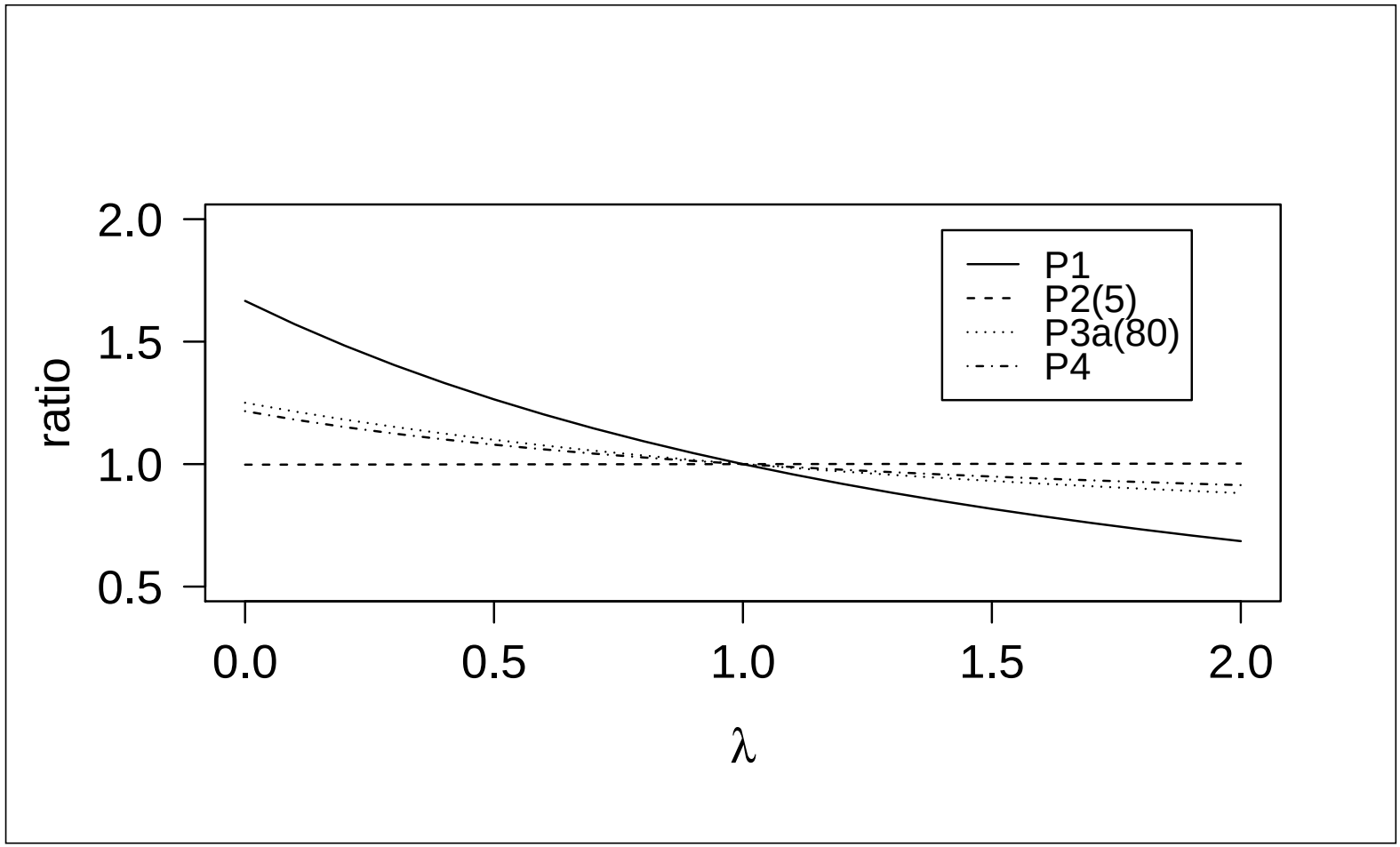
See following figures

Packaging life and LTC insurance benefits *(cont'd)*

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

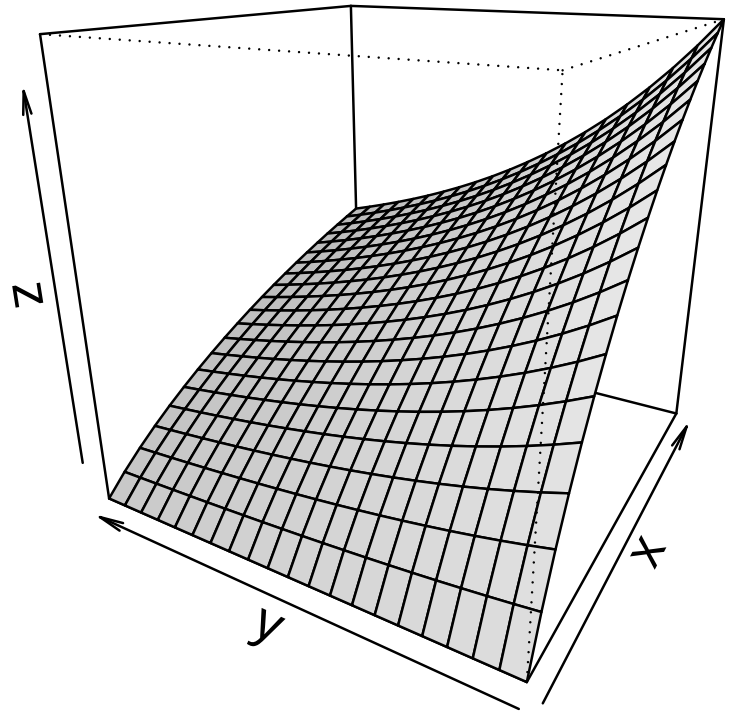
- for products P1, P2, P3:

