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Market Products for Longevity Risk Hedging

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PACIFIC GLOBAL ADVISORS

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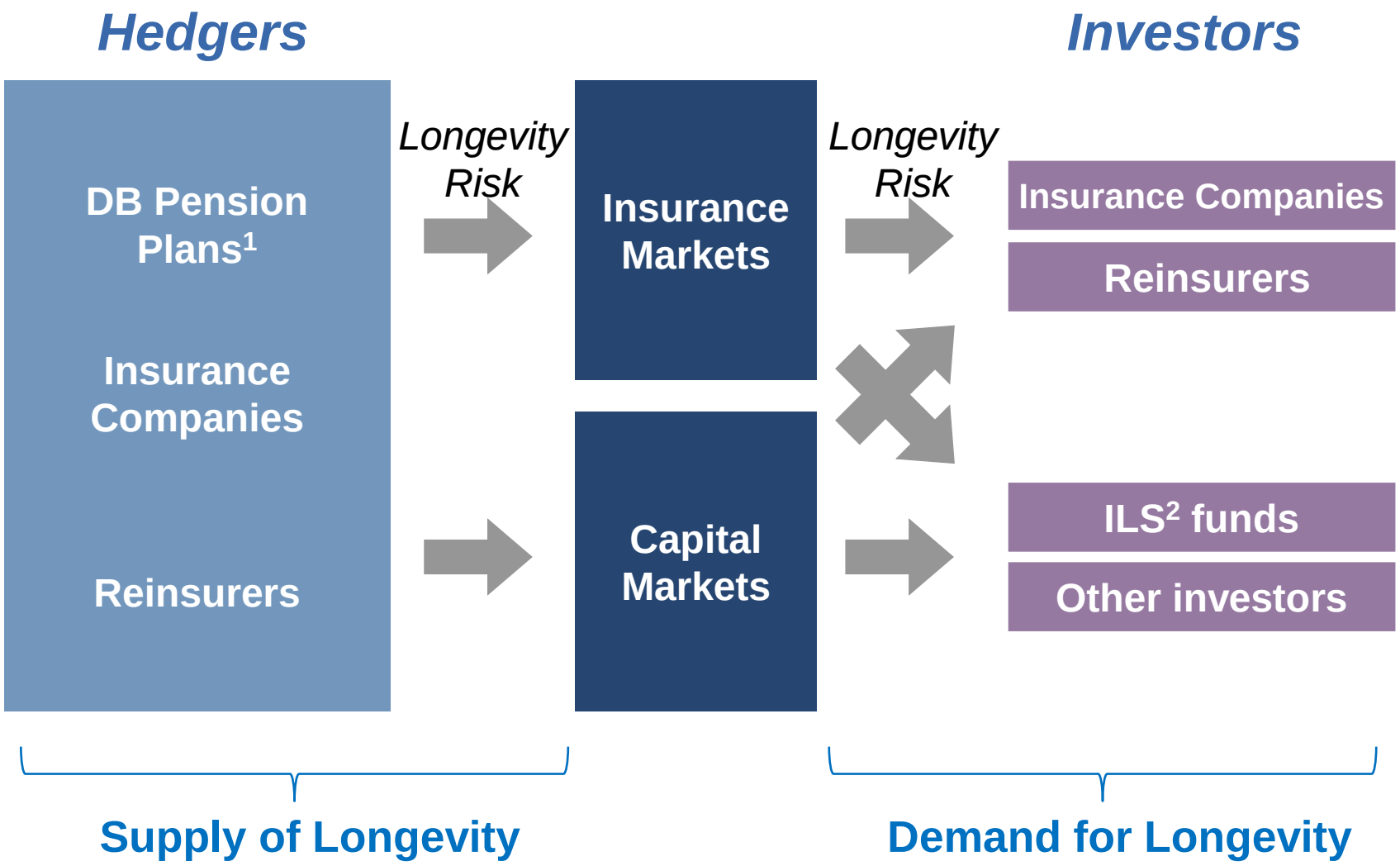
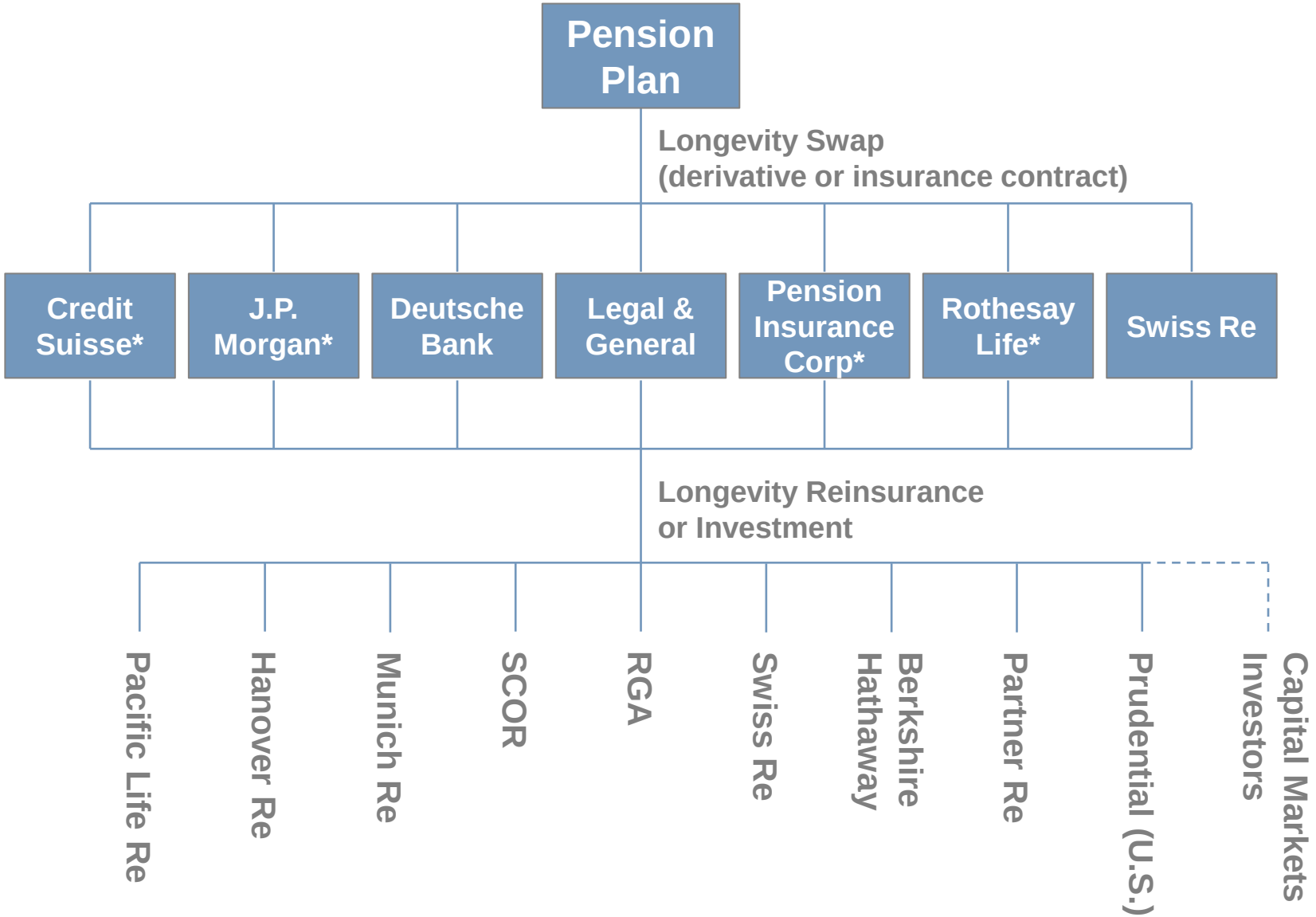
Agenda

