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Innovative Solutions for the Decumulation Phase of Pension Products

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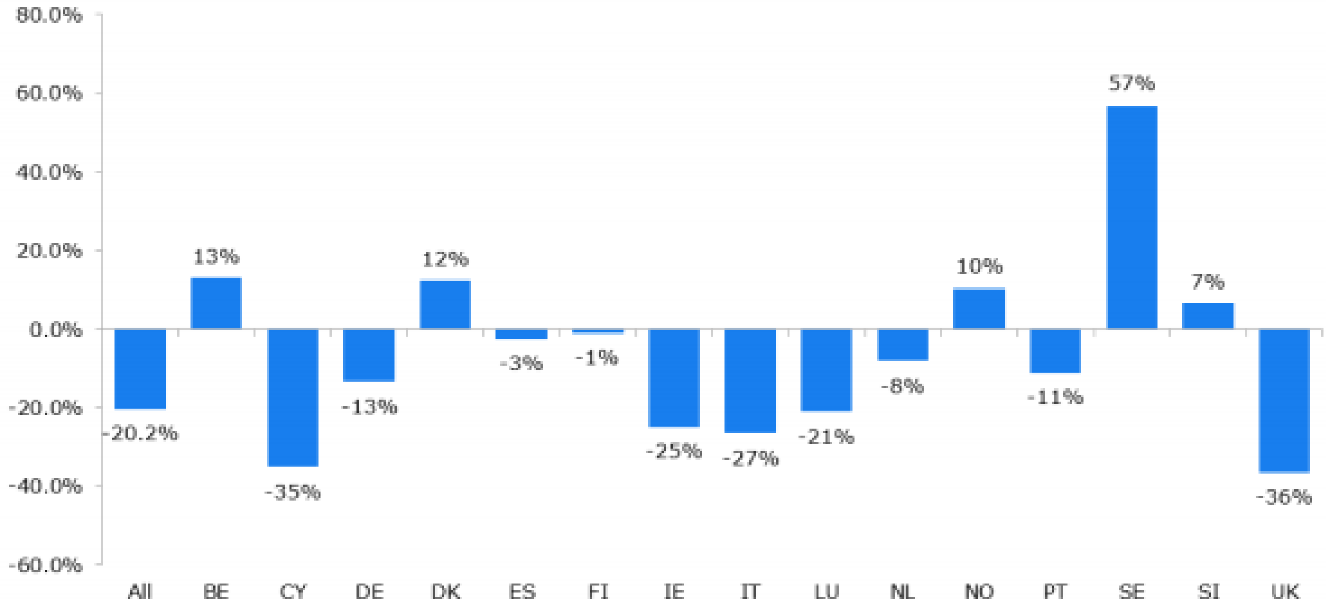
Funded Retirement Systems Face Sustainability Issues

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 renegociation 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)

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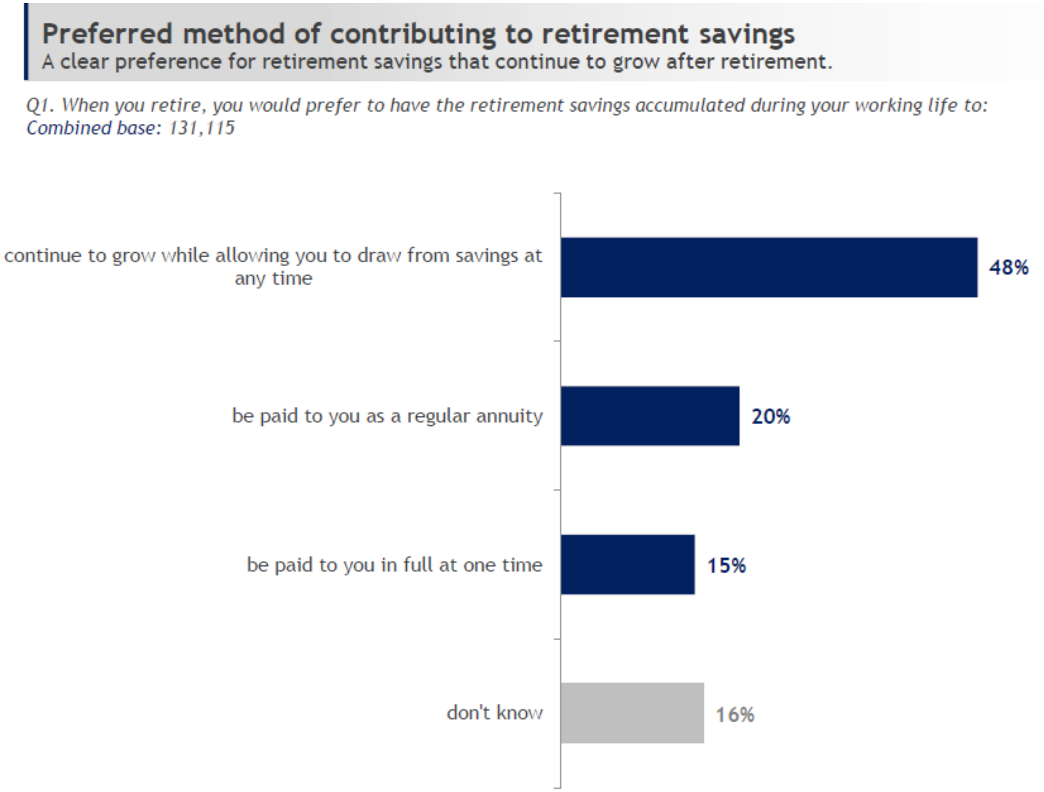
What People Need for the Decumulation

