Long guarantees with short duration: The rolling annuity

Søren F. Jarner, VP
ATP Pension Fund

1 June 2016
Outline

• ATP and market value accounting
• The problem
• The rolling annuity
• Reserving and hedging
• Implementation at ATP
• Example
• Summing up
The ATP pension fund

• The Danish Supplementary Labour Market Pension Scheme
  – … or ATP for short (DK ‘Arbejdsmarkedets Tillægspension’)
  – Founded by law in 1964 as a supplement to State Pension
  – Mandatory scheme for all Danish employees (voluntary for self-employed)
  – Almost 5M members and assets under management of approximately €100B.

• Pension product
  – Life-long nominal annuity receivable from State Pension age (cohort dependent)
  – Discretionary indexation of pensions when the funding ratio of the fund is sufficiently high
  – Individual guarantees purchased for 80 pct. of contributions, remaining 20 pct. are “risk capital”.

Institute and Faculty of Actuaries
Market value accounting and its implications for ATP

- Market value accounting since 2003
  - “Pure” market rate discounting
    - Long-dated liabilities discounted at 30Y rate
    - Allows delta-hedging (in normal markets)
  - Huge interest rate sensitivity
  - Fully hedged in swaps and bonds
  - Decrease in interest rates increased value of liabilities dramatically.

- Discounting curve under Solvency 2
  - Long-dated liabilities valued at UFR
  - *Long-dated liabilities cannot be hedged*
    - Discounted value ≠ value of (delta) hedge
The problem

• The old annuity product at ATP
  – 80 pct. of contribution converted to nominal life-long annuity at the time of payment
  – Annuity level (tariff) updated annually to reflect current market rates and life expectancy.

• Large hedge demand at long-dated maturities
  – Increasingly difficult – and costly – to maintain the necessary hedge
  – Long-dated liabilities non-hedgeable (due to “semi” market rate discounting).

• The Board of ATP wants guarantees!
  – Not an option to move to unit-link type products
  – “Could you please design a hedgeable life-long guarantee”.

Institute and Faculty of Actuaries
... and one more thing

- “Please make sure to preserve the business model”
  - The liability side of the balance sheet is very simple
  - … allowing a very sophisticated asset side
  - Accommodation of all guarantees in one (simple) business model.

- Implication 1: Type of guarantee
  - All pension rights in the form of “guaranteed annual pension“
  - No individual unit-link accounts.

- Implication 2: Same status of new and old guarantees
  - Collective risk sharing of financial and biometric risks
  - New and old guarantees should entail same, or at least very similar, risks and have the same “claim” on free reserves (BP).
Traditional annuity vs rolling annuity

- Consider a person paying a contribution of 100 at time 0 and retiring at $R$
  - Denote by $p_t(T)$ the price at time $t$ of a zero-coupon bond (ZCB) maturing at time $T$

- Traditional (deferred) life-long annuity
  - Ignore tax, safety loadings, technical basis etc.
  - Guaranteed annuity level = \( \frac{100}{\int_R^\infty p_0(w)S(w|0)dw} \).

- The rolling annuity replaces the long interest rate guarantee with shorter ones
  - Assume interest rate guarantee of 15 years
  - Initial guarantee: $z(0) = \frac{100}{\int_R^\infty S(w|0)dw} \frac{1}{p_0(15)}$
  - Guarantee after 15 years: $z(15) = z(0) \frac{1}{p_{15}(30)}$
  - Final guarantee: $z(30) = \frac{z(15) \int_R^\infty S(w|30)dw}{\int_R^\infty p_{30}(w)S(w|30)dw}$.
Market value reserve

• Consider the reserve associated with a contribution paid at time 0
  – Let $z(u)$ denote the guarantee at time $u \geq 0$
  – Prior to the final guaranteed increase, the reserve is
    • $V(u) = z(u)e(R|u)p_u(\tau_N(u))$,
    • where $e(R|u)$ is the expected no. of years in retirement given survival to time $u$, and $\tau_N(u)$ is the time of the next increase.
  – At or past the final guaranteed increase, the reserve is
    • $V(u) = z(u) \int_{\max\{u,R\}}^{\infty} p_u(w)S(w|u)dw$, i.e. the reserve for an ordinary, life-long annuity.