The longevity market involves two distinct channels and multiple participants



[1] DB = Defined Benefit
[2] ILS = Insurance-Linked Securities

UK longevity market participants:
DB pension plan segment



* No longer active in the longevity swap segment of the UK market

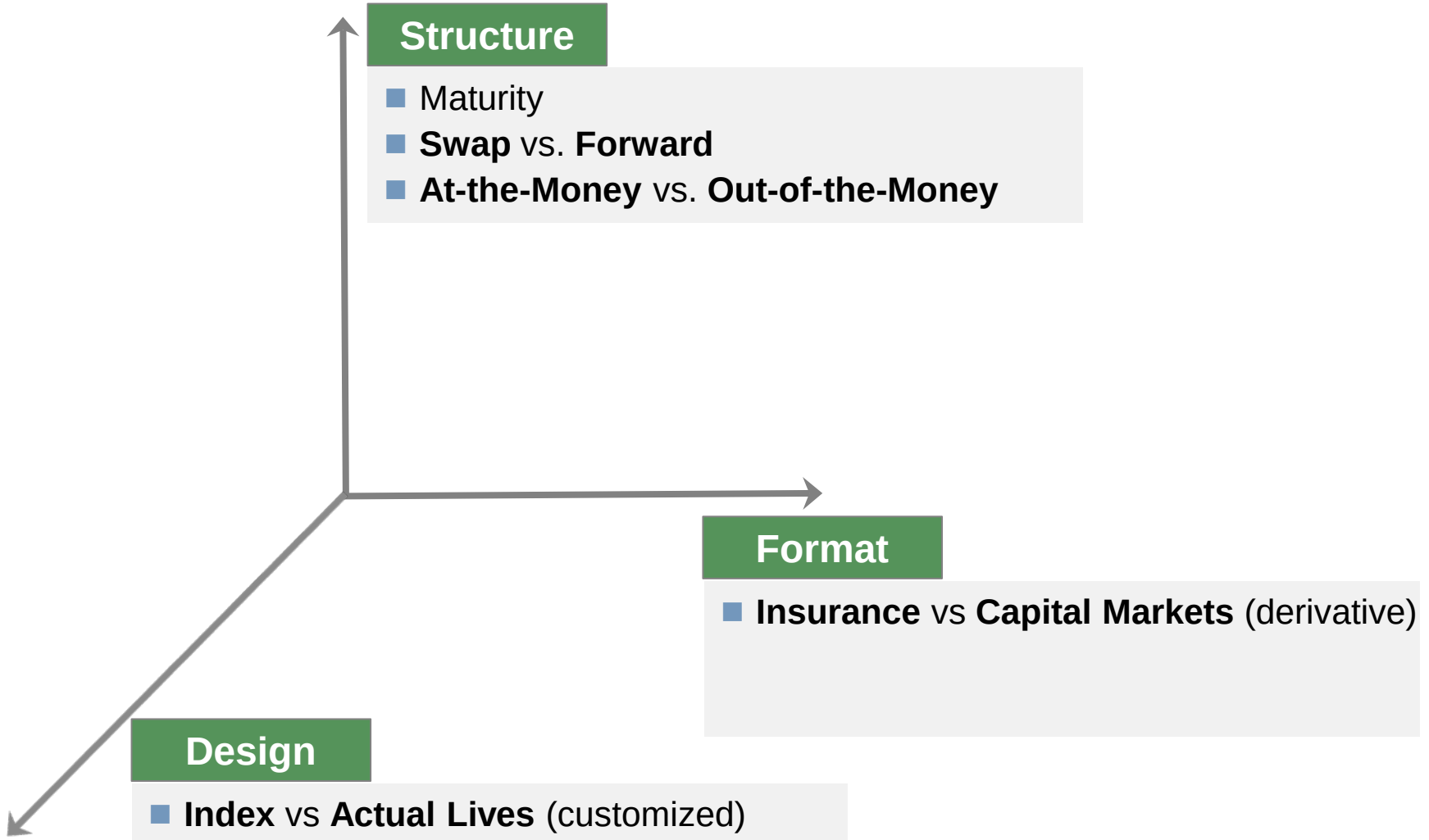
Traditional instruments for managing longevity risk in DB pension plans

Traditional instrument	Type of contract	Risks transferred/ hedged	Comments
Buyout or termination (annuitization)	Insurance	Longevity risk + all other financial and demographic risks	Removes pension obligation from sponsor's balance sheet
Buy-in (annuitization)	Insurance	Longevity risk + all other financial and demographic risks	Annuities become assets of the pension plan and the plan remains on the sponsor's balance sheet
Lump sum offer	Agreement between sponsor and beneficiaries	Longevity risk + all other financial and demographic risks	Removes pension obligation from sponsor's balance sheet

"New" instruments enable longevity risk to be transferred on its own

New instrument	Type of contract	Risks transferred/ hedged	Comments
Longevity swap	Capital markets or Insurance	Longevity risk only	Exchanges actual liability payments (based on realized *longevity*) for a fixed set of payments
Out-of-the-money longevity swap	Capital markets or Insurance	Only the longevity risk associated with large increases in life expectancy	An out-of-the-money option on a longevity swap, with attachment and detachment points.
q-Forward ("Mortality forward")	Capital markets	Longevity risk only	Exchanges a payment based on a realized *mortality* rate for fixed payment
S-Forward ("Survivor forward")	Capital markets	Longevity risk only	Exchanges a payment based on a realized *survival* rate for fixed payment
LEO ("Longevity Experience Option")	Capital markets	Longevity risk only	An out-of-the-money option on an S-Forward, with attachment and detachment points.