- 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

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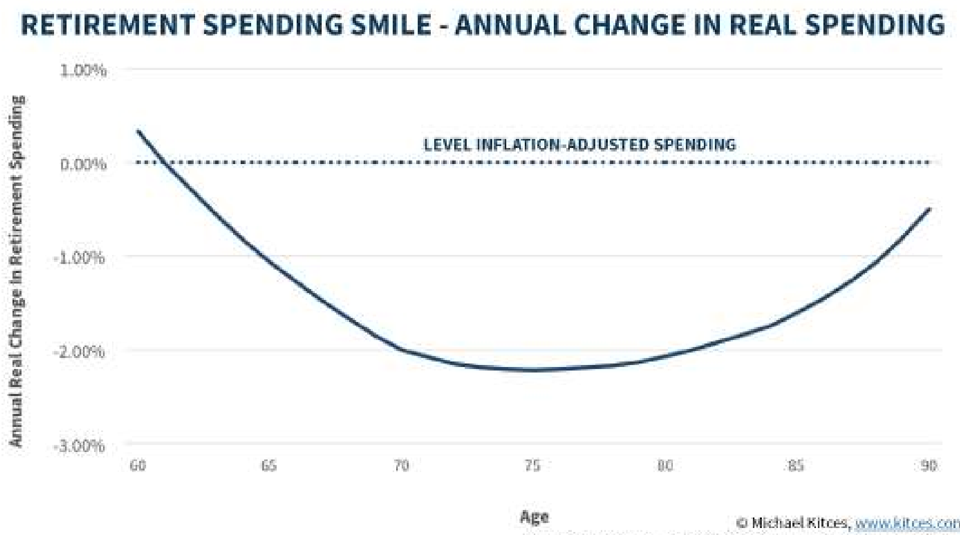
Cope with liquidity needs	Secure essential consumption needs until dealth	Transfer capital to bequest
▪ Exceptional, unforseen expenses	▪ U-shape: high in early and late retirement	▪ Residual wealth



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Source: Figure 5. Annual real change in consumption for Retirees.
Adapted from "Estimating the true cost of retirement," by D. Blanchett, 2013, Morningstar.

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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 ealier 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

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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)

Deferred annuities

Fixed annuities	Inflation-indexed annuities	Variable annuities
▪ Pays a fixed nominal rate	▪ Payments indexed on an inflation index	▪ Payments indexed on the value of a chosen invesment portfolio

BUT

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

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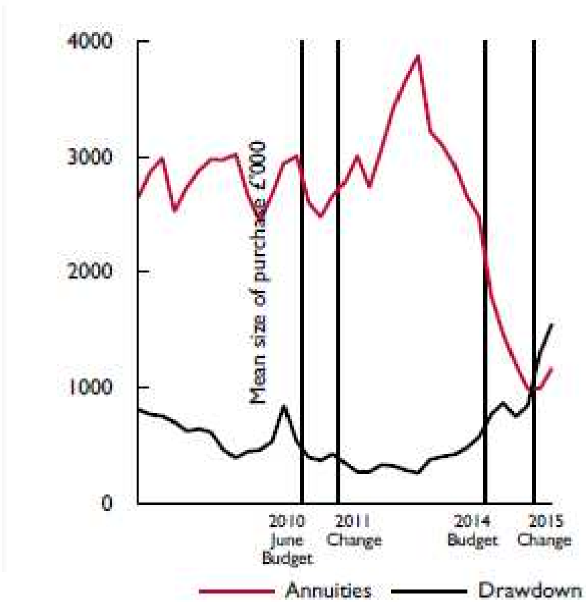
Two Polar Solutions Offered for the Decumulation

