Innovative Solutions for the Decumulation Phase of Pension Products

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Funded Retirement Systems Face Sustainability Issues

EIOPA estimation of excess of assets over liabilities of DB/hybrid funds in baseline scenario, % liabilities

Source: EIOPA (2017)
### The Trend Towards Pension Individualization

#### Collective Systems
- Effective risk-sharing mechanisms
  - Intergenerational risks for investment and longevity
  - Risk sharing between employer and employees through renegotiation of contracts
- But hard commitments and sustainability issues

#### Individualized Systems
- Flexibility to adapt products to preferences of heterogeneous individuals
- But greater risks for individuals
  - Investment risk
  - Annuity conversion, insurer default risk
  - Longevity risk
- Lack of products answering individuals’ needs at retirement (decumulation)

- Use of **individual accounts** (Hungary, Slovak Republic)
- Reforms to **eliminate the guarantees** (notional DC, collective DC)
- Switch from **DB to DC** (US, UK, Germany, Switzerland)
What People Need for the Decumulation

- Consumer demand for flexible options at retirement
  - Continue investing and keep flexibility in the use of accumulated savings (48%)
  - Receive a regular income (20%)

Source: Audirep, Amundi, Natixis survey (2018)
Three Main Objectives for the Decumulation

- Cope with liquidity needs
  - Exceptional, unforseen expenses

- Secure essential consumption needs until death
  - U-shape: high in early and late retirement

- Transfer capital to bequest
  - Residual wealth
Two Polar Solutions Offered for the Decumulation

Annuities

- Provides guaranteed income and insurance against longevity risk

- Allows to benefit from the mortality credit (people dying earlier leave their capital to the pool)

- BUT

- Protection comes at the cost of relatively low income at retirement

- Lack of flexibility – annuity irreversible:
  No possibility to leave bequest to your heirs, to recover capital in case of unforeseen expenses in retirement

- Costly capital requirements for insurers with Solvency II, and (small) default probability
Two Polar Solutions Offered for the Decumulation

- Only fixed immediate annuities offered in most countries
  - Limited value of immediate annuitization (mortality credit is small in early retirement)

BUT
- No inflation protection
- No equity risk premium
- Expensive in current economic environment

Deferred annuities

- Fixed annuities
  - Pays a fixed nominal rate

- Inflation-indexed annuities
  - Payments indexed on an inflation index

- Variable annuities
  - Payments indexed on the value of a chosen investment portfolio
Two Polar Solutions Offered for the Decumulation

- Little appetite for life annuities (« Annuity puzzle »)
  - Ex: Australia or UK, introduction of « Pension Freedom » removing mandatory conversion

Total value of contracts sold (in £millions)

Source: Cannon et al. (2016)
Two Polar Solutions Offered for the Decumulation

Drawdown Strategies

- Offers to gradually withdraw your capital during retirement
- Often preferred, flexible
- Allows to bequeath capital
- Continue to invest in risky assets

- BUT
  - Risk of exhausting capital before death
How to Manage Longevity Risk?

- Life expectancy at birth: evolution in Europe

How to Manage Longevity Risk?

- Two components of longevity risk
  - **Systematic** (risk of misestimating the probability of future survival)
  - **Idiosyncratic** (risk that the individual’s date of death is different from expected, given known probability of survival)
How to Manage Longevity Risk?

– Idiosyncratic risk is diversifiable, systematic risk is not

Number of individuals in the pool
How to Manage Longevity Risk?

- Full insurance is possible with an annuity purchased from an insurer
  - Idiosyncratic risk pooled
  - Systematic risk born by shareholders requiring a remuneration

- But the protection is costly
  - Capital requirements for insurers with Solvency II
  - Insurer is subject to default risk (Koijen and Yogo, 2017)

- What about an intermediate solution? Group Self-Annuitization (GSA)
  - Pool idiosyncratic risk
  - Systematic risk born by individuals
  - Contracts introduced by Pigott (2005)
Our Paper

- Compares two longevity risk management contracts in retirement
  - **Collective arrangement (GSA):** pools idiosyncratic risk, distributes systematic risk to participants
  - **Annuity:** all risks borne by an insurance company relying on shareholders, with a certain cost and default risk

- Measures the relative attractiveness of both contracts for individuals

- Examines the viability of the insurance solution through the financial reward of equityholders
  - To provide insurance against systematic risk, the annuity provider requires a buffer capital (equity contribution or contract loadings) to absorb unexpected shocks
  - Equityholders should have a **sufficient compensation** (longevity risk premium) to bear the risk
Our Paper

- Main finding: the collective arrangement yields higher individual welfare than the annuity contract priced at its best estimate.