Longevity risk transfer instruments vary along three key dimensions: Format, structure and design



Insurance companies were the first hedgers in the longevity swap market

- The 1990s saw several non-public longevity swap reinsurance transactions
  - But had virtually no impact on market development
- The market really started in 2008-09
  - Investment banks were innovators and intermediaries
- Longevity reinsurance via swaps is now commonplace

Early longevity swap transactions

Date	Insurer	Counterparty	Format	Value (£mm)
Jan 2008	Lucida	J.P. Morgan	Capital markets*	100
Jul 2008	Canada Life	J.P. Morgan	Capital markets	500
Feb 2009	Abbey Life	Pacific Life Re	Insurance	1,500
Mar 2009	Aviva	Royal Bank of Scotland	Capital markets	475

* This was actually a "q-Forward" – see later.

Source: http://www.artemis.bm/library/longevity_swaps_risk_transfers.html; http://www.insurancedaily.co.uk/2009/02/10/pacific-life-re-announces-longevity-deal-with-abbey-life/; Norwich Union/Partner Re/RBS Press Release March 19, 2009; PGA

Longevity swaps executed by DB pension plans in the UK total $80 billion (or £47 bn)

Date	Pension Plan Sponsor	Counterparty	Format	Value (£mm)
Jul 2014	BT	Prudential (U.S.A.)*	Insurance	16,000
Mar 2014	Aviva	Swiss Re, Munich Re, SCOR*	Insurance	5,000
Dec 2013	BAE Systems (2 plans)	Legal & General	Insurance	1,800
Dec 2013	Carillion (5 plans)	Deutsche Bank	Capital markets	1,000
Dec 2013	AstraZeneca	Deutsche Bank	Capital markets	2,500
May 2013	Bentley	Abbey Life (Deutsche Bank)	Insurance	400
Feb 2013	BAE Systems	Legal & General	Insurance	3,200
Dec 2012	Liverpool Victoria Friendly Society	ReAssure (Swiss Re)	Insurance	800
May 2012	Akzo Noble	ReAssure (Swiss Re)	Insurance	1,400
Dec 2011	Pilkington	Legal & General	Insurance	1,000
Dec 2011	British Airways	Rothesay (Goldman Sachs)	Insurance	1,300
Nov 2011	Rolls-Royce	Deutsche Bank	Capital markets	3,000
Aug 2011	ITV	Credit Suisse	Capital markets	1,700
Jan 2011	Pall	J.P. Morgan	Capital markets	70
Jun 2010	British Airways	Rothesay (Goldman Sachs)	Insurance	1,300
Feb 2010	BMW	Abbey Life (Deutsche Bank)	Insurance	3,000
Dec 2009	Babcock International	Credit Suisse	Capital markets	300
Dec 2009	Royal County of Berkshire	ReAssure (Swiss Re)	Insurance	750
Sep 2009	Babcock International	Credit Suisse	Capital markets	350
Jul 2009	RSA Insurance Group (2 plans)	Rothesay (Goldman Sachs)	Insurance	1,900
Jun 2009	Babcock International	Credit Suisse	Capital markets	500
Total (27 longevity swaps)				£47,270mm

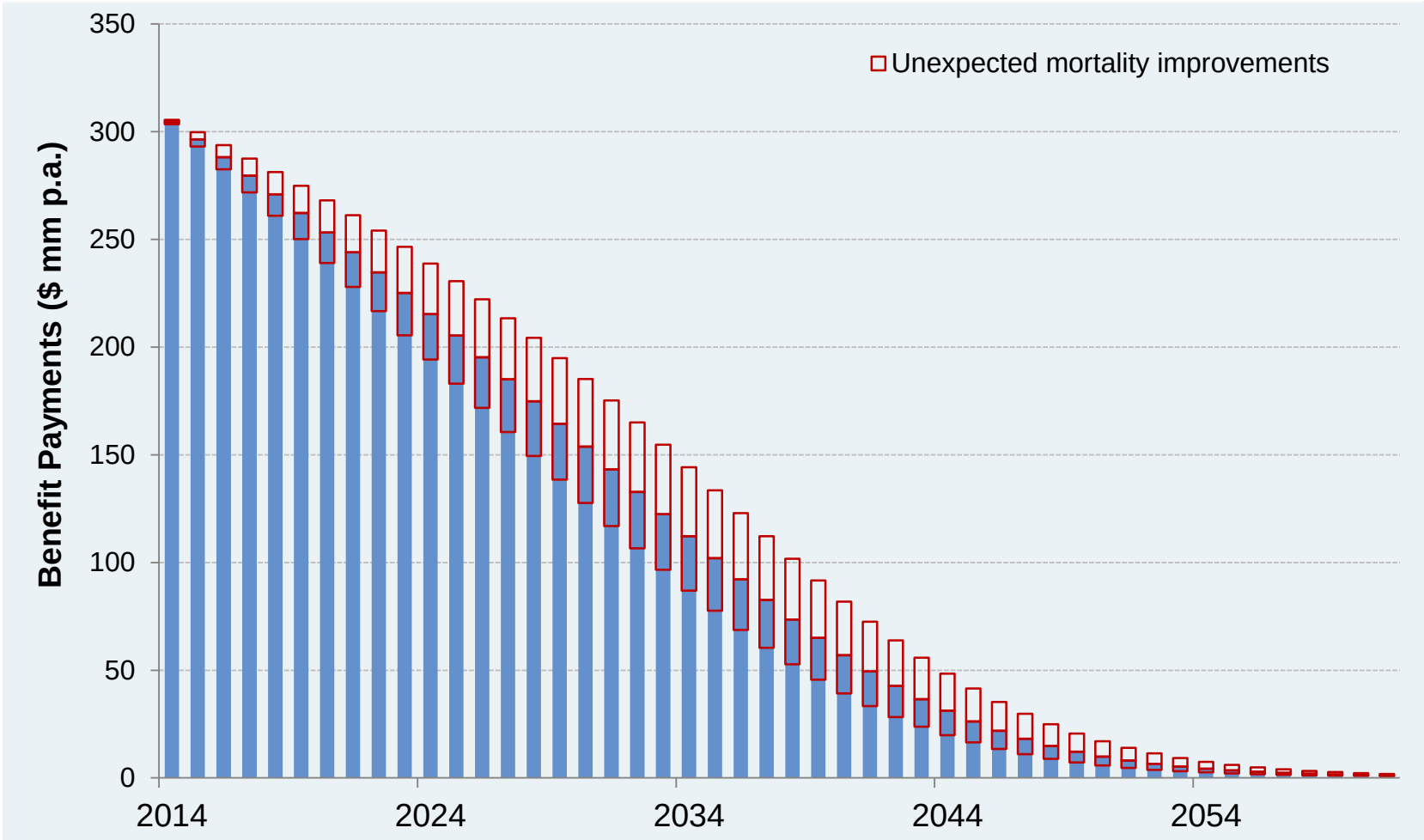
* These are reinsurers who transacted directly with a captive insurer.