- 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

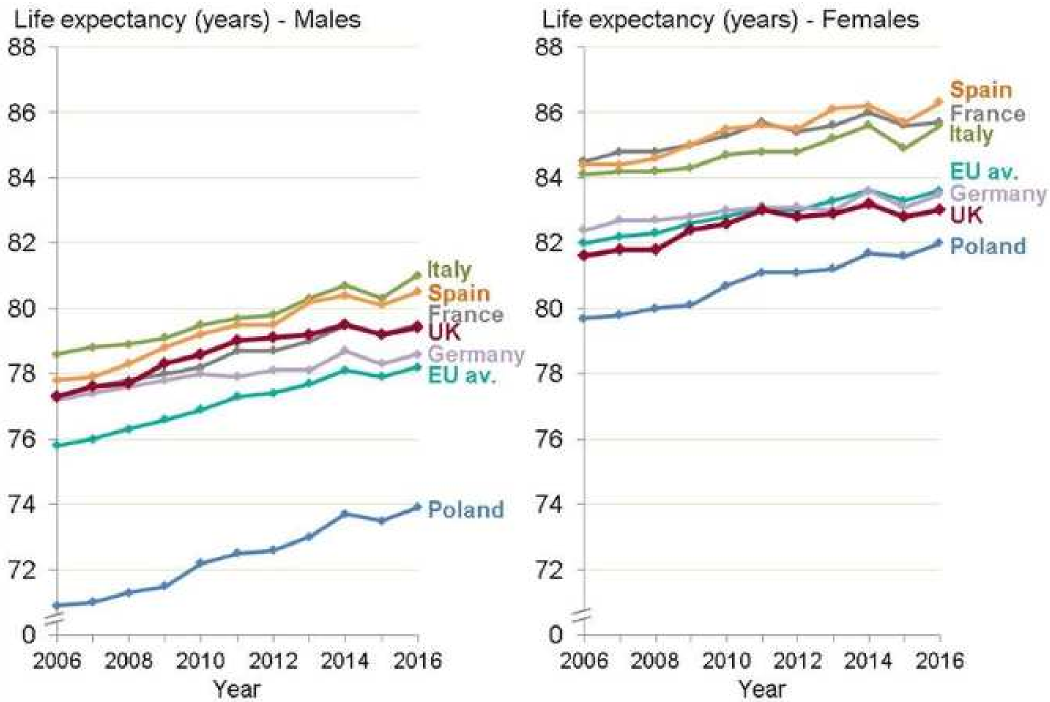
Drawdown Strategies

- 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?

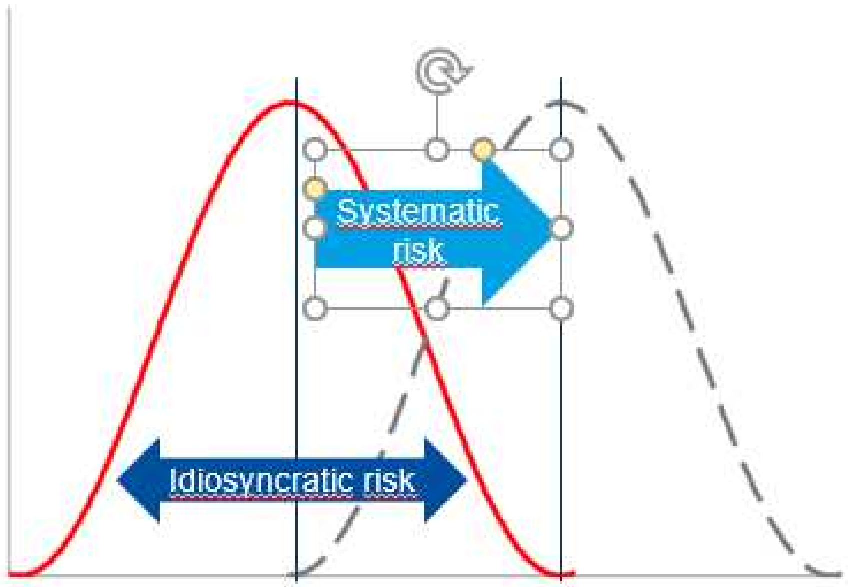
– Life expectancy at birth: evolution in Europe



