

LONGEVITY RISK IN A PENSION FUND ALM CONTEXT

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ADVISORY

ABOUT LONGITUDE SOLUTIONS

CORPORATE PROFILE

Longitude Solutions is a transaction-oriented advisor with deep expertise in longevity risk

- 3 Senior Partners in USA, Netherlands and UK, with access to a team of quantitative resources
- Exclusive advisor on €3.5bn Dutch longevity transaction, 2017 (*nominee, Life Transaction of the Year, Trading Risk Awards*)
- Executed assignments for S&P 500, FTSE 100 and Stoxx 50 (re)insurance and asset management companies

Specialist consulting firm helping life insurers, reinsurers and pension funds navigate longevity risk markets

- Longevity risk analysis, transaction structuring and optimization
- Support risk placement, documentation and execution
- Up-to-date knowledge of global regulatory landscape with respect to longevity risk

Longitude assists in longevity risk analysis to understand benefits of risk-transfer

- Develop stochastic and deterministic profiles for liabilities to examine downside potential and peak funding strains
- Demonstrate the effectiveness of potential hedges in an ALM context using relevant client metrics
- Develop Longevity Risk Management governance

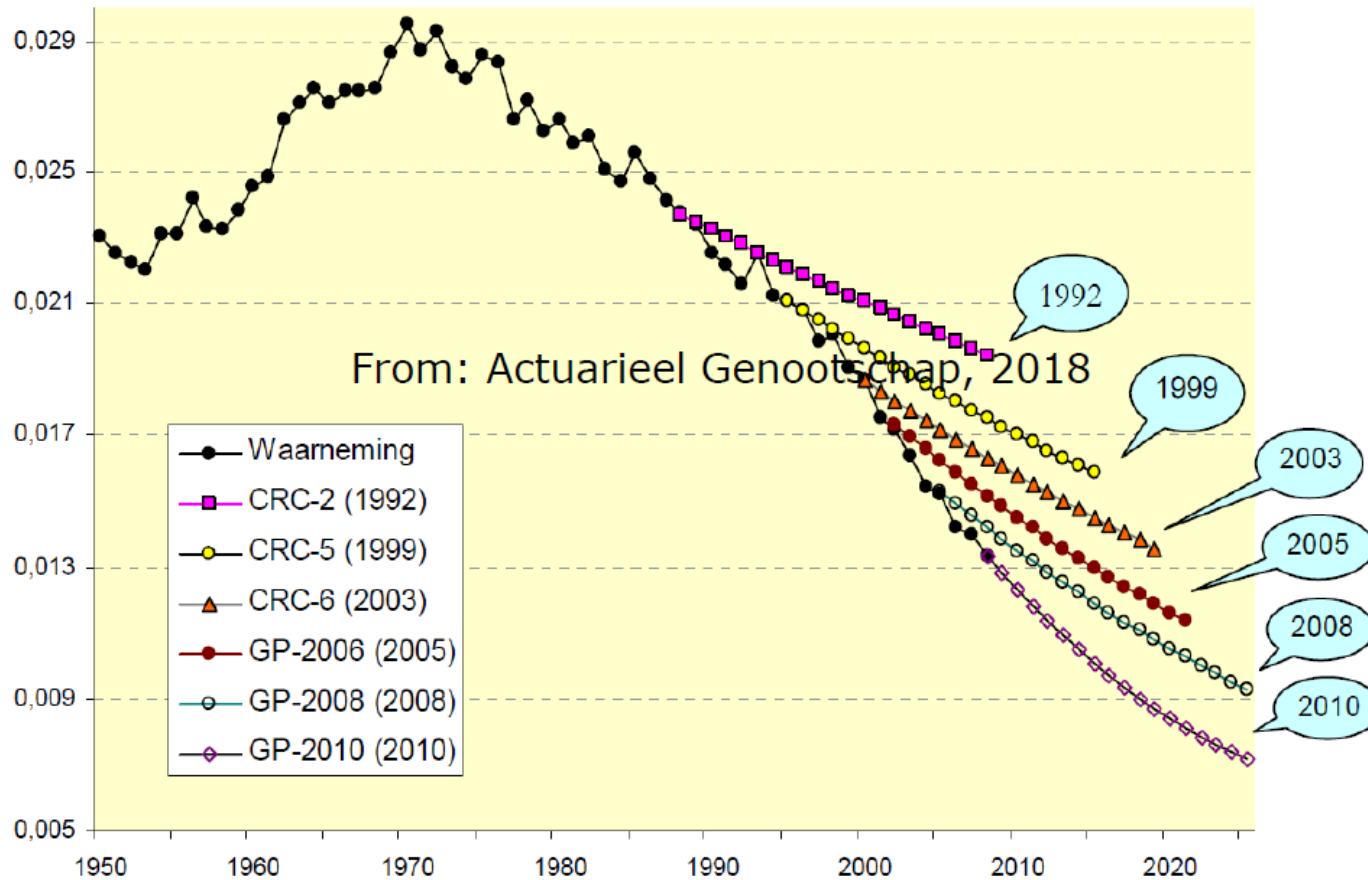
DISCUSSION OF LONGEVITY RISK

LONGEVITY RISK DEFINED

- Longevity Risk is defined as the risk that people live longer **than expected**
 - Be careful: it is not the risk that people live longer than previous generations because this is included in the expectation
 - How to measure longevity risk in practice?
- The change in life expectancy as published by the Dutch CBS understates longevity risk
 - The mortality probabilities *at any given time* for a given age or gender are input to the calculation of “life expectancy”
 - This is *not* actual expectation of remaining time period to time of death since it ignores that mortality probabilities *evolve over time* (and are therefore at risk of further improvement)
- Actuarial reserves are based on *generation tables* considering the *expected* evolution of mortality probabilities over time. Furthermore reserves are measured in money terms which helps translate into a good risk measure