Source: Lane Clark & Peacock LLP, Grant Thornton, Hymans Robertson, PGA

Agenda

Longevity risk introduces significant uncertainty into liability cash flows

Impact of longevity risk on retiree benefit payments (Age 65+)



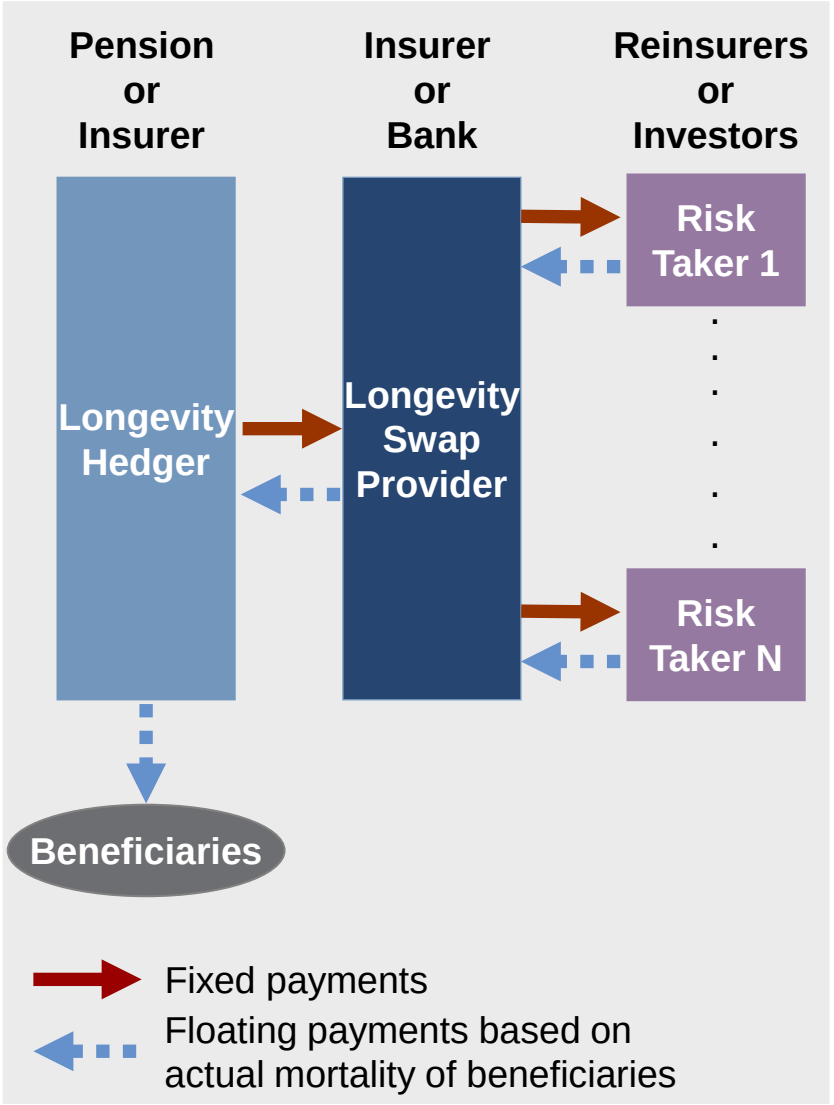
Source: PGA calculations
This slide contains hypothetical information which may have inherent limitations.

This leads to uncertainty in the value of the pension liability

Longevity swaps have become the market standard for pure longevity risk transfer

- **Cash flow hedge:** Removes longevity risk and fixes the liability cash flows
- **Like an interest-rate swap:** Exchanges fixed and floating payments
  - Floating payments are linked to the actual longevity of retirees in the pension plan
- **Long-dated hedge:** 50+ years tenor
- **Format:** Insurance contract or derivative
- **Considerations**
  - Reference actual beneficiary lives
  - Retirees (pensioners) only
  - Collateralized
  - Ongoing death reporting requirement
  - Valuation based on mark-to-model