 Source: Public Health England (2017)

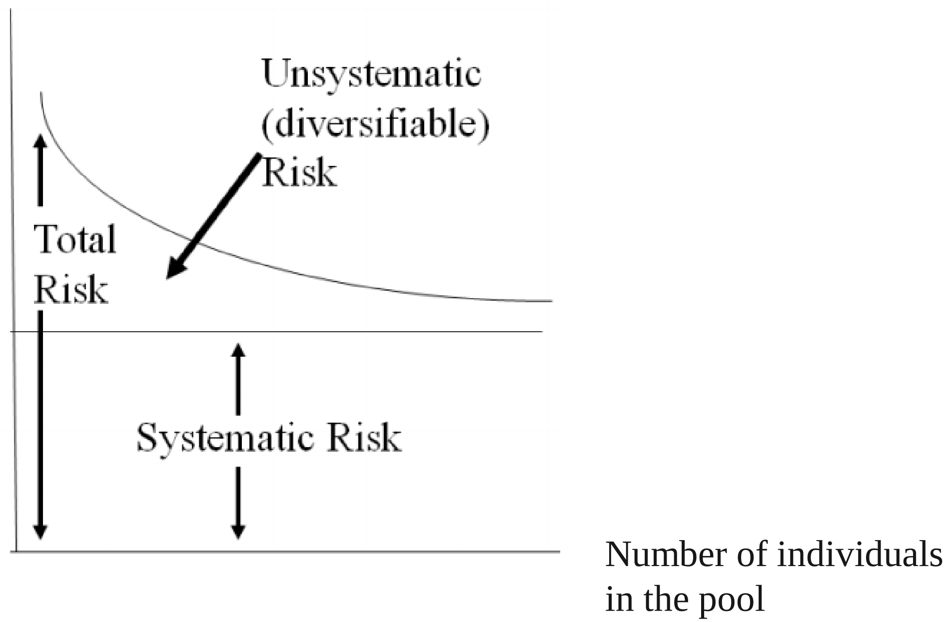
How to Manage Longevity Risk?

– 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



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)

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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

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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 (γ = 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

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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, Ξ_t, between ages 66 to 95, conditional on survival.
- Maximise expected CRRA Utility in retirement: $\int_{t_R}^{T} e^{-\beta t} \frac{\Xi_t^{1-\gamma}}{1-\gamma} \cdot {}_{t-t_0} p_{25} dt$

Simulations: Results based on 500 000 replications

t_0, t_R, T : years when the individual is aged 25, 66 and 95.. ${}_{t-t_0}p_{25}$ is the probability of someone aged 25 to be alive in $t - t_0$ years.

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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

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Financial Contracts for Retirement: GSA

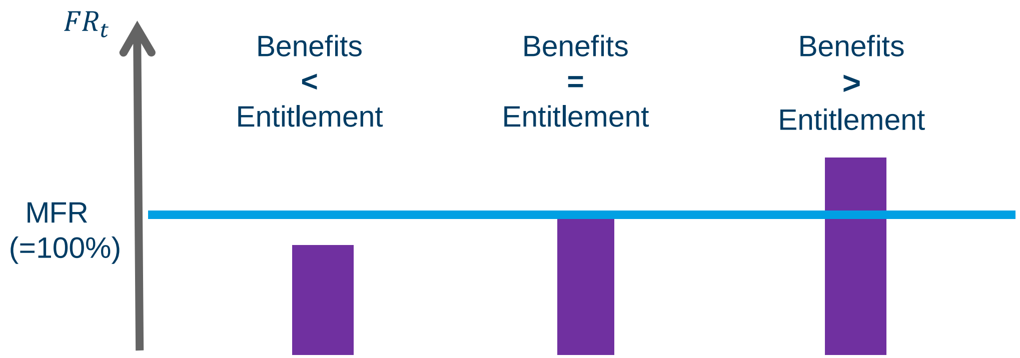
The DVA and the GSA treat **financial market risk identically** (fully borne by individuals), but **differ** in the **longevity risk distribution.**

