BIOMETRIC RISK TRANSFERS IN LIFE ANNUITIES AND PENSION PRODUCTS: A SURVEY

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Agenda

1. Motivation
2. From traditional modeling to risk-oriented approach
3. Building the post-retirement income
4. A range of annuity products
5. Some arrangements for the payout phase
6. The payment profile
7. Concluding remarks

1 MOTIVATION

Focus on:

- ▷ life annuities provided by occupational pension schemes
- ▷ purchased life annuities

Stressing the need for a shift from traditional actuarial methods to ERM approach, including the *product design*

Looking at risk transfers (annuity provider $\Leftrightarrow$ annuitants) implied by each specific *guarantee / option* structure involved by the product design

Allowing for both perspectives:

- annuitants
- annuity provider

Nothing original from a scientific point of view: this presentation only aims at providing a review of products available on insurance and pension markets, with a special focus on features related to biometric risk sharing

2 FROM TRADITIONAL MODELING TO RISK-ORIENTED APPROACH

A basic feature of the biometric model underlying traditional formulae for life annuities

Deterministic model:

- although relying on probabilities (according to actuarial notation: ${}_hp_x$, ${}_{k|1}q_x$, ...), only *expected values of benefits* are finally addressed
- possible impact of *risks originated by guarantees* (interest, mortality / longevity, etc) not (explicitly) accounted for
- just implicit safety loading via adoption of prudential technical bases for premium calculation

Risks in current scenarios

Current biometric scenario:

- mortality improvements $\Rightarrow$ projected life tables
- uncertainty in future mortality trend $\Rightarrow$ aggregate risk

Other risk sources in the financial scenario

- ▷ volatility in financial markets
- ▷ unknown future trends in interest rates
- ▷ inflation ...

Focus on biometric risks, and in particular aggregate longevity risk (non-diversifiable via pooling inside the traditional insurance - reinsurance process)

See, for example:
Pitacco et al. [2009]
and references therein

From traditional modeling to risk-oriented approach *(cont'd)*

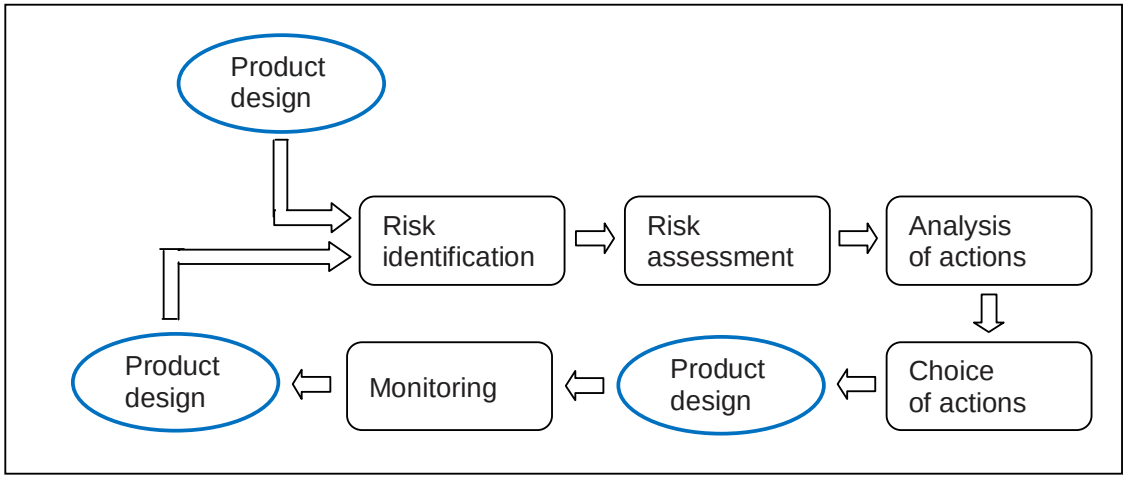
Our aims

(1) to single out risks (in particular biometric risks) in the accumulation phase and the payout phase

(2) to look at feasible transfers: annuitants $\Leftrightarrow$ annuity provider

In particular:

- (1) $\Rightarrow$ *risk identification* step in the ERM process
- (2) $\Rightarrow$ *product design*



From traditional modeling to risk-oriented approach *(cont'd)*

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 in the case of LTC claim)

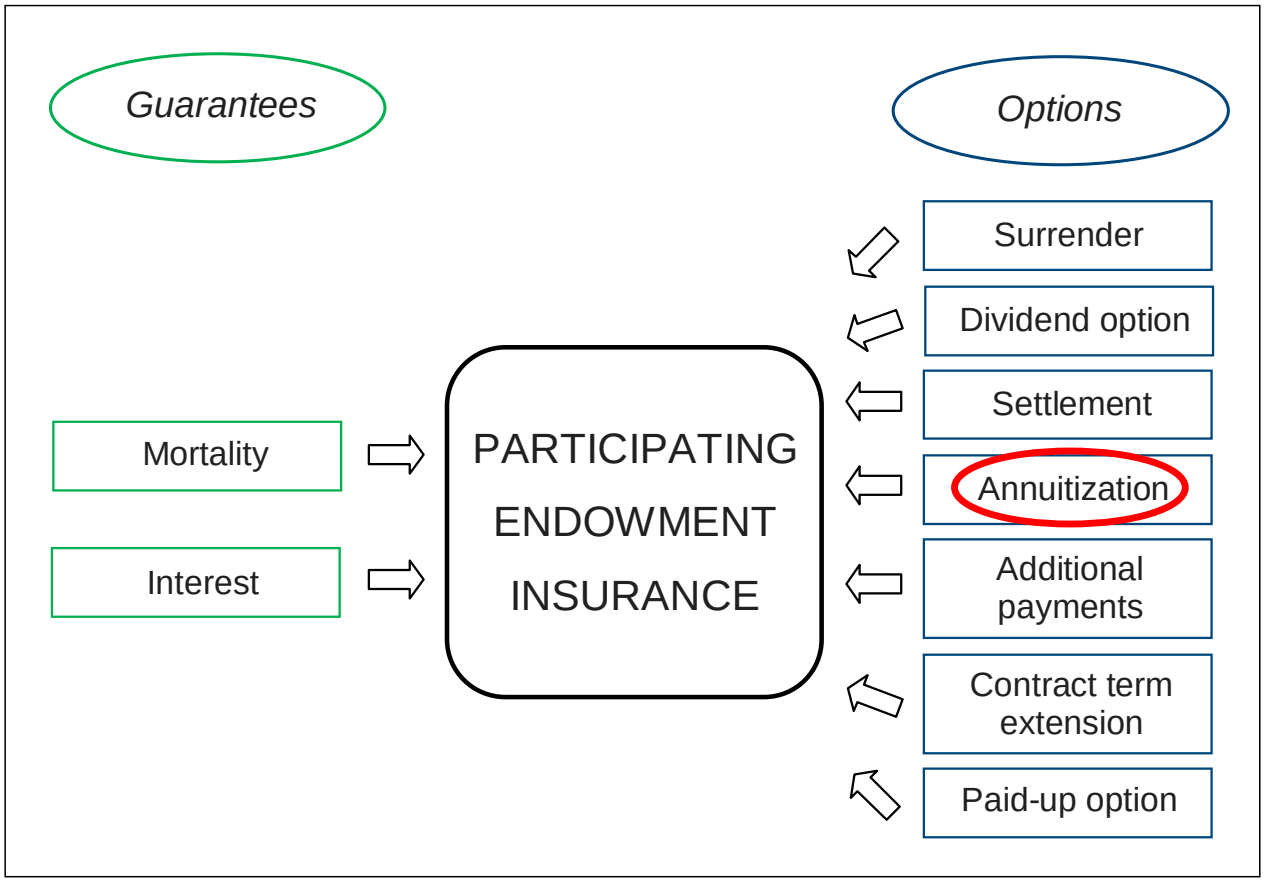
$\Rightarrow$ Look at life annuities and pension products as *packages of guarantees and options*