Longevity swap structure



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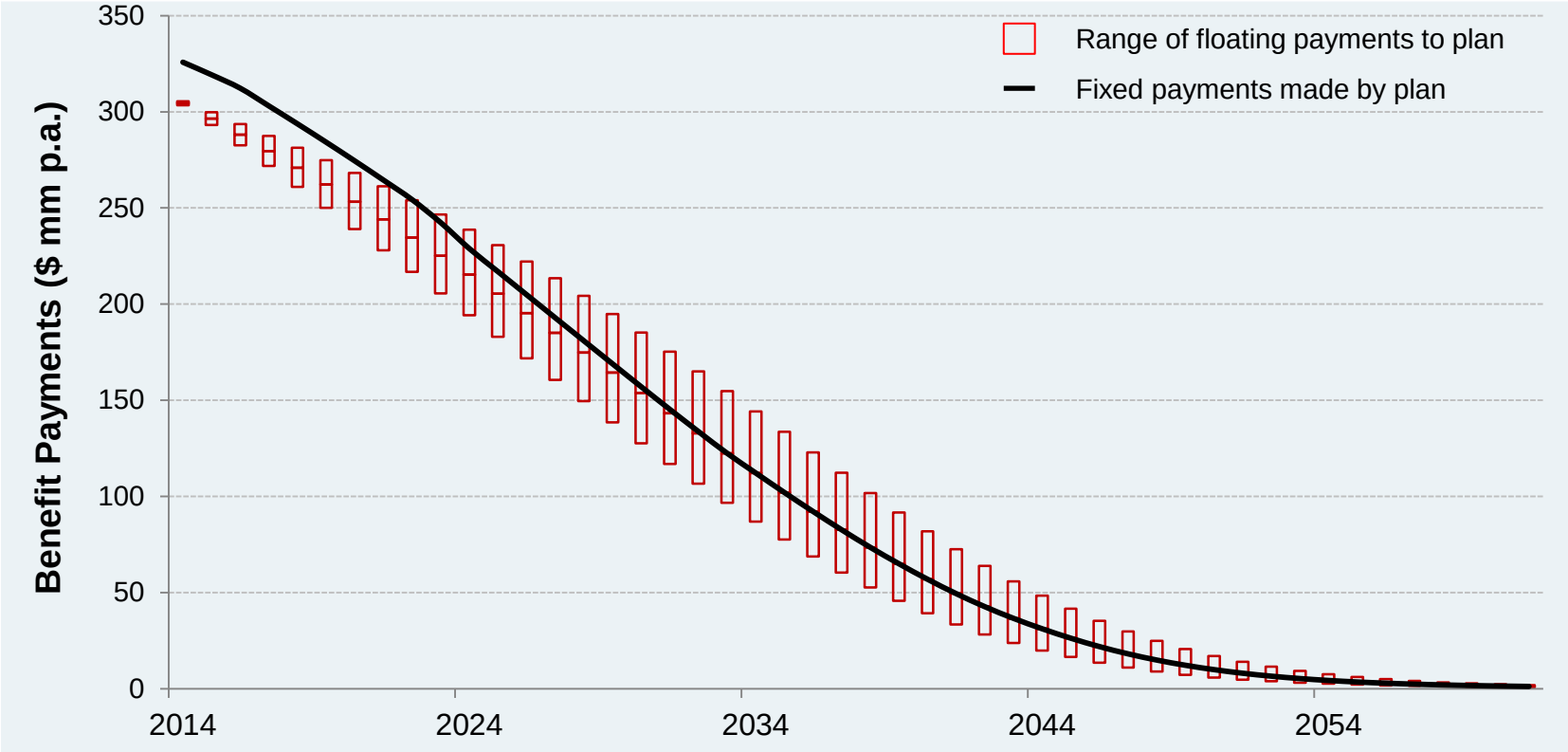
Longevity swaps are priced by setting the fixed payments equal to the expected floating payments plus a risk premium

Illustrative payments on a retiree longevity swap (Age 65+)



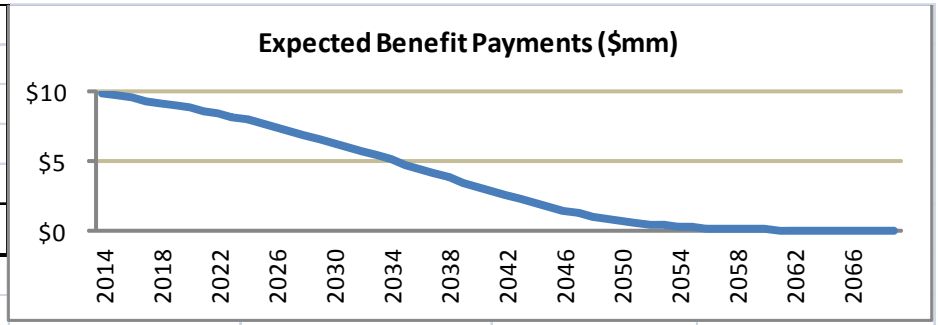
Source: PGA calculations for fixed (non-COLA) benefits
This slide contains hypothetical information which may have inherent limitations.

- **Floating payments** = actual benefit payments made to beneficiaries
- **Fixed payments** = "Best Estimate" expectation of floating payments + Risk Premium
- Valuation is based on discounting expected floating payments and fixed payments using:
  - Up-to-date mortality data (not standard tables) and current interest rates (swap curve)

Calculating the value of the floating leg of a longevity swap is straightforward in principle

Simplified example based on 65-year-old U.S. males

No. Beneficiaries	**1000**
Age of Beneficaries	**65**
Current Year	**2014**
Annual pension	**$10,000**
Discount rate	**4%**
Value of liability	**$129 mm**



A	B	C	D	E	F	G
Year	Age at Year End	Expected No of Beneficiaries Alive at Year End	Size of Pension Payment to Each Beneficiary	Expected Benefit Payments Due Each Year ($mm)	Discount Factor for Each Cash Flow	PV of Each Year's Benefit Payment ($mm)
				(= C X D)		(= E x F)
2014	66	986	$10,000	$9.86	0.962	$9.48
2015	67	971	$10,000	$9.71	0.925	$8.97
2016	68	955	$10,000	$9.55	0.889	$8.49
2017	69	939	$10,000	$9.39	0.855	$8.02
2018	70	921	$10,000	$9.21	0.822	$7.57
2019	71	903	$10,000	$9.03	0.790	$7.14
2020	72	884	$10,000	$8.84	0.760	$6.72
2021	73	864	$10,000	$8.64	0.731	$6.31
2022	74	843	$10,000	$8.43	0.703	$5.92
2023	75	821	$10,000	$8.21	0.676	$5.55
2024	76	798	$10,000	$7.98	0.650	$5.18
2025	77	774	$10,000	$7.74	0.625	$4.83
2026	78	749	$10,000	$7.49	0.601	$4.50

Source: PGA calculations

This slide contains hypothetical information which may have inherent limitations.