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.

$$\frac{Funding\ Ratio\ in\ year\ t\ (FR_t)}{Minimum\ Funding\ Requirement\ (MFR)}$$



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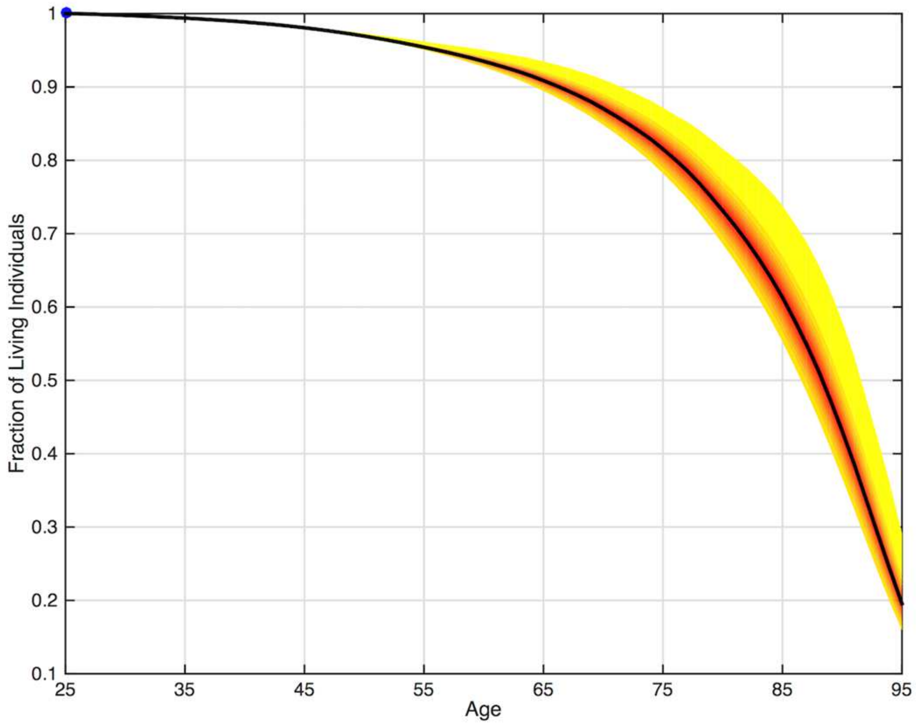
Longevity Risk

Fan plot of the fraction of living individuals by age

– Lee and Carter (1992) model calibrated on U.S. female mortality data from 1980 to 2013 (Human Mortality Database)
– Wide range of variation between min and max realizations (> 20% at age 88)



Model calibrated on U.S. female mortality data from 1980 to 2013, from the Human Mortality Database. Fan plot based on 10,000 replications.

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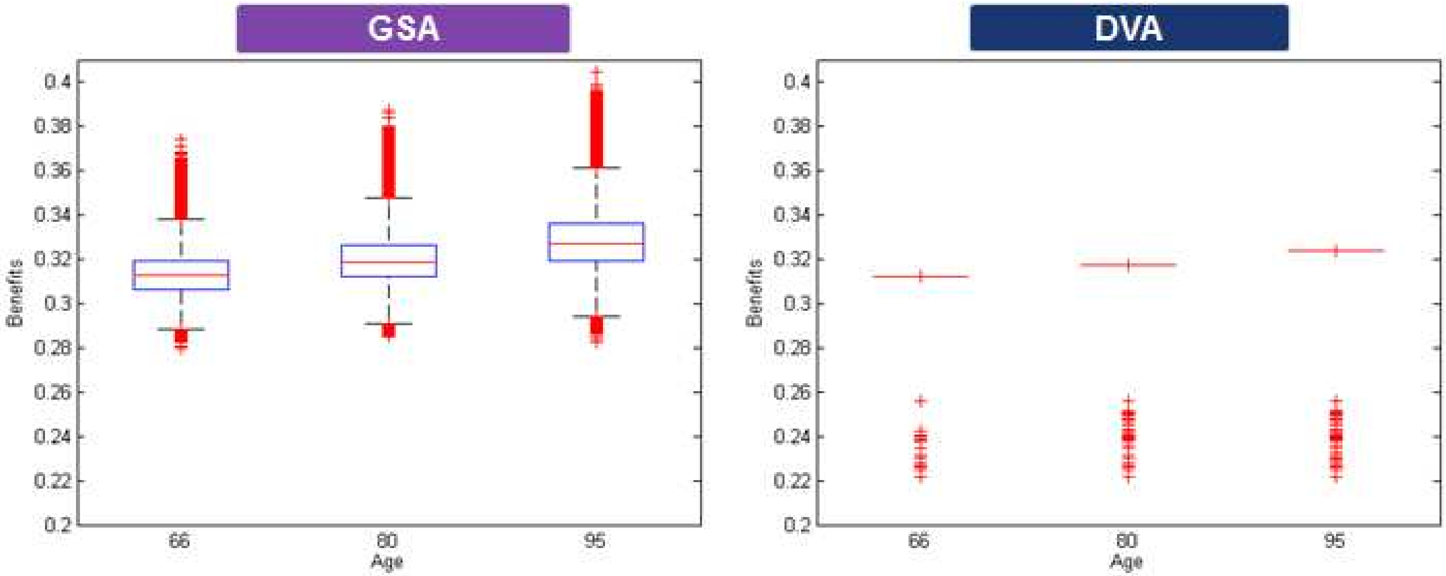
Boxplot of Benefits