- Under perfect competition, the annuity provider is unable to adequately compensate its equity holders for bearing longevity risk.

- Outcome is robust to individuals’ risk aversion ($\gamma = 2, 5, 8$), deferral period, stock exposure, parameter uncertainty of the longevity model time trend’s drift.

- Individuals exhibit preference for the annuity contract only if the uncertainty on life expectancies at late ages is heightened but default risk is curtailed.
## Model Description

### Financial Market
- Constant interest rate, \( r \)
- Stochastic stock market index: \( dS_t = S_t (r + \lambda_S \sigma_S) dt + S_t \sigma_S dZ_{S,t} \)

### Life Expectancy
- Lee and Carter (1992): log central death rate of individual of age \( x \) in year \( t \), \( \ln(m_{x,t}) = a_x + b_x k_t + \varepsilon_{x,t} \)
- Time trend, \( \{k_t\}_{t=t_0}^T \) follows an ARIMA(0,1,0) process.
- Omission of idiosyncratic longevity risk.

### Individual Preference
- Choose a contract at age 25 in year \( t_0 \), receive retirement benefits, \( \Xi_t \), between ages 66 to 95, conditional on survival.
- Maximise expected CRRA Utility in retirement: \( \int_{t_R}^{T} e^{-\beta t} \frac{\Xi_t^{1-\gamma}}{1-\gamma} \cdot p_{25} dt \)

### Simulations: Results based on 500 000 replications

\( t_0, t_0, T \): years when the individual is aged 25, 66 and 95. 
\( p_{t-t_0} \) is the probability of someone aged 25 to be alive in \( t - t_0 \) years.
Financial Contracts for Retirement: DVA

The DVA and the GSA treat financial market risk identically (fully borne by individuals), but differ in the longevity risk distribution.

Deferred Variable Annuity (DVA)

- Parametrized by the Assumed Interest Rate (AIR) defining the path of benefit payments over time
- Indexed to a reference portfolio (0-20% equity, glide path)
- Individuals bear full market risk

- Entitlements determined using longevity forecasts on the date of contract sale
  - Insurer fully hedges market risk by adopting the reference portfolio’s investment policy
  - Benefits received are equivalent to entitlements while insurer is solvent

- Regulatory requirement: 100% Funding ratio
  - Shareholders initially provide a lump sum capital: 10% of contract’s price best estimate
  - Default occurs if the DVA provider’s Value of assets < Value of liabilities
  - In default, individuals recover the residual wealth, used to buy a portfolio of equally-weighted bonds, maturities from retirement year (or present year if in retirement) to max age
Financial Contracts for Retirement: GSA

The DVA and the GSA treat financial market risk identically (fully borne by individuals), but differ in the longevity risk distribution.

Group Self-Annuitization (GSA)

- Entitlement calculation is identical to that of a DVA with zero loading
  - Indexed to a Reference Portfolio
  - Parametrized by the Assumed Interest Rate (AIR)

- No regulatory requirements: entitlements are adjusted each year by this ratio to determine the benefits paid-out.

\[
\text{Funding Ratio in year } t (FR_t) = \frac{\text{Benefits}}{\text{Entitlement}}
\]

Minimum Funding Requirement (MFR)

\[\text{MFR} (=100\%)\]

- Benefits < Entitlement
- Benefits = Entitlement
- Benefits > Entitlement
Longevity Risk

Fan plot of the fraction of living individuals by age

- Wide range of variation between min and max realizations (> 20% at age 88)
Boxplot of Benefits

Comparable median benefits but GSA has higher standard deviation
- DVA upwards adjustments captured by shareholders, severe downward adjustments are rare and due to default (cumulative default rates over individual’s planning horizon < 0.01%)

Note that median benefit grows with age (AIR* = 3.5% < risk-free interest rate = 3.6%)
GSA upwards adjustments are more frequent than downwards (non-linearity in Lee-Carter model: positive surprise in log central death rate leads to higher entitlement adjustments than negative surprise)
Boxplot of Equity Holders’ Excess Return