Longevity swaps require collateralization

- Collateral must be posted for both insurance and capital markets longevity swaps

Collateral mechanism for longevity swaps (generic example)	
Collateral Framework	■ **Initial Margin:** Pension plan posts, for example, the present value of the risk premium as up-front collateral ■ **Variation Margin:** Pension plan posts collateral on the present value of future changes to the Best Estimate of the floating leg

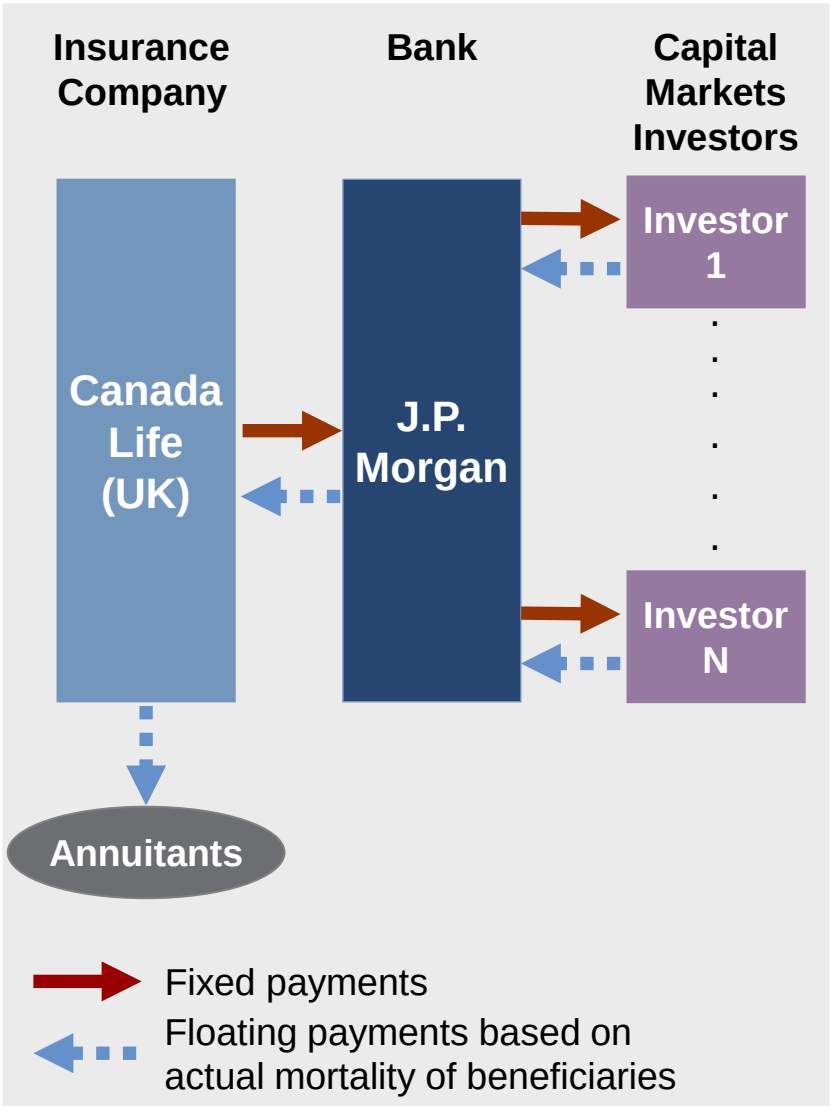
Variation Margin	■ **Calculated daily** for changes in interest rates and inflation (if relevant)
	■ **Calculated monthly** for mortality experience
	  ▪ **Mark-to-Experience (MTE):** A backward-looking analysis of changes in mortality trends
	  ▪ **Mortality Review:** A forward-looking analysis that may lead to a new Best Estimate for the floating leg. An independent expert can be called in.

Eligible Collateral	■ Cash and high-quality government bonds
Threshold	■ Minimum transfer amount

The first capital markets longevity swap was executed in July 2008

- **Canada Life (UK):** Hedged the longevity risk in an annuity portfolio
- **Longevity swap characteristics**
  - Transacted as a derivative
  - 25,000+ annuitants
  - £500 million share of £3.7 billion liability
  - Collateralized
  - Valuation based on mark-to-model
- **Considerations**
  - 100% of the longevity risk was passed through to capital markets investors