See, for example:
Gatzert [2009], Hardy [2004], Pitacco [2012]
and references therein

From traditional modeling to risk-oriented approach *(cont'd)*

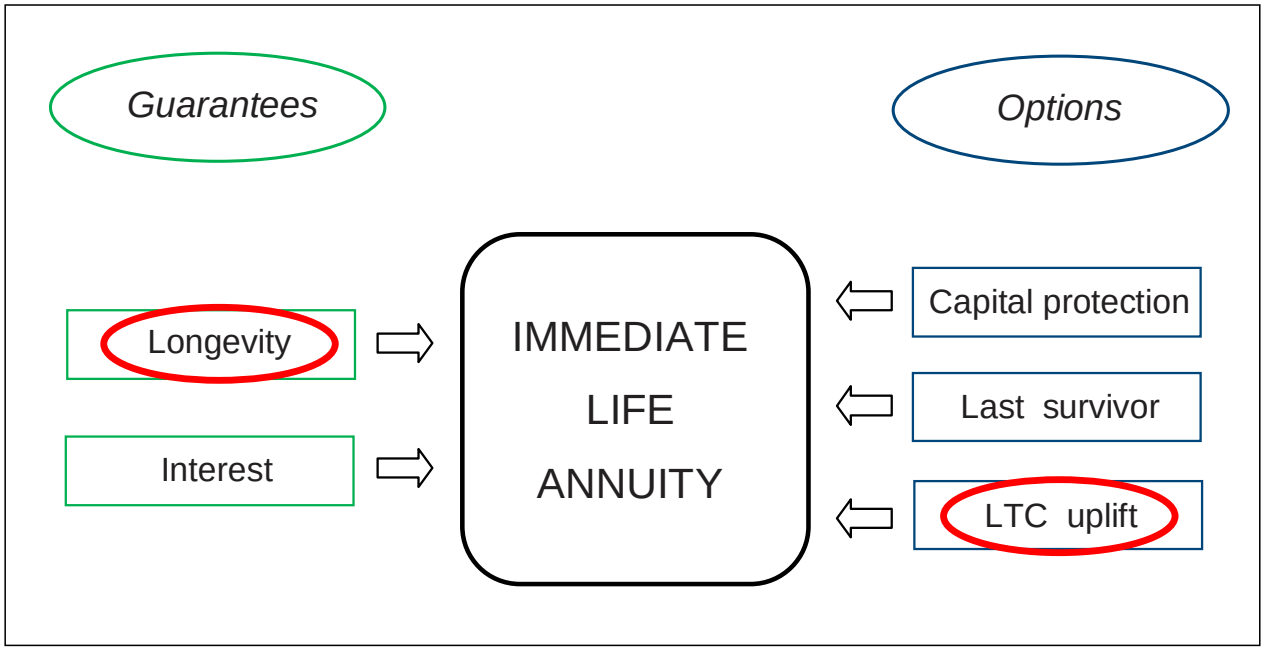
Some examples

Endowment Insurance (a product for the accumulation phase)



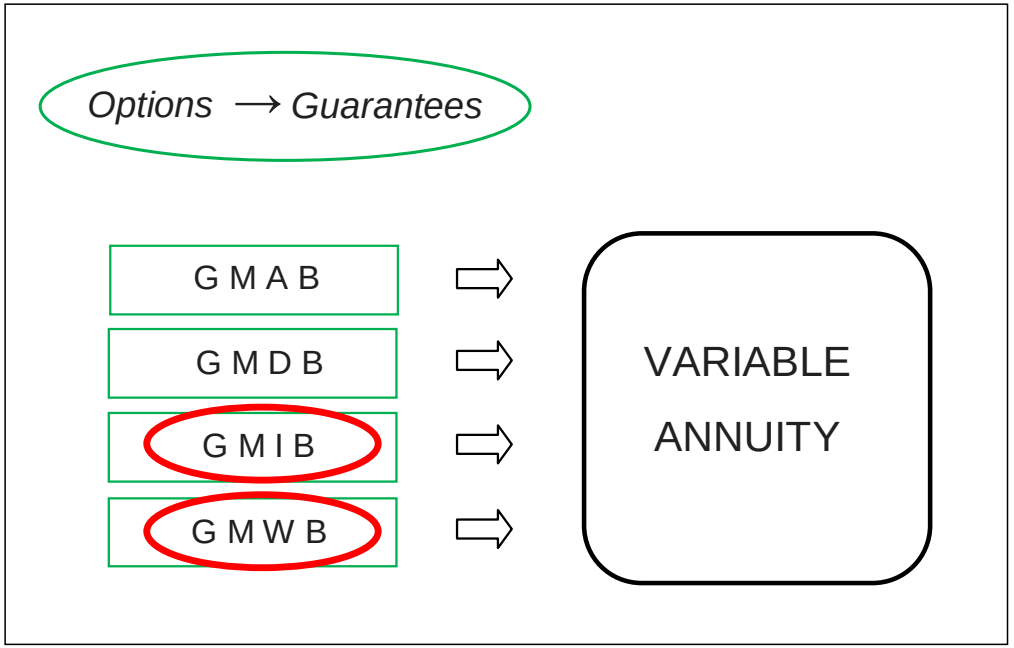
From traditional modeling to risk-oriented approach *(cont'd)*

Immediate Life Annuity



From traditional modeling to risk-oriented approach *(cont'd)*

In Variable Annuity products the presence of guarantees follows policyholder's choices



3 BUILDING THE POST-RETIREMENT INCOME

Introduction

We describe various arrangements, involving either the accumulation phase, or the payout phase, or both

Various products are available on financial and insurance markets, each product with a specific guarantee structure (conventional life annuities either immediate or deferred, Variable annuities, withdrawal plans, etc.)