Comparable median excess returns but higher standard deviation for an investment in the life insurer

- Shareholders contribute 10% of contract’s best estimate and receive terminal wealth of insurer as dividend
- Higher excess return in the best scenario, but greater downside risk

Individuals with $\gamma = 5$, underlying portfolio is 20% invested in the risky stock index, 80% in the money market account. Annualized returns calculated in excess of the risk-free rate.
Key Statistics

Default Risk of the DVA

Optimal AIR
Maximizing the individual’s welfare

Cumulative Default Rates
Zero-loading DVA with 40-year deferral
Equity capital = 10% of the liabilities in the year the contract is sold

<table>
<thead>
<tr>
<th>θ (%)</th>
<th>2</th>
<th>5</th>
<th>8</th>
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<tbody>
<tr>
<td>0</td>
<td>3.31</td>
<td>3.50</td>
<td>3.54</td>
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<tr>
<td>20</td>
<td>4.00</td>
<td>4.48</td>
<td>4.48</td>
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<table>
<thead>
<tr>
<th>θ (%)</th>
<th>2</th>
<th>5</th>
<th>8</th>
</tr>
</thead>
<tbody>
<tr>
<td>0</td>
<td>0.0102</td>
<td>0.0084</td>
<td>0.0082</td>
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<tr>
<td>20</td>
<td>0.0070</td>
<td>0.0038</td>
<td>0.0038</td>
</tr>
</tbody>
</table>

- **Higher AIR** leads to benefits paid **earlier in retirement**, when longevity forecasts are more accurate
- **Lower default rate**
Key Statistics

### Individuals

**Certainty Equivalent Loading (CEL)**

- The proportional loading on the DVA contract for which the individual derives the same expected utility under the DVA and under the GSA.

<table>
<thead>
<tr>
<th>θ (%)</th>
<th>γ</th>
<th>2</th>
<th>5</th>
<th>8</th>
</tr>
</thead>
<tbody>
<tr>
<td>0</td>
<td>-0.350</td>
<td>-0.200</td>
<td>-0.055</td>
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<tr>
<td></td>
<td>[-0.362, -0.339]</td>
<td>[-0.211, -0.188]</td>
<td>[-0.067, -0.044]</td>
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<tr>
<td>20</td>
<td>-0.349</td>
<td>-0.200</td>
<td>-0.052</td>
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</tr>
<tr>
<td></td>
<td>[-0.361, -0.338]</td>
<td>[-0.216, -0.184]</td>
<td>[-0.088, -0.016]</td>
<td></td>
</tr>
</tbody>
</table>

Values are in %.

θ is the % invested in stocks.

γ is the risk aversion parameter.

### Equity Holders

**Sharpe Ratio (SR)**

- The ratio of the annualized investment return in excess of the money market return, over its annualized standard deviation.

<table>
<thead>
<tr>
<th>Statistic</th>
<th>θ (%)</th>
<th>γ</th>
<th>2</th>
<th>5</th>
<th>8</th>
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<tr>
<td>$\mathbb{E} [R^{(A_{exs})}]$ (%)</td>
<td>1.44</td>
<td>1.44</td>
<td>1.44</td>
<td>1.44</td>
<td></td>
</tr>
<tr>
<td>$\sigma^{(A_{exs})}$ (%)</td>
<td>5.04</td>
<td>4.95</td>
<td>4.95</td>
<td>4.95</td>
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</tr>
<tr>
<td>$SR$</td>
<td>0.29</td>
<td>0.29</td>
<td>0.29</td>
<td>0.29</td>
<td></td>
</tr>
<tr>
<td></td>
<td>[0.29, 0.29]</td>
<td>[0.29, 0.29]</td>
<td>[0.29, 0.29]</td>
<td></td>
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</tr>
</tbody>
</table>

Reference portfolio: 20% in the stock index.

$R^{exs} = 1.43\%$  $\sigma^{exs} = 3.17\%$

$SR = 0.45$

No loading charged.
Sensitivity Analysis: General

- **Baseline case**
  - $\gamma = 5$, 20% in stocks, 10% capital, cumulative default rate = 0.0038%, CEL = -0.2%

- **Sensitivity to risk aversion**
  - Individuals who are **highly risk-averse** prefer the **DVA**, $\gamma = 20$; CEL = 0.62%.