Canada Life longevity swap

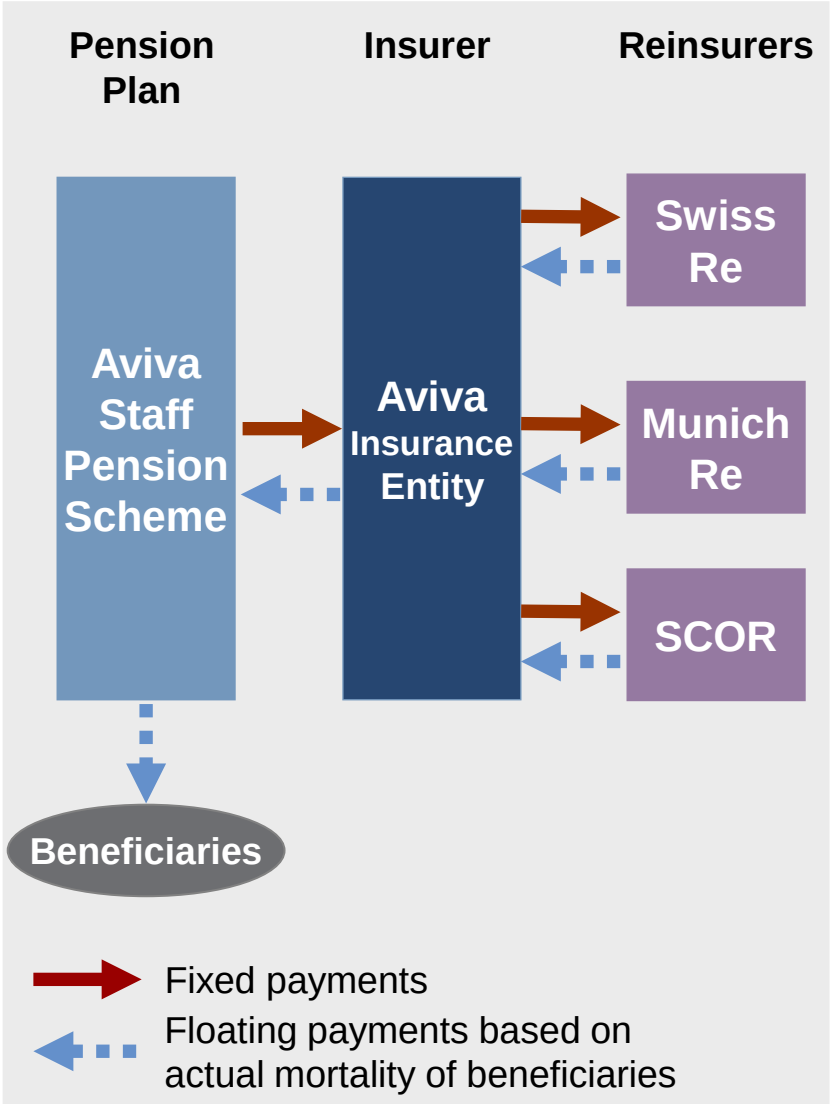


Source: "Longevity - Canada Life hedges Equitable longevity with JP Morgan swap", Oct 2008. http://www.risk.net/insurance-risk/news/1514939/longevity-canada-life-hedges-equitable-longevity-jp-morgan-swap

In March 2014 Aviva announced a massive longevity swap covering £5 billion ($8.5bn) of pension liabilities

- **Aviva** is a UK insurance company
- **Longevity swap characteristics**
  - Transacted as insurance policy
  - 19,000 retirees (pensioners)
  - 1/3 of plan's liabilities
- **Insurer** was one of Aviva's own entities
  - So the swap could be brokered directly with reinsurance market
  - Saved approx 2% on the price
- **Club Vita's** pooled dataset was used:
  - To provide insights on life expectancy
  - As an independent check on pricing

Aviva longevity swap

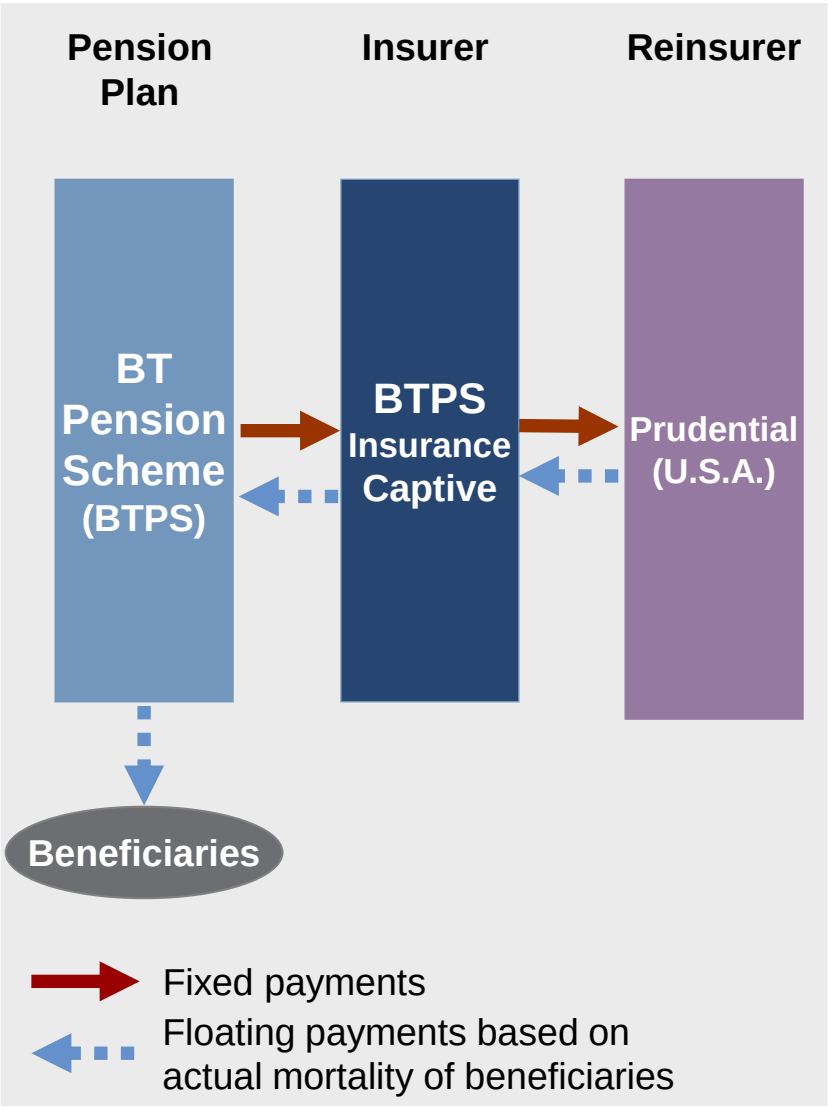


Source: "Swiss Re, SCOR in £5 billion longevity swap transaction for Aviva" http://www.artemis.bm/blog/2014/03/06/swiss-re-scor-in-5-billion-longevity-swap-transaction-for-aviva/
"Aviva longevity swap raises questions for intermediaries" http://www.risk.net/insurance-risk/news/2334993/aviva-longevity-swap-raises-questions-for-intermediaries

In July 2014 BT announced a record £16 billion ($27bn) longevity swap

- **BT** is a UK telecommunications company
- **Longevity swap characteristics**
  - Transacted as insurance policy
  - Covers retirees only
  - 1/4 of plan's liabilities
- **Insurer** was a captive set up by the pension plan
  - So the pension plan could negotiate directly with the reinsurer