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%)

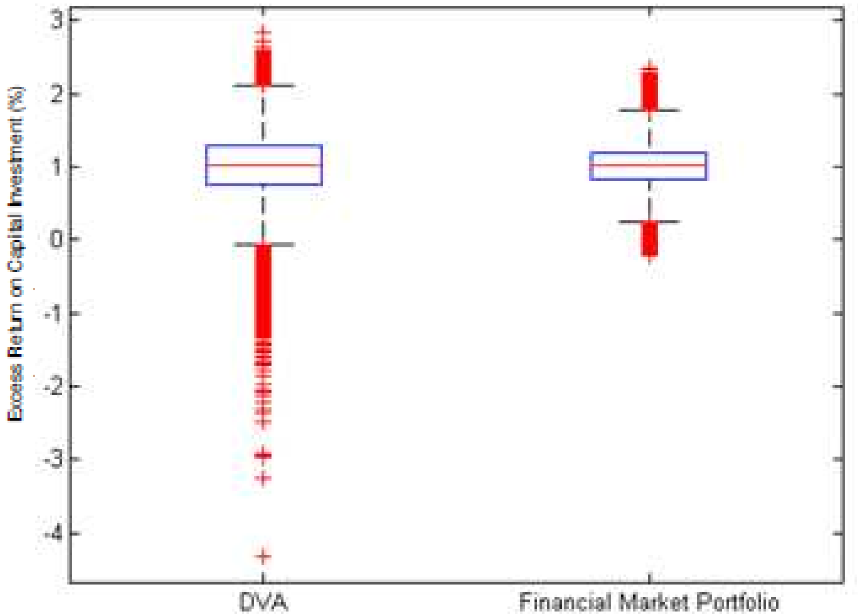
GSA upwards adjustments are more frequent than downwards (non linearity in Lee-Carter model: positive surprise in log central death rate leads to higher entitlement adjustments than negative surprise)

Individuals with $\gamma = 5$, portfolio 100% invested in the money market (constant return 3.62%). Annuitization capital at age 25 is normalized to 1. Line in the middle of the box is the median, edges of the box are 25% and 75% percentiles, + are data 1.5 larger than interquartile range.

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% iin 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

θ (%)	γ		
	2	**5**	**8**
0	3.31	3.50	3.54
20	4.00	4.48	4.48

Cumulative Default Rates

Zero-loading DVA with 40-year deferral

Equity capital= 10% of the liabilities in the year the contract is sold

θ (%)	γ		
	2	**5**	**8**
0	0.0102	0.0084	0.0082
20	0.0070	0.0038	0.0038

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

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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.

θ (%)	γ		
	2	**5**	**8**
0	-0.350 [-0.362, -0.339]	-0.200 [-0.211, -0.188]	-0.055 [-0.067, -0.044]
20	-0.349 [-0.361, -0.338]	-0.200 [-0.216, -0.184]	-0.052 [-0.088, -0.016]

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**.