• \textbf{Before the final increase, the reserve for a cohort equals the price of a ZCB maturing at $\tau_N(u)$ with principal $\bar{z}(u) \times \text{total no. of years in retirement}$}
  – The liability can be semi-statically hedged, i.e. hedge needs to be adjusted only every $L$ years
  – For $L$ up to 20 years, say, the hedge can be implemented in liquid markets
  – In practice, the reserve is based on updated mortality assumptions
  – Longevity risk is borne collectively, i.e. guarantees are unaffected.
Implementation at ATP

• Rolling annuities were implemented at ATP with effect from 1 January 2015
  – Guarantee period of $L = 15$ years
  – The effect from contributions received in 2015 can be seen as an increased “payment” in 2030
  – The remaining cash flow stems from ordinary annuities; both old guarantees and guarantees written in 2015 for members within 15 years of retirement.

• Hedgeable at large scale
  – The bulk of the (rolling annuity) cash flow is at maturities where market liquidity is high
  – Ordinary life-long annuities are issued only close to retirement.
Example: Longevity risk

- Table shows the relative reserve increase when applying a 20% mortality stress
  - GM mortality law*: \( \mu(x) = 1.5 \cdot 10^{-5} \exp(0.1 \cdot x) + 2 \cdot 10^{-4} \)
  - Stressed mortality law: \( \tilde{\mu}(x) = 0.8 \mu(x) \)
  - Flat yield curve: \[ p_T(t) = \exp\left(-\frac{T-t}{y}\right), \text{ for some fixed } r \]
  - Single premium at age \( x \), age of retirement \( R = 65 \) yrs, and guarantee period of \( L = 15 \) yrs.

<table>
<thead>
<tr>
<th>( \Delta V/V )</th>
<th>( \text{Age} \ (x) )</th>
</tr>
</thead>
<tbody>
<tr>
<td>Rate ( (r) )</td>
<td>25</td>
</tr>
<tr>
<td>----------------</td>
<td>--------------------------</td>
</tr>
<tr>
<td>0%</td>
<td>11.4%</td>
</tr>
<tr>
<td>2%</td>
<td>11.4%</td>
</tr>
<tr>
<td>4%</td>
<td>11.4%</td>
</tr>
</tbody>
</table>

* Independent of interest rate

* Gompertz-Makeham law fitted to Danish unisex population mortality for 2011
Example: Building up of guarantee

Annual contribution of 100 indexed by inflation of 2% from age 25 to age 64. Interest rate of 3%, and guarantee period of $L = 15$ years.
Example: Duration

Left plot: Reserve for maturities over 30 years as fraction of the total reserve.
Right plot: Duration of total reserve measured in years.

In both plots the solid line represents a guarantee period of $L = 15$ years, while the dashed lines represent guarantee periods of 5 and 25 years, respectively. The vertical dotted line at age $R = 65$ years marks the age of retirement.
Summing up

• Initial minimum guarantee and subsequent guaranteed increases prior to retirement
  – Prior to the final increase, the reserve equals a zero-coupon bond maturing at the next increase
  – Rolling annuities can be hedged at large scale for guarantee periods of up to, say, 20 years
  – Keeping the duration below 20 years imply very similar financial and regulatory (S2) value
  – This simplifies risk management considerably
  – Rolling annuities have been implemented at ATP with a guarantee period of 15 years.

• Longevity risk can be reduced by weakening the “life expectancy guarantee”
  – However, the rolling annuities at ATP have full longevity risk (similar to existing annuities).

• Rolling annuity guarantees are intended as part of a with-profits contract
  – A complementing return-seeking portfolio is essential to obtain broad market exposure
  – The guarantees entail both longevity risk and hedging risk and thus can apply to only part of contributions
  – At ATP, rolling annuities are acquired for 80 pct. of contributions.