- **Sensitivity to insurer’s leverage ratio**
  - Higher leverage ratio (lower capital) implies a **stronger preference for the GSA**
  - Ex: Initial capital 5%, cumulative default rate rises to 5%, CEL decreases to -12.9%.

- **Sensitivity to deferral period (40Y, 20Y or immediate annuity)**
  - No material impact: shorter deferral period allows for **more accurate survival probabilities forecast** but **more imminent longevity shocks** to utility

- **Sensitivity to stock exposure**
  - No material impact of a change to 0, 20, 40, 60, the optimum $\left(\frac{\lambda_S}{\gamma \sigma_S}\right)$, and a glide path (90% at age 25, diminishing to 30% by age 66).
Sensitivity Analysis: Longevity Model (1/3)

Doubled Time Trend Errors’ Variance

- Time trend process:
  \[ k_t = c + k_{t-1} + \delta_t \]

- \( \delta \sim N(0, 2\sigma_\delta^2) \)

Drift Parameter Uncertainty

- \( k_t = c + k_{t-1} + \delta_t \)

- \( \hat{\delta} \) is estimated by maximum likelihood, and is distributed as
  \( \hat{\delta} \sim N(c, \sigma_c^2) \)

- For the \( l^{th} \) replication, draw a \( c_l \) from the distribution \( N(\hat{\delta}, \sigma_c^2) \)

Alternate Longevity Model

- Cairns, Blake and Dowd (2006)

- \( \text{logit}(q_{t,x}) = \kappa_t^{(1)} + \kappa_t^{(2)} (x - \bar{x}) \)
Drift Parameter Uncertainty

- No material change to the default rates, CEL, and equity holders’ investment performance.

Doubled Time Trend Errors’ Variance

- Default rates increase from 0.0038% to 3.41%: CEL = -7.7%;

- If equity capital is raised sufficiently to eliminate default risk: CEL = 3.2%;

- Lower Sharpe ratio with longevity risk exposure when loading is 3.2% and equity capital is raised sufficiently.
Sensitivity Analysis: Longevity Model (3/3)

Alternate Longevity Model

- **Cairns-Blake-Dowd**
- **Lee-Carter**

- **Higher uncertainty** on the likelihood of survival at older ages
- Default rises to 0.48%: CEL = -0.5%
- Absent default: CEL = 0.46%
- **Lower Sharpe ratio** with longevity risk exposure

Both models calibrated on U.S. female mortality data from 1980 to 2013, from the Human Mortality Database. Fan plot based on 10,000 replications.
Conclusion (1/2)

- We investigate systematic longevity risk management in retirement under two arrangements:
  - Distributing the risk as a collective (GSA)
  - Insuring the risk with an annuity contract (DVA)

- We model individual / insurance equityholders’ preferences
  - Individuals prefer the contract yielding the highest expected utility
  - Equity holders are willing to provide capital if the risk-return trade-off from longevity exposure is more attractive than pure financial market return

- Main results
  - Individuals have a slight preference for the GSA
  - Equity holders attain a lower Sharpe ratio when exposed to longevity (if DVA priced at its best estimate, no loading charged)
Conclusion (2/2)

– Under perfect competition, annuity contracts would not co-exist with collective arrangements
  - Unless there is competitive advantage of insurance company to **hedge longevity risk in its balance sheet** (not considered here)

– Preference for the GSA is insensitive to
  - Risk aversion (except very high risk aversion)
  - Contract deferral period
  - Exposure to stock market risk
  - Longevity time trend’s drift parameter uncertainty

– Higher longevity risk enhances DVA’s appeal only if the provider restrains default risk with sufficient capital
  - Aggravated longevity risk leads to higher variability of the equity holder payoff
  - Equity holders Sharpe ratio remains lower than pure financial market investment
Policy Implications

- Need for innovative, flexible and personalized solutions

- Efficient strategies for the decumulation do not involve full hedging of longevity risk
  - Disentangling systematic / idiosyncratic component of longevity risk
  - Systematic longevity risk hedging is costly in an immediate life annuity
  - For individuals – main risk is the idiosyncratic component of longevity risk

- A number of academic proposals in that direction
  - Combination of drawdown strategies with deferred annuities
  - Group-Self-Annuitization contracts
Further Readings


Also available on SSRN: https://papers.ssrn.com/sol3/papers.cfm?abstract_id=2926902

and Amundi Research Center research-center.amundi.com
-- MENTIONS LEGALES

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