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

- for product P4:

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

Packaging life and LTC insurance benefits *(cont'd)*



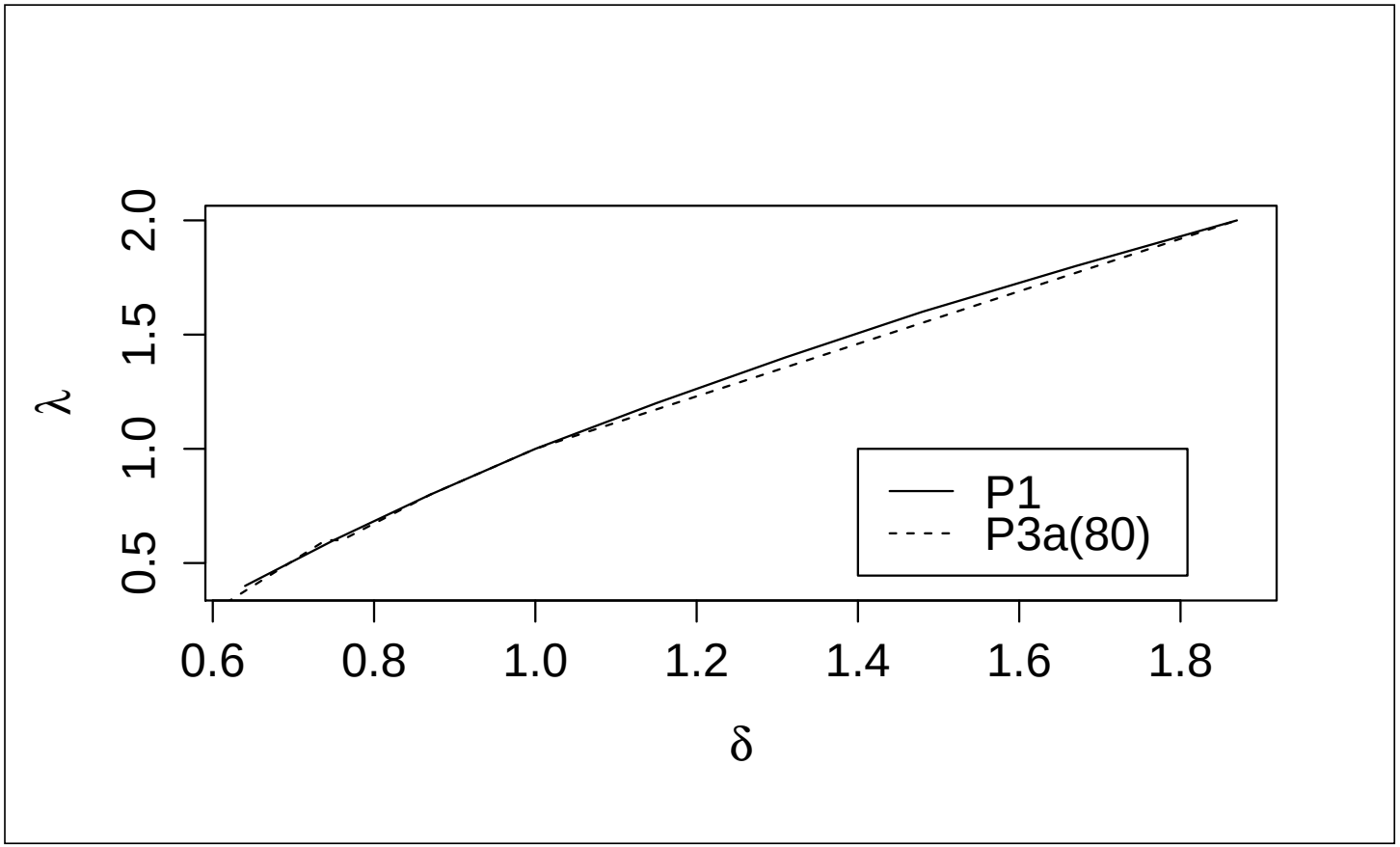
Product P3a(80)

$X = \delta \Rightarrow$ *disablement*

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

$Z = \Pi \Rightarrow$ *premium*

Packaging life and LTC insurance benefits *(cont'd)*



Offset effect: isopremium lines

CONCLUDING REMARKS

Appropriate product design can help in mitigating risks taken by the insurance company

Three examples show how:

(1) to lower longevity risk (and possibly market risk) by delaying the definition of the annuitization rate

(2) to lower market risk by weakening some guarantees, in particular the interest rate guarantee in participating endowment policies

(3) to lower risk arising from uncertainty in technical bases by packaging LTCI benefits with lifetime-related benefits

In general, risk mitigation $\Rightarrow$ less capital absorbing products

In particular, as regards (3) we note what follows

Combined 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

Concluding remarks *(cont'd)*

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 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)

Many thanks for your kind attention