 - The AG2018 table of the Dutch Actuarieel Genootschap is such a generation table
 - We can measure longevity risk using the change in reserves for pension benefits
- Ex-post vs. ex-ante measurement of the risk: Realized vs. Expected or Simulated vs. Expected

HOW GOOD ARE WE AT PREDICTION?

(Predicted) Mortality Rate of a Dutch 65-year old male



From: Actuarieel Genootschap, 2018

From: Generatietafels Pensioen 2010 – Verbond van Verzekeraars

Source: Leendert van Gastel, Longevity risk mitigation from a supervisory perspective, Presented at Longevity 14

THE NATURE OF LONGEVITY RISK IS CHANGING

- Biotechnological advances will impact life expectancy in a way that is [unimaginable](#)
 - We are at the 20-year mark of stem cell manufacturing. 20 year is the usual discovery-to-product time-span
 - Medical research has the power to understand how to turn on cell regeneration capabilities that are turned off at the infant stage of human body development
 - Although a single [cure for cancer](#) is not likely, many life insurers consider this scenario as part of their longevity risk decision making and it is included in the RMS standard set of longevity scenarios
- While health advances beyond decreasing smoking rates are also taking place
 - Researchers are only starting to understand the impact of food and sleep on longevity
 - The cost on society of unhealthy aging will trigger changes in social organization and create monetary incentives to live a healthier life
- Anti-aging interventions or treatments are currently a business model and attracting major investments
 - Calico by Google is reported to [invest](#) 1.5\$Bln into anti-aging
 - AgeX, Juvenescence, Rejuvenate Bio, RestorBio and Human Longevity Inc. are all companies set-up to make money by offering anti-aging products & services
- Life expectancy of 2019 newborns is predicted by some researchers to be as high as 150 years

LONGEVITY RISK MEASURED

- Longevity Risk shown as potential increase in life expectancy over time, and in extreme scenarios

Life Expectancy 65 Year Unisex	Current		2027		2037
CBS 2017	19.88	+5.2%	20.92	+5.6%	22.09
CBS 2017 90% quantile	-		22.18		23.87