Statistic	γ		
	2	**5**	**8**
$\mathbb{E}\left[R^{(A_{exs})}\right]$ (%)	1.44 [1.44, 1.44]	1.44 [1.44, 1.45]	1.44 [1.44, 1.45]
$\sigma^{(A_{exs})}$ (%)	5.04 [5.03, 5.06]	4.95 [4.94, 4.96]	4.95 [4.94, 4.96]
SR	0.29 [0.29, 0.29]	0.29 [0.29, 0.29]	0.29 [0.29, 0.29]

Reference portfolio: 20% in the stock index.

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

$SR = \mathbf{0.45}$

No loading charged

The values in parentheses are the 99% confidence intervals.

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Sensitivity Analysis: General

– **Baseline case**
  - γ = 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**, γ = 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 ($\frac{\lambda_S}{\gamma\sigma_S}$), and a glide path (90% at age 25, diminishing to 30% by age 66).

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Sensitivity Analysis: Longevity Model (1/3)

Doubled Time Trend Errors' Variance

- Time trend process: $k_t = c + k_{t-1} + \delta_t$
- $\delta \sim N(0, \mathbf{2}\widehat{\sigma_\delta^2})$

Drift Parameter Uncertainty

- $k_t = \boldsymbol{c} + k_{t-1} + \delta_t$
- $\hat{c}$ is estimated by maximum likelihood, and is distributed as $\hat{c} \sim N(c, \sigma_c^2)$
- For the l^{th} replication, draw a $\boldsymbol{c_l}$ from the distribution $\boldsymbol{N}\left(\hat{\boldsymbol{c}}, \widehat{\boldsymbol{\sigma}_{\boldsymbol{c}}^2}\right)$

Alternate Longevity Model

- **Cairns, Blake and Dowd (2006)**
- $logit(q_{t,x}) = \kappa_t^{(1)} + \kappa_t^{(2)}(x - \bar{x})$

Sensitivity Analysis: Longevity Model (2/3)

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.

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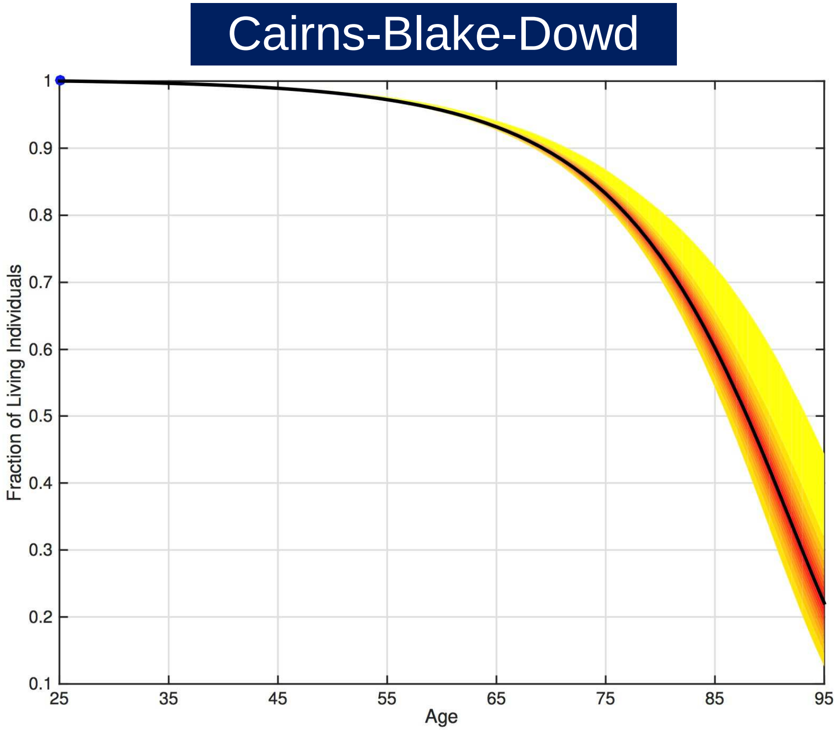
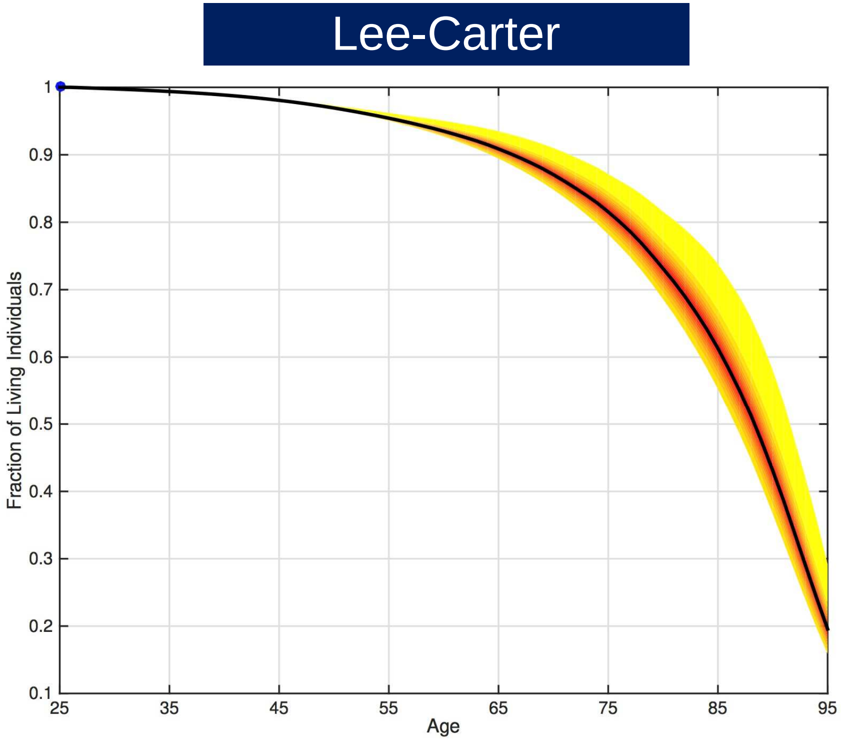
Sensitivity Analysis: Longevity Model (3/3)