See:

Shapiro [2010]

This research provides an extensive literature review of post-retirement financial strategies

See also:

Pitacco et al. [2009], Rocha et al. [2011], Wadsworth et al. [2001]

and references therein, for general issues on life annuities

We focus on guarantees provided by each arrangement

Risks taken by the intermediary, in particular the annuity provider (either insurer or pension fund) immediately identified looking at the guarantee structure

In the following figures:

x = age at policy issue, or at entering the pension scheme

$x + r$ = age at retirement

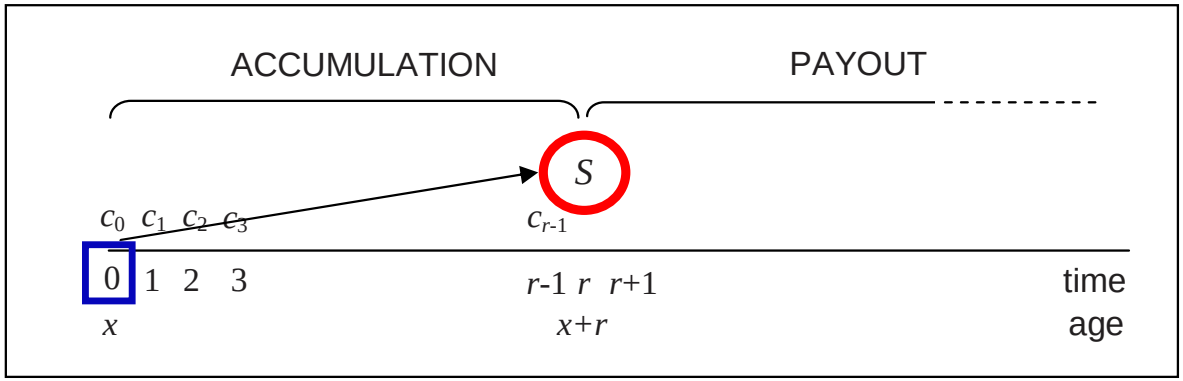
Time at which the guarantee is stated in quantitative terms

Ultimate object of the guarantee

Some basic structures

Structure 1 - Accumulation phase only

For any given sequence of contributions / premiums / savings
$c_0, c_1, \ldots, c_{r-1} \Rightarrow$ amount S guaranteed

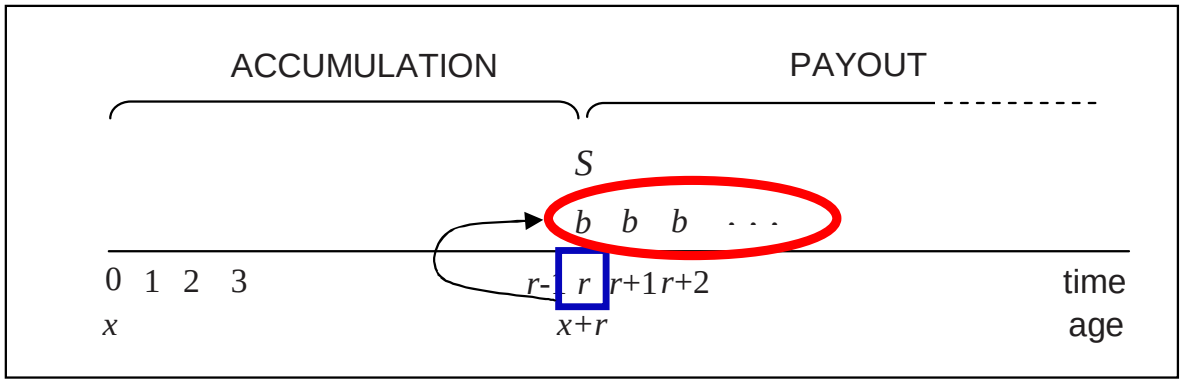


Examples

- financial product: interest guarantee
- insurance product, e.g. pure endowment insurance or endowment insurance: interest guarantee and mortality guarantee

Structure 2 - Payout phase only

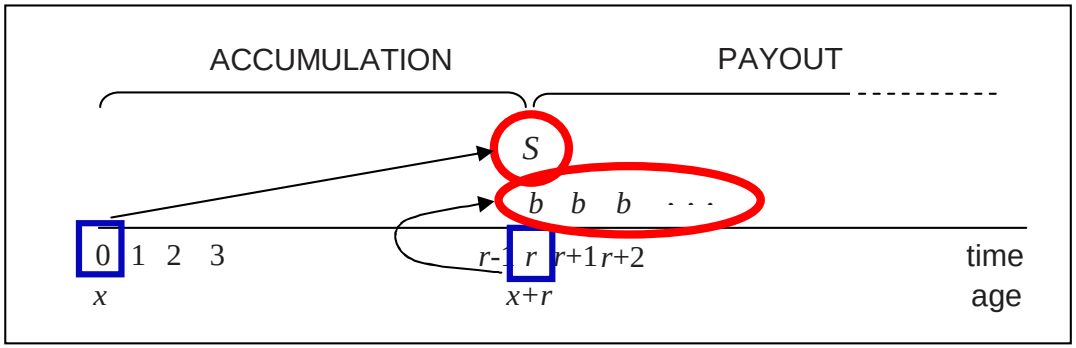
For any given amount S $\Rightarrow$ annual benefit b guaranteed (assuming a flat payment profile)



Examples

- financial product: interest guarantee $\Rightarrow$ annual benefit b guaranteed up to fund exhaustion (at a defined time)
- insurance product, i.e. a CAR immediate life annuity: interest guarantee and mortality guarantee $\Rightarrow$ benefit b guaranteed lifelong $\Rightarrow$ *longevity guarantee* (CAR = current annuity rate)

Structure 3 - Accumulation phase + Payout phase (combining structure 1 and 2)

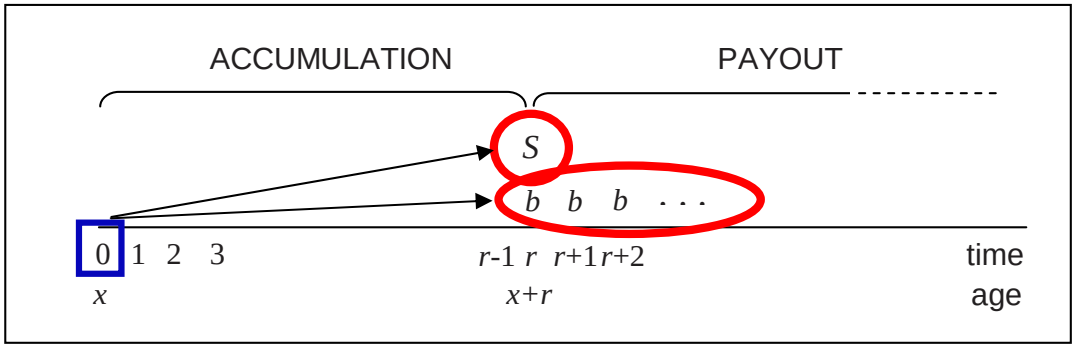


Examples

- financial product for the accumulation phase: interest guarantee $\Rightarrow$ S guaranteed
- insurance product, i.e. a CAR immediate life annuity for the payout phase: for any given S, interest guarantee and mortality guarantee $\Rightarrow$ benefit b guaranteed lifelong

Structure 4 - Accumulation phase + Payout phase

All guarantees stated at time 0 (a challenge for the annuity provider !)