- Every additional year of life expectancy at age 65 adds ~5% to pension liabilities
- An actuarial reserving model calibrated to these figures shows that Longevity Risk adds significant volatility to the Funding Ratio, roughly ~4% (depending on age profile) relative to a Funding Ratio volatility of 10-12% for a typical diversified asset allocation

QUANTIFYING RISK & CAPITAL MEASURES

- The table shows different measures of longevity risk taken from regulatory capital frameworks (Solvency II, US Reg Cap, BMA SCR, Dutch FTK) and an Affine Stochastic Mortality model.

Longevity Risk Measure \ Benefit Type	50-year old male	70-year old male
Solvency II Standard Formula	7.2%	9.8%
U.S. Regulatory Capital	0%	0%
BMA SCR	2%	4%
Dutch FTK S6 (TSO only)	5%	2%
Affine Makeham 90% scenario	8.8%	4.1%
Affine Makeham 90% scenario + 60% experience ratio	7.5%	4.2%
Affine Makeham 90% scenario + 2% interest rate shock	7.4%	3.0%

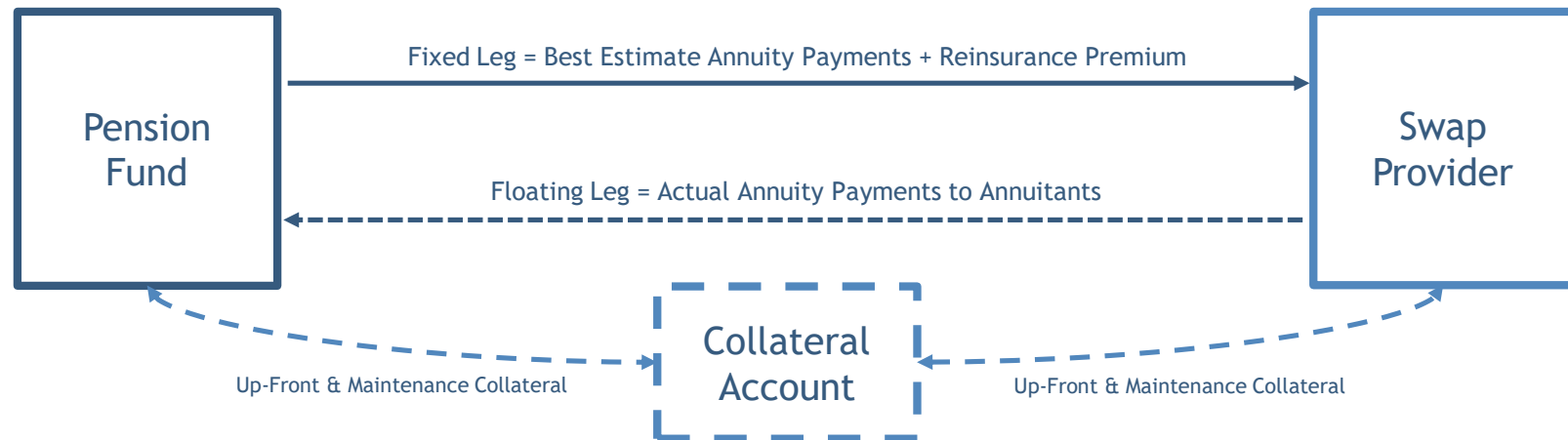
LONGEVITY RISK HEDGING IN A PENSION FUND CONTEXT

LONGEVITY RISK HEDGING FOR PENSION FUNDS

- Pension funds have made significant advancements in their ALM process
 - Stochastic Modelling
 - Optimization of the Strategic Asset Allocation
 - Duration Management & Derivative Overlays
- However, persistently-low interest rates and ever-increasing life expectancies continue to put funding ratios under pressure and require further attention from managers
- To deal with this, UK Pension funds have started using longevity swaps and other de-risking tools
 - Longevity swaps exchange actual pension payments for expected payments, plus a fee
 - Pensions can access reinsurers directly via a captive insurer they can set up or “rent”
 - Index-based longevity hedges bring capital markets investors in competition with reinsurers
- ALM benefits of considering Longevity reinsurance as part of ALM decision framework
 1. Removes a significant downside risk to funding ratio
 2. Creates more certainty around funding ratio level
 3. Frees risk budget for investments with higher expected return