Alternate Longevity Model





- **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

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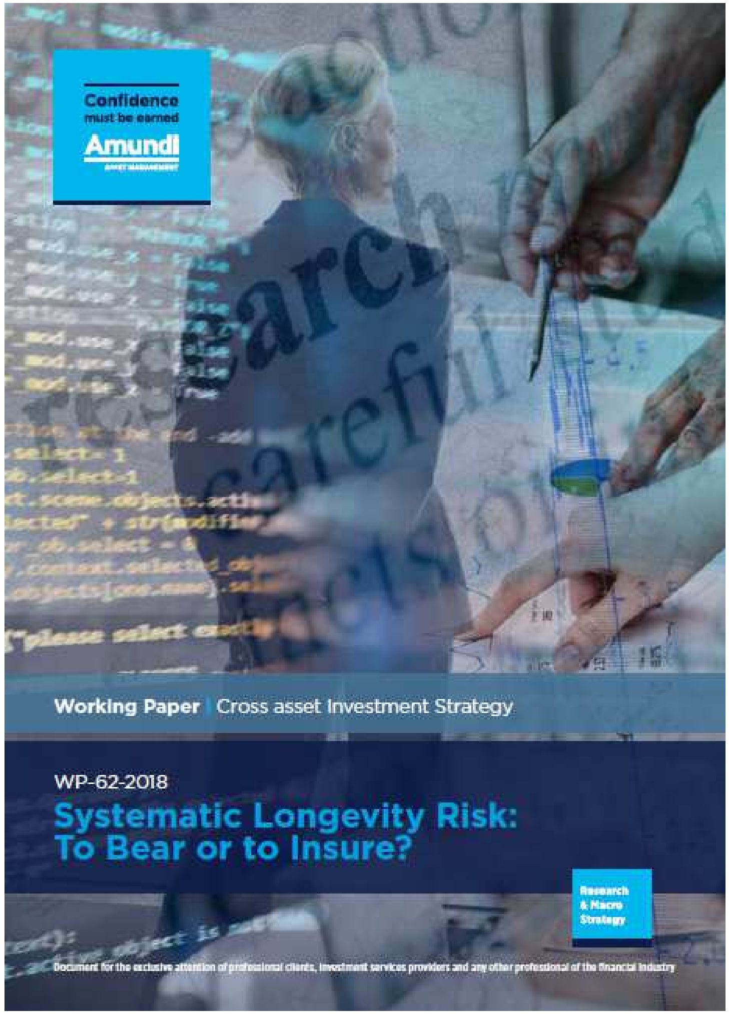
Further Readings

Boon L.N., Brière M. and Werker B.,
« Systematic Longevity Risk: To Bear or to Insure? », Amundi Working Paper, 2017.

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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