Examples

- GAR deferred life annuity (GAR = guaranteed annuity rate)

  Remark

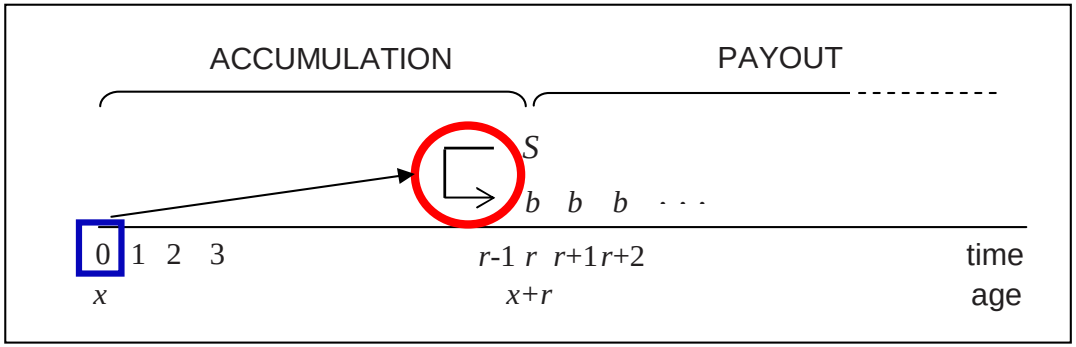
  Structure implied in particular by the classical actuarial formula

  $P\,\ddot{a}_{x:r\rceil} = b\,{}_{r|}\ddot{a}_x \;\Rightarrow\; S = \ddot{a}_{x+r} =$ policy reserve at time r

- financial product with interest guarantee for the accumulation phase and GAR immediate life annuity for the payout phase

Structure 5 - Accumulation phase + Payout phase

Conversion rate stated at time 0



Example

- financial product for the accumulation phase and immediate life annuity for the payout phase; guaranteed conversion rate

  Remark

  In particular: GAO product, providing the options (at retirement):

  - ▷ lump sum
  - ▷ annuitization at CAR
  - ▷ annuitization at GAR

Remark 1

Assume that the accumulation phase works according to the logic of single recurrent premiums (that is, a particular progressive funding of S)

Then, guarantees in both Structure 4 and Structure 5 can be weakened by linking the guarantee specification (the accumulation guarantee and/or the conversion rate) to each single recurrent premium

Remark 2

Starting from the basic structures (see above) it is possible to conceive product design by moving in various directions; in particular:

- ▷ reducing the "scope" of some guarantees, viz the longevity guarantee
- ▷ designing a non-guaranteed product, allowing for the inclusion of one or more guarantees, chosen by the client $\Rightarrow$ Variable Annuities and GMxB

See what follows

4 A RANGE OF ANNUITY PRODUCTS

We describe two specific products:

- Advanced Life Delayed Annuity (ALDA)
- Ruin Contingent Life Annuity (RCLA)

and one “category” of products:

- Variable Annuities

All these products involve both accumulation phase and payout phase

Advanced Life Delayed Annuity (ALDA)

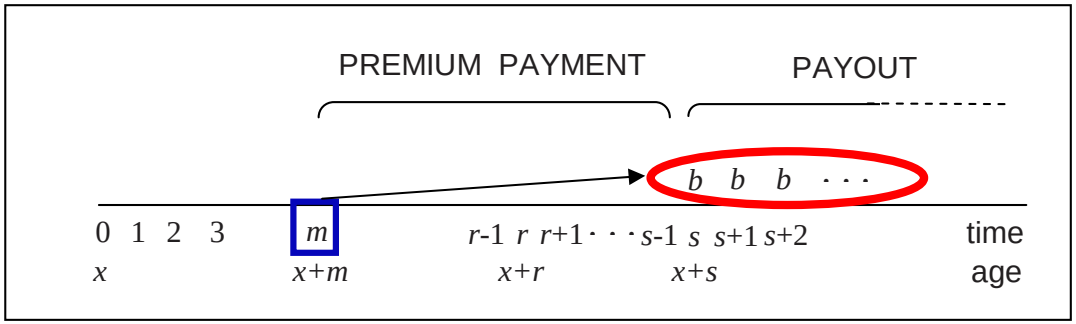
The premium payment period does not necessarily coincide with the (traditional) accumulation phase, being possibly shifted towards older ages

The payout period starts after retirement time (age 80 or 85, say)

$\Rightarrow$ withdrawal from a fund throughout the time interval $(r, s-1)$ to get post-retirement income

See:

Milevsky [2005], Gong and Webb [2010], Stephenson [1978]



See Structure 4, adapted by shifting: $0 \rightarrow m$, $r \rightarrow s$

Purposes of ALDA:

- to provide longevity insurance at old ages only (that is, insurance cover with a deductible)
- to pay an inflation-adjusted income
- to reduce premium amount (with respect to conventional deferred annuities)
- to enhance rates of voluntary annuitization

Ruin Contingent Life Annuity (RCLA)

The post-retirement income is provided by

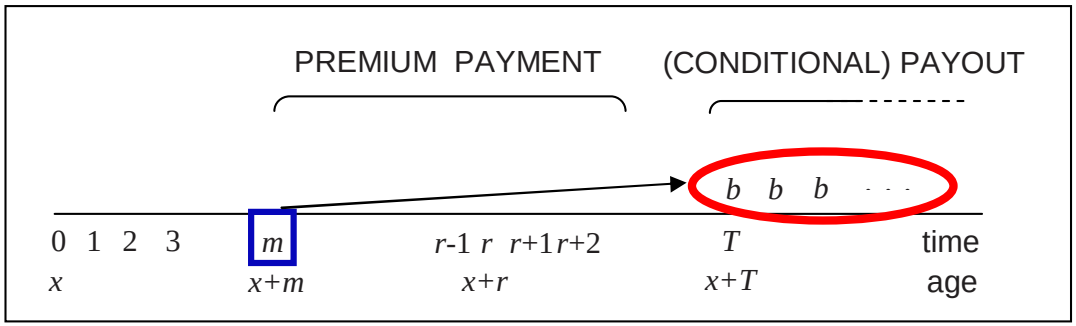
(1) withdrawal from a fund from time r onwards, up to (possible) exhaustion of the fund

(2) a life annuity paid to the retiree from (random) time T of fund exhaustion because of "adverse" scenario

- ▷ poor performance of the fund
- ▷ long lifetime

See:

Huang et al. [2009]



RCLA can be thought as

(a) an ALDA with random delay $T - r$, and trigger given by the scenario

(b) an insurance product generating annuitization as a worst case scenario

Pricing RCLA $\Rightarrow$ need for constructing a pseudo-index, accounting for

- the behaviour of a market performance index
- a set of reasonable withdrawal rates throughout the payout phase

Variable Annuities (VA)

An investment product (throughout the accumulation phase), then providing a post-retirement income

No guarantee is implicitly embedded

Various guarantees (GMxB = Guaranteed Minimum Benefit of type x) can be choosen by the client and then included

See, for example:
Bacinello et al. [2011], Kalberer and Ravindran [2009], Pitacco [2012]
and references therein

Including guarantees logically results in structures we have defined above

In what follows we disregard the Guaranteed Minimum Death Benefit (GMDB)

Let F_t denote the balance (fund value) at time t

Guaranteed Minimum Accumulation Benefit (GMAB)
(referring for simplicity to a single premium Π)