HOW A TRADITIONAL LONGEVITY SWAP WORKS

- A Longevity Swap is a Regular Fixed Premium Quota Share reinsurance contract
- Hedger “swaps” expected annuity payments for actual annuity payments (based on the realized longevity of the annuitants) and pays a fixed premium (a fixed % of the expected payments)
 1. The assets and asset risk remain with the pension fund (reducing credit risk)
 2. Net cash flows are exchanged on an annual basis depending on realized mortality
 3. Collateral can be exchanged to reduce exposures as forward expectations change

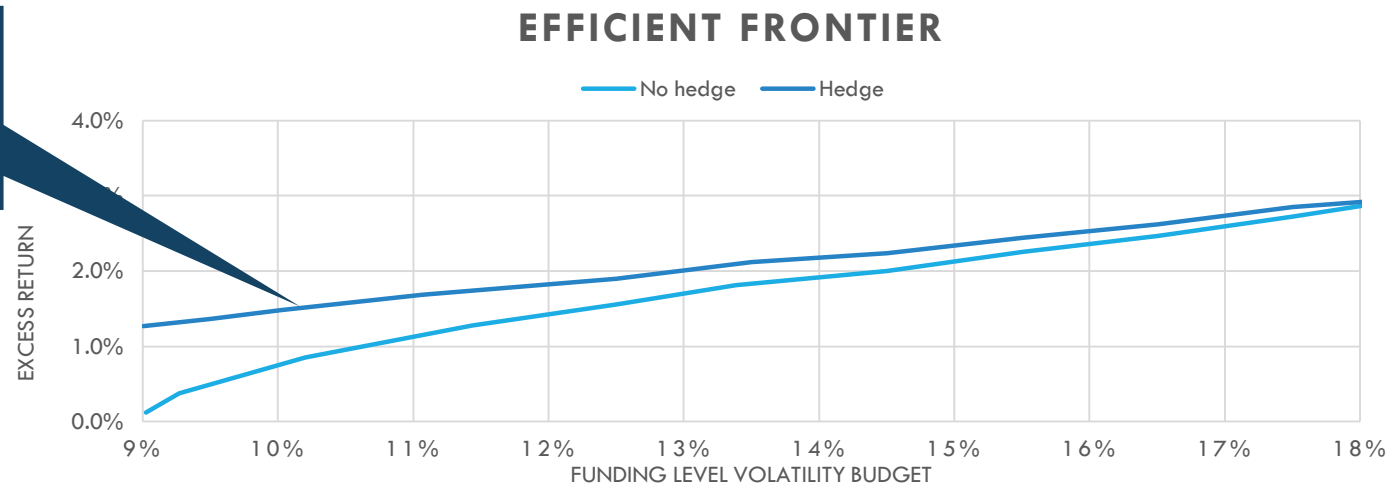


$$\text{Net Monthly Payment} = (\text{Expected Payment} - \text{Actual Payments}) + \text{Reinsurance Premium}$$

HEDGING LONGEVITY RISK HAS ALM BENEFITS

- Hedging of Longevity Risk creates risk budget for a more optimal asset allocation ([Schrager](#))
 - Paper available from the Longitude Solutions website

Significantly higher return under optimal asset allocation after hedging longevity risk



- This figure is based on hedging 100% of the risk with Longevity Swap
 - A change in reinsurance premium causes a parallel shift in the Efficient Frontier
- Further optimization is possible using structures that optimize reinsurance premium vs. risk cover

STRATEGIC FIT FOR DUTCH PENSION FUNDS

Avoid pension benefit cuts

- A Longevity hedging program could be structured with the intention of minimizing the probability of needing to cut pension benefits due to increases in life expectancy
 - Calibrate the hedge “Attachment Point” (i.e., point at which hedge starts to pay off) to the critical funding level where benefit cuts may become a necessity (given other fixed projections)
 - Hedging at this part of the risk spectrum is cost-efficient given the cover is “out-of-the-money”, and structuring flexibility enables optimization of premium paid versus risk reduction achieved.

Positive impact on society

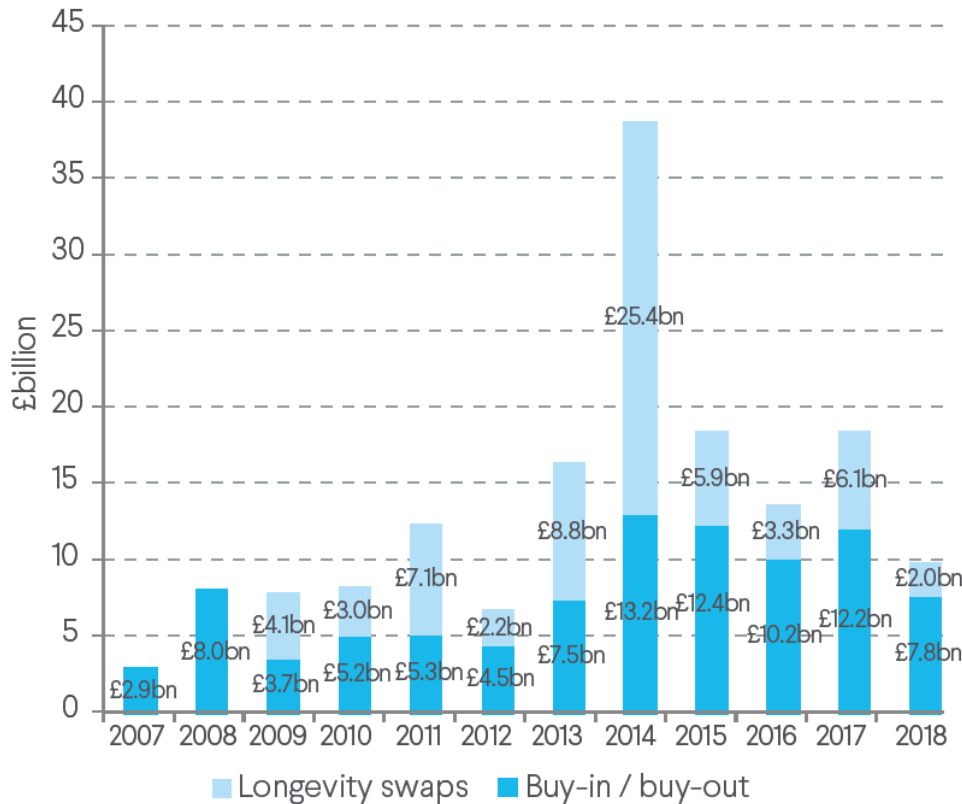
- The risk budget created by hedging Longevity risk can be deployed in higher-yielding asset strategies like infrastructure and private equity (i.e., participation in start-ups and scale-ups)
 - Assist in the transformation of Dutch economy and labor market
 - Marginal impact of increased investment will be large

Little to no cost to pension plan members

- The hedge premium paid is offset by higher asset returns which makes the strategy self-funding
 - Our research shows that longevity risk-transfer at reasonable pricing levels improves risk-return