- *return of premiums* $G_r^{[\mathrm{A}]} = \Pi$
- *roll-up guarantee* $G_r^{[\mathrm{A}]} = \Pi\,(1+i')^r$
- *ratchet guarantee* $G_r^{[\mathrm{A}]} = \max_{t_h<r}\{F_{t_h}\}$
  where t_h, $h = 1, 2, \ldots$ are stated times
- *reset guarantee* $G_r^{[\mathrm{A}]} = F_{\max\{t_j:\, t_j<r\}}$
  where t_j, $i = 1, 2, \ldots$ are the stated reset times

See Structures 1, 3 and 4:

$$S \geq G_r^{[\mathrm{A}]}$$

Guaranteed Minimum Income Benefit (GMIB)

Provides a life annuity, i.e. a lifelong post-retirement income

Two possible arrangements

(1) Amount to annuitize; then

$$b^{[\mathrm{I}]} = \frac{1}{\ddot{a}_{x+r}^{[\mathrm{CAR}]}} \max\{F_r, G_r^{[\mathrm{I}]}\}$$

where $G_r^{[\mathrm{I}]}$ can be defined as $G_r^{[\mathrm{A}]}$

See Structure 3:

$$S \geq G_r^{[\mathrm{I}]}$$

(2) Annuitization rate; then

$$b^{[\mathrm{I}]} = F_r \, \max\left\{ \frac{1}{\ddot{a}_{x+r}^{[\mathrm{CAR}]}}, \, \frac{1}{\ddot{a}_{x+r}^{[\mathrm{GAR}]}} \right\}$$

Guarantee aka GAO

See Structure 5

In principle, the two guarantees can be combined; in practice, resulting product very expensive, because of insurer's huge risk

(3) Amount & annuitization rate; then

$$b^{[\mathrm{I}]} = \max\{F_r, G_r^{[\mathrm{I}]}\} \, \max\left\{ \frac{1}{\ddot{a}_{x+r}^{[\mathrm{CAR}]}}, \, \frac{1}{\ddot{a}_{x+r}^{[\mathrm{GAR}]}} \right\}$$

See Structure 4

Guaranteed Minimum Withdrawal Benefit (GMWB)

Guaranteed benefits even in the case of fund exhaustion because of

- ▷ poor investment performance
- ▷ long lifetime

The guarantee affects both

- benefit amount
- benefit duration
  - (i) fixed
  - (ii) fixed provided that the retiree is alive
  - (iii) lifelong

Guaranteed duration (iii) $\Rightarrow$ logical structure of RCLA

5 SOME ARRANGEMENTS FOR THE PAYOUT PHASE

Basic features of the life annuity product

1. The life annuity relies on the mutuality mechanism; hence:
   (a) amounts released by the deceased annuitants are shared among the annuitants still alive $\Rightarrow$ mortality credits
   (b) on the annuitant's death, her / his estate not credited with any amount (no bequest available)
2. A life annuity provides an "inflexible" income (annual amounts cashed by the annuitant must be in line with the payment profile, as stated by policy conditions, or by pension plan rules)

Features 1(b) and 2: possibly perceived as disadvantages $\Rightarrow$ weaken propensity to immediately annuitize the whole amount available at retirement.

Disadvantages can be mitigated:

- ▷ purchasing a particular product (life annuity + other benefits)
- ▷ adopting a specific annuitization strategy

Life Annuity with a Guarantee Period

Temporary annuity-certain (throughout the guarantee period)
+ deferred life annuity

	Guarantee period		
	0	5	10
$x + r = 65$	$18\,070$	$18\,131$	$18\,386$
$x + r = 70$	$15\,265$	$15\,376$	$15\,832$

Single premium at retirement age; $b = 1\,000$

Value-Protected Life Annuity (i.e. with "capital protection")

In case of early death of the annuitant $\Rightarrow$ difference (if positive) between single premium and cumulated benefits paid to the annuitant is paid to the beneficiary

Usually, capital protection expires at some given limit age

	Limit age		
	70	75	80
$x + r = 65$	18 596	19 213	19 807
$x + r = 70$	15 265	16 062	16 936

Single premium at retirement age; $b = 1\,000$

Remark

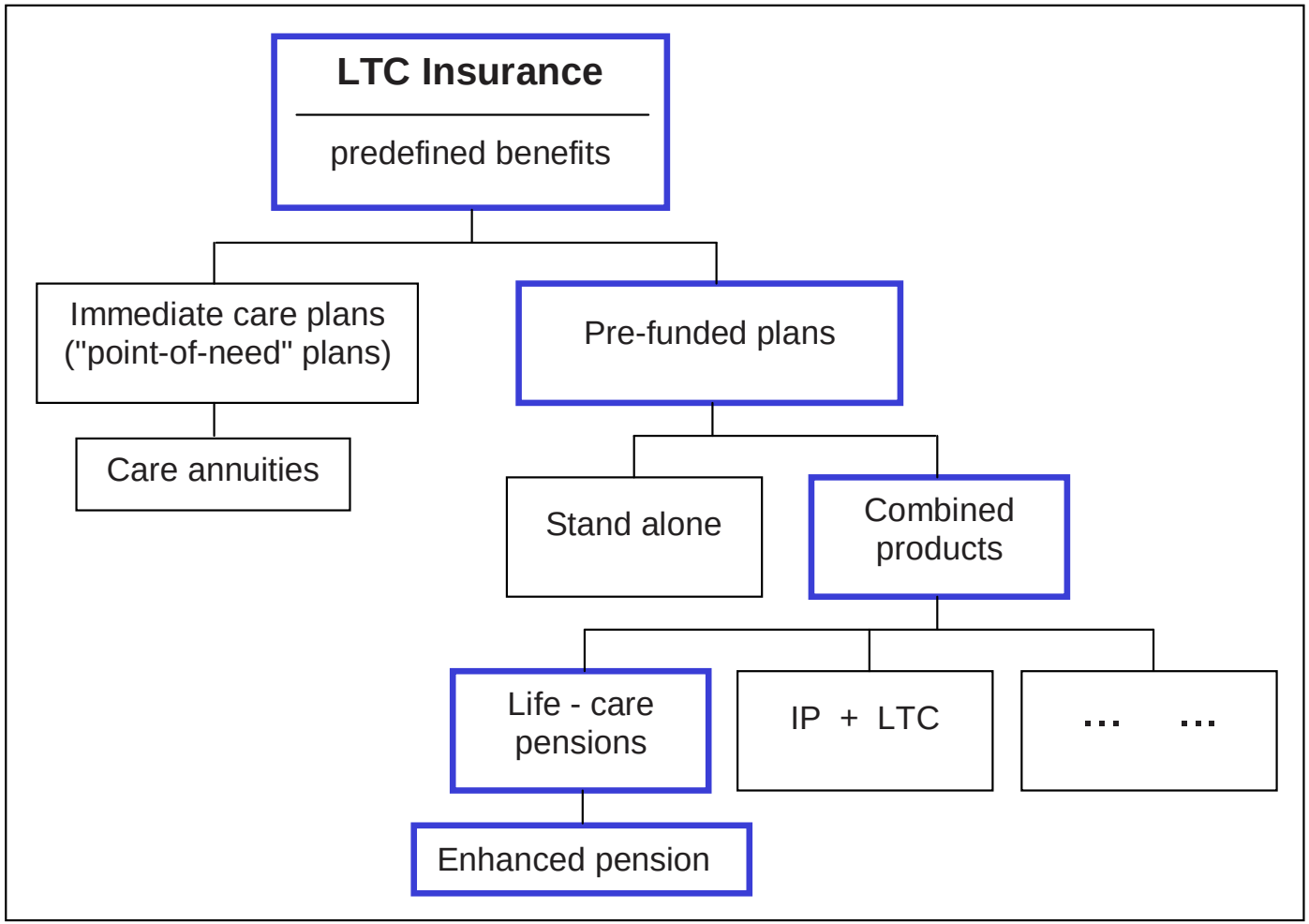
In both the products *Life Annuity with a Guarantee Period* and *Value-Protected Life Annuity* the extra-premium is small or very small, depending on the extension of the rider benefit

Obvious reason: the mortality in the age intervals involved is small or very small

Under the annuity provider's perspective: capital protection (i.e. a death benefit) does not provide an effective hedge against the (aggregate) longevity risk

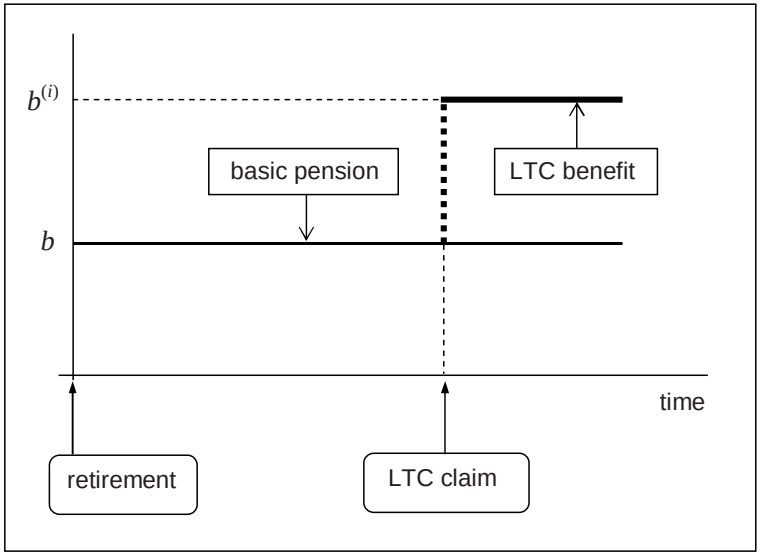
Natural hedging of the aggregate longevity risk (both *across LOBS* and *across time* as well) remains a difficult issue !

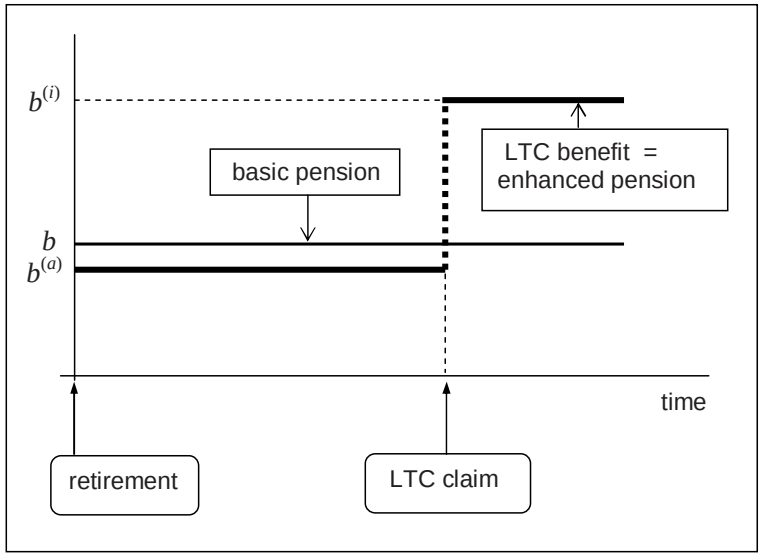
Annuity products providing LTC benefits



Some arrangements for the payout phase *(cont'd)*

The Life Care Annuity





The Enhanced Pension:
Life Care Annuity financed via reduction of the basic pension

Life Care Annuity

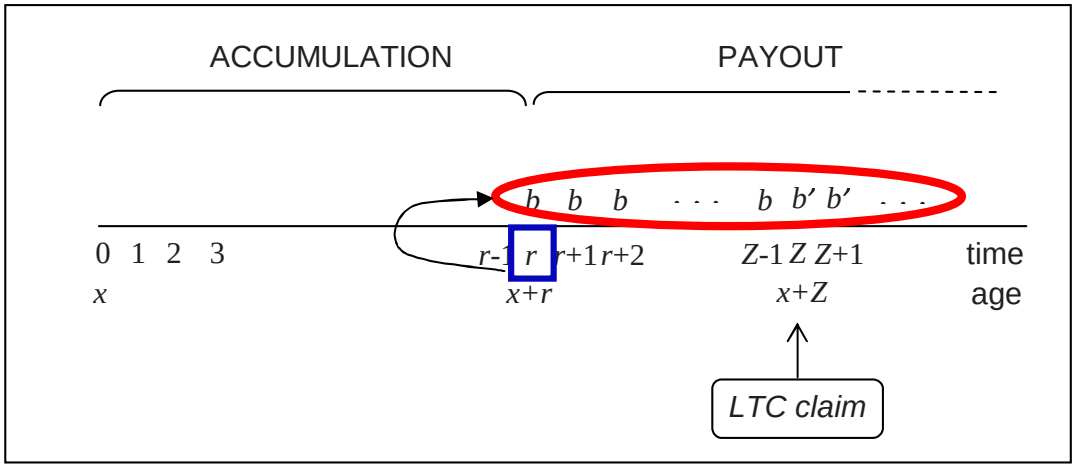
A health-related product: in the case of Long Term Care need $\Rightarrow$ shift from the basic benefit b to b' $(b' > b)$

See, for example:

Warshawsky [2007], Zhou-Richter and Gründl [2011]

and references therein

Life annuity with benefit $b' - b$ $\Rightarrow$ logical structure of RCLA conditional on health status (but different financial structure !)



Purpose: to reduce the prevailing risk feature of the stand-alone LTC annuity

A further option: financing the uplift via reduction of the basic benefit

$\Rightarrow$ *Enhanced pension*

See, for example:

Haberman and Pitacco [1999]

and references therein

Packaging LTC annuity and ALDA

Insurance package including:

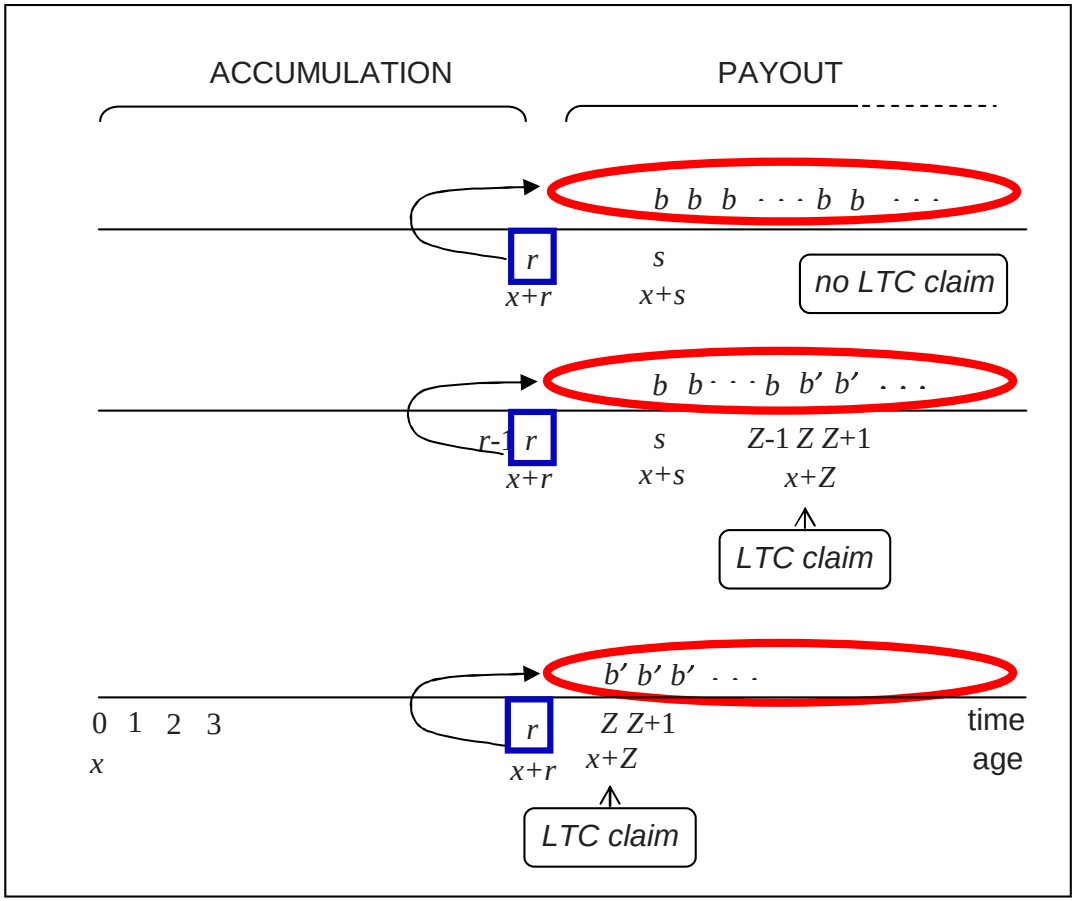
(1) LTC annuity

(2) deferred life annuity (e.g. from age 80), while the insured is not claiming LTC benefits

See following Figure

Another example of product design aiming at a reduction of the prevailing risk feature of the stand-alone LTC annuity

Some arrangements for the payout phase *(cont'd)*



Possible outcomes, depending on lifetime and LTC need

Remark

When a Life Care annuity or a LTC annuity is involved, a specific type of aggregate longevity risk is taken by the annuity provider, inherent the lifetimes of elderly people claiming for LTC

Various theories concerning the relation between trend in expected total lifetime and trend in expected healthy lifetime

See, for example:
Olivieri and Ferri [2003]
and references therein

Progressive annuitization

See:

Blake et al. [2003], Horneff et al. [2008], Milevsky and Young [2002]

Assume that, at time of retirement, amount S available to the retiree

The retiree can choose between two alternatives:

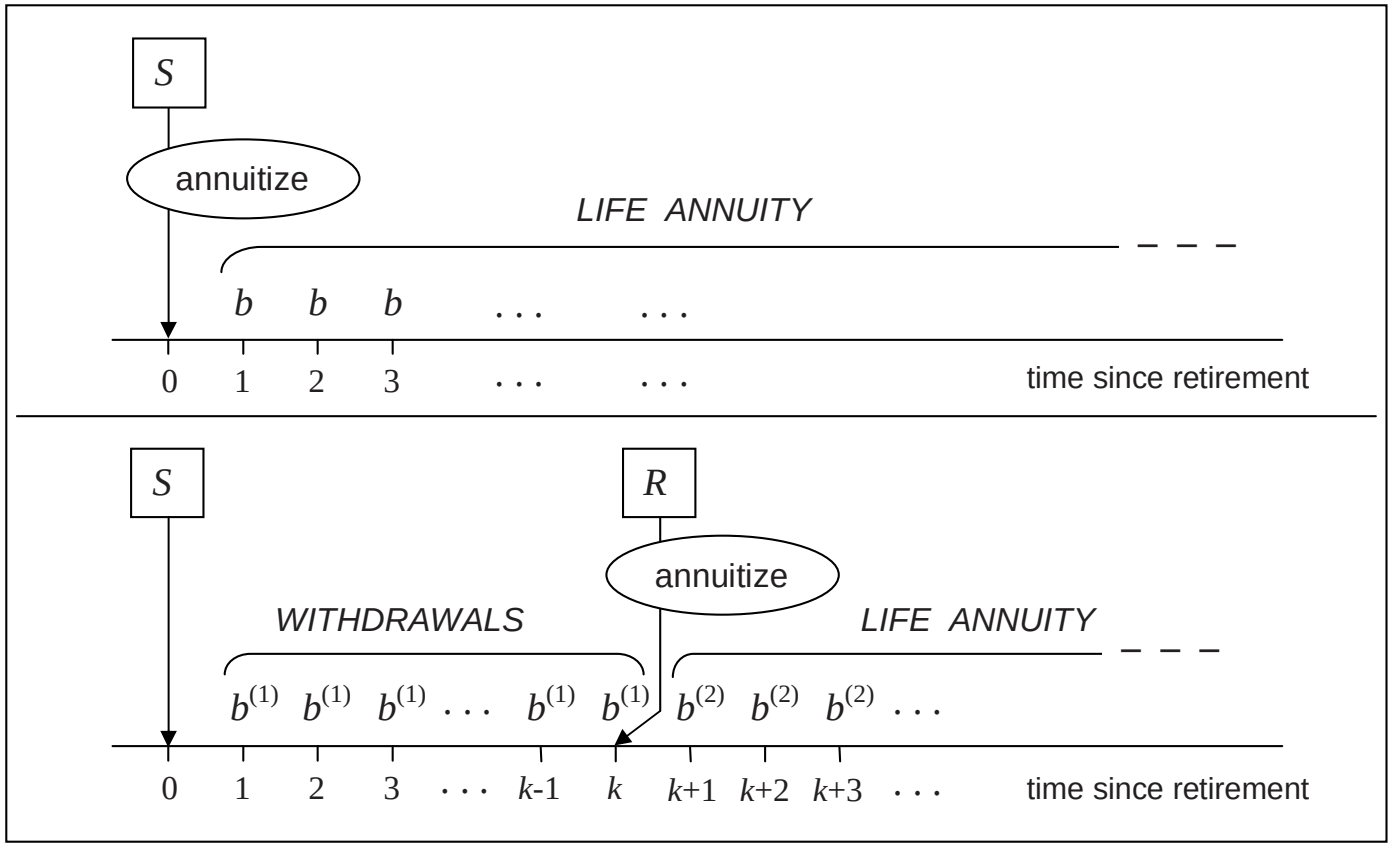
(1) to purchase an immediate life annuity, with annual benefit b (i.e. to annuitize amount S); see Figure, upper panel