GROWING DEMAND FOR LONGEVITY RISK TRANSFER

UK market growth — DB pension scheme risk transfer



2007 – mid 2018

£93 bn Buy-in / buy-out

£67 bn Indemnity longevity Swaps

£0.1 bn Index longevity Swaps

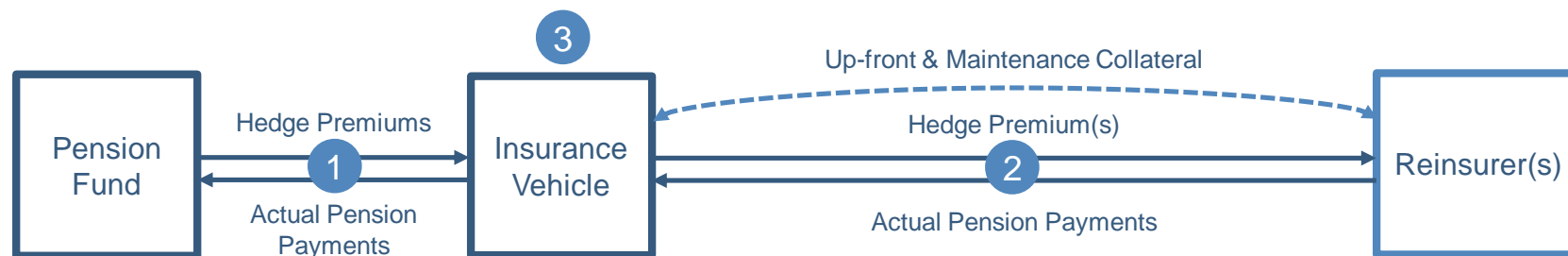
Source: Buy-outs, buy-ins and longevity hedging – H1 2018, Hymans Robertson LLP, Presented at Longevity 14

RELEVANT DE-RISKING TRANSACTIONS

- Pension schemes have accessed reinsurers for longevity swaps by first transacting with insurers
 - Zurich provided a in £2bn longevity swap to [National Grid](#), which it reinsured with Canada Life
 - [Bell Canada](#) did a \$5B longevity swap with Sun Life, reinsured by SCOR and RGA
- Large UK pensions have gained cost-efficiency by accessing reinsurers more “directly” via captives
 - [British Airways](#) pension did a £1.6bn longevity swap using a captive insurance cell in Guernsey
 - [British Telecom \(BT\)](#) pension did £1.6bn longevity swap transaction by establishing its own insurer
- Index-based longevity hedges have been used in The Netherlands to achieve optimized results
 - [NN Life](#) placed an ATM index-based longevity hedge with Hannover Re (Longitude advised)
 - [Delta Lloyd](#) placed two €1.2bn OTM index-based longevity swap deals with RGA
- Capital Market players recently showed appetite for a ~€20bn Dutch pension portfolio in the acquisition of VIVAT

DIRECT ACCESS TO REINSURANCE MARKET

- Pension funds can gain structuring flexibility and better pricing by accessing the reinsurance market directly, without involving a life insurance company
- There are two alternative routes for achieving this:
 1. The pension fund can set up a special purpose insurance company (a captive) which provides it an insurance policy, the captive then faces a reinsurer on a back-to-back transaction
 2. Some reinsurers have insurance vehicles in Solvency II jurisdictions which could face a pension fund



1. A traditional longevity swap is used to move risk from the Pension Fund to the Insurance Vehicle
2. Vehicle will face reinsurer(s) directly for longevity swap transactions, using on-going collateralization
3. [Optional] A credit guarantee on the Insurance Vehicle could be obtained from the parent

INDEX HEDGING CAN BRING ADDITIONAL BENEFITS

- Contrary to Longevity Swaps which hedge (close to) 100% of portfolio risk, hedge structures based on mortality indices can be used in case of large portfolios to create a hedge instrument which is more liquid and accessible to a broad range of risk takers including capital markets
- Index-based hedges reference general-population mortality data; sub-population datasets are available from CBS
- Hedges account for pensions' portfolio composition and expected longevity to minimize basis risk
 - Replace portfolio death rates with experience ratio adjusted population death rates in cash flow calculations
- Most longevity hedge transactions in the Netherlands have been index-based
- Challenges for quants:
 - Structure indices / instruments to minimize basis risk
 - Measure basis risk
 - Optimize hedge effectiveness / risk reduction given a budget

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