(2) to leave amount S in a fund, and then

  (a) withdraw the amount $b^{(1)}$ at times $h = 1, 2, \ldots, k$ (say, with $k = 5$ or $k = 10$) $\Rightarrow$ temporary withdrawal process

  (b) convert at time k the remaining amount R into an immediate life annuity with annual benefit $b^{(2)}$ $\Rightarrow$ delayed annuitization (provided she / he is alive); see Figure, lower panel

Some arrangements for the payout phase *(cont'd)*



Immediate annuitization versus delayed annuitization

Advantages of delay in the purchase of the life annuity:

- in the case of death before time k, the fund available constitutes a bequest
- more flexibility gained, as the annuitant may change her / his income profile modifying the withdrawal sequence (however, with possible change in the fund available at time k)

Disadvantages:

- a higher interest rate than that provided by the annuity, to recover the absence of mortality credits (i.e. absence of mutuality)
- risk of a shift to a different life table in the pricing basis
  $\Rightarrow$ conversion rate at time k possibly less favorable to the annuitant
- if k is high, difficult to gain the required yield avoiding too risky investments

Interest rate $g(k)$ needed to recover mortality credits lost in $(0, k)$ ($i = 0.02$)

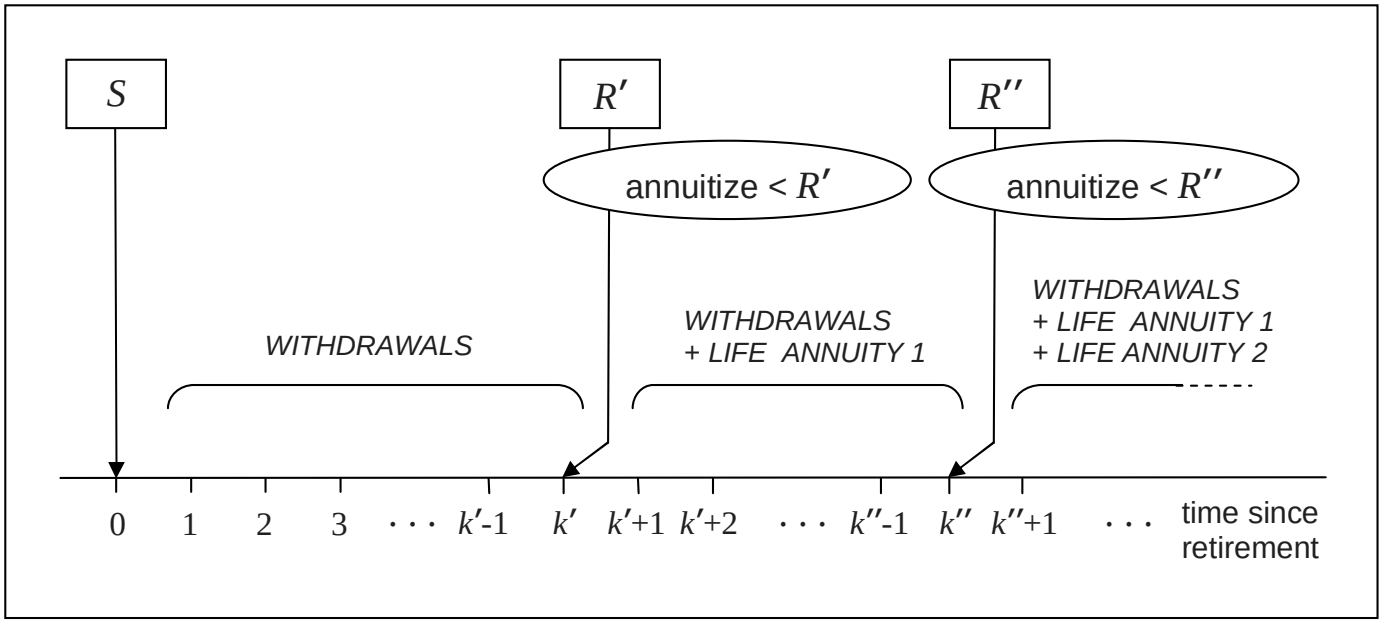
k	$g(k)$
5	0.02748
10	0.03009
15	0.03336
20	0.03718

Interest rate $g(k) \Leftrightarrow b^{(1)} = b^{(2)} = b$

Delayed annuitization $\Rightarrow$ trade-off between mortality risk and financial risk (and longevity risk as well, because of possible change in the annuitization rate)

Some arrangements for the payout phase *(cont'd)*

A more general arrangement:



Staggered annuitization

6 THE PAYMENT PROFILE

So far we have focussed on *level annuities* $\Rightarrow$ income which is constant in nominal terms

A number of models of "varying" annuities have been derived, mainly with the purpose of protecting the annuitant against the loss of purchasing power because of inflation

In particular:

1 *Fixed-rate escalating annuities* (or *constant-growth annuities*)

2 *Index-linked annuities*

- 2.a Inflation-linked annuities
- 2.b Equity-indexed annuities

3 *Investment-linked annuities*

- 3.a With-profit annuities (UK)
- 3.b Annuities with profit participation mechanisms
- 3.c Unit-linked annuities

Participation mechanisms (3.b) can involve both financial and mortality experience

Possible problem: poor mortality experience because of unexpected increase in longevity $\Rightarrow$ aggregate longevity risk

In traditional life annuity and pension design, the longevity risk is borne by the annuity provider

Alternative product design $\Rightarrow$ transfer part of the longevity risk to the annuitants $\Rightarrow$ definition of a *longevity-linked life annuity*

Sharing the (aggregate) longevity risk

Formally: *Adjustment process* $\Rightarrow$ benefit b_t due at time t:

$$b_t = b_0 \, \alpha_t^{[\mathrm{m}]}$$

with $\alpha_t^{[\mathrm{m}]}$ = coefficient of adjustment over $(0, t)$, according to mortality trend measure $[\mathrm{m}]$

Coefficient $\alpha_t^{[\mathrm{m}]}$ can incorporate investment profit participation
$\Rightarrow$ longevity loss can be offset by investment profit

Various interesting contributions regarding practicable models for the adjustment process and the measure $[\mathrm{m}]$

See:

Denuit et al. [2011], Goldsticker [2007], Kartashov et al. [1996], Lüty et al. [2001], Olivieri [2013], Piggott et al. [2005], Richter and Weber [2011], Rocha et al. [2011], Sherris and Qiao [2011], van de Ven and Weale [2008], Wadsworth et al. [2001]

7 CONCLUDING REMARKS

Actuarial mathematics and technique traditionally focussed on "benefits" in terms of the relevant expected present value ($\Rightarrow$ basically, a deterministic approach)

Risks implied by *guarantees* and *options* provided by policy conditions and pension plan rules usually disregarded (or, at least, not explicitly accounted for)

Current scenarios (market volatility and uncertainty in longevity dynamics) $\Rightarrow$ careful consideration of risks inherent in the life annuity and pension structures

Purpose of this presentation: to focus (according to ERM guidelines) on *risk identification* and *product design* looking at possible risk (in particular, biometric risk) transfers between annuitants and annuity provider

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Many thanks for your kind attention