BT longevity swap



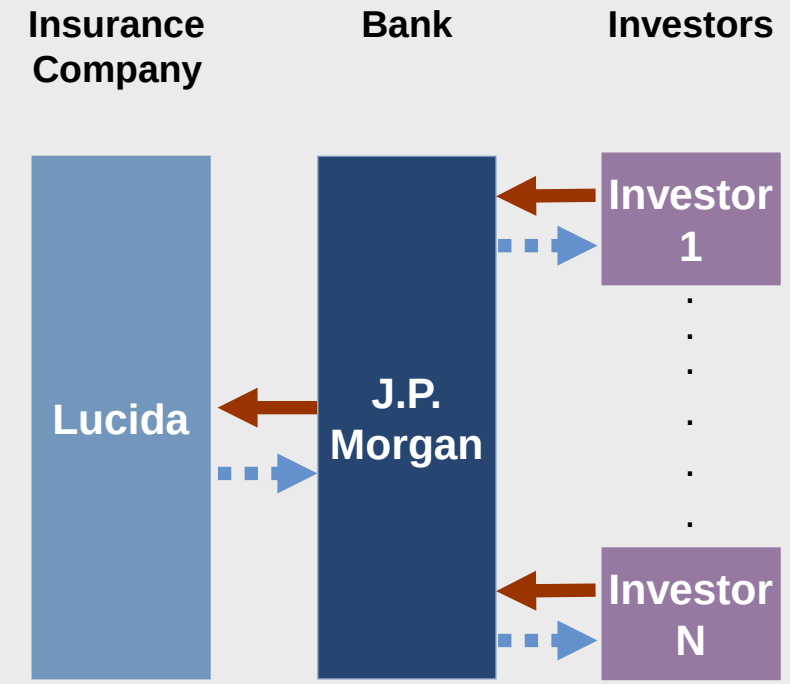
Source: Professional Pensions (July 4, 2014). "BT scheme agrees £16bn longevity swap" http://www.professionalpensions.com/professional-pensions/news/2353740/bt-scheme-agrees-gbp16bn-longevity-swap
RISK.net (July 11, 2014). "BT longevity swap points way for pass-through structures" http://www.risk.net/insurance-risk/feature/2354844/bt-longevity-swap-points-way-for-pass-through-structures

Agenda

A *"q-Forward"* was the first capital markets longevity hedge

- **Lucida – January 2008**
  - Lucida was a UK pension insurer
- **A financial derivative**
  - Exchanges realized (floating) mortality for fixed mortality at maturity
  - Floating payments linked to the realized mortality of a mortality index
- **Relatively short tenor:** 10 years
- **Considerations**
  - Both retirees and non-retirees
  - Hedge of liability value not cash flow
  - Basis risk: Index population vs. actual beneficiaries
  - Collateralized
  - Valuation based on mark-to-model

Lucida q-forward



Note: Fixed and floating payments are in the opposite direction from a longevity swap, since mortality and longevity are opposites

Source: "Lucida guards against longevity", February 2008.
http://www.efinancialnews.com/story/2008-02-19/lucida-guards-against-longevity

It was a US company that used a q-Forward for the first hedge of *non-retiree* longevity – for their UK pension plan

- **Execution date:** January 2011
- **Sponsor:** UK Subsidiary of Pall Corporation
- **Plan:** Pall (UK) Pension Plan
- **Hedge:** A q-forward with the floating payment based on the mortality rates of England and Wales
  - Based on LifeMetrics index
- **Size of hedged liability:** £70 million ($115 million)
- **Maturity:** 10 years
- **Longevity hedge** of non-retirees, i.e., deferred (or terminated vested) members

PALL Pall Corporation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News . Defined Benefit

Pall scheme completes world's first longevity hedge for non-retired members

Professional Pensions | 01 Feb 2011 | 09:43

By Jonathan Stapleton


FINANCIAL NEWS

It's a longevity hedge ... but not as we know it

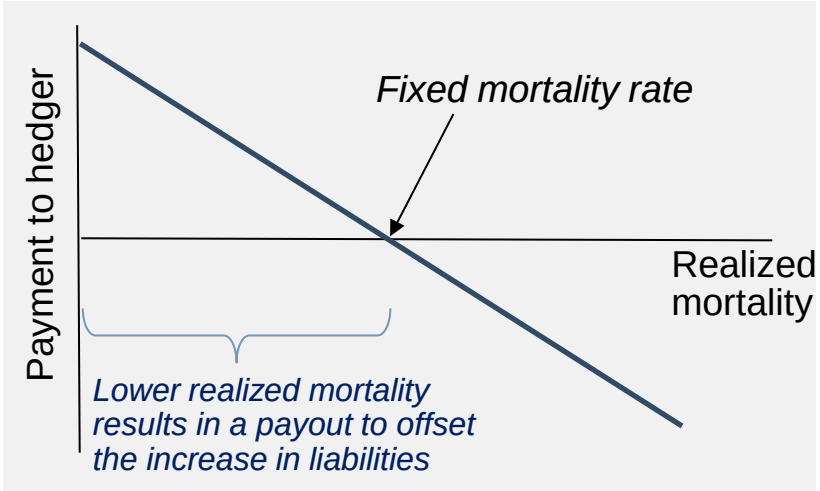
Mark Cobley

01 Feb 2011

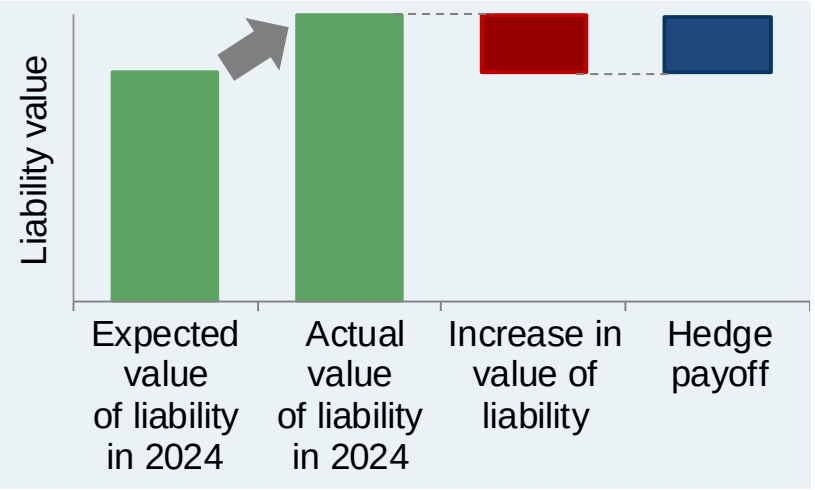
Source: Professional Pensions, February 1, 2011; Financial News, February 1, 2011

A q-forward is a hedge of liability value

The payoff of a q-forward



The payoff offsets the increase in liabilities



- Assume a q-forward hedge is put on in 2014
- If mortality rates in 2024 are lower than expected, then:
  - Longevity will be higher than expected
  - The value of the liability will be larger than expected
  - And the q-forward will make a payoff that matches the increase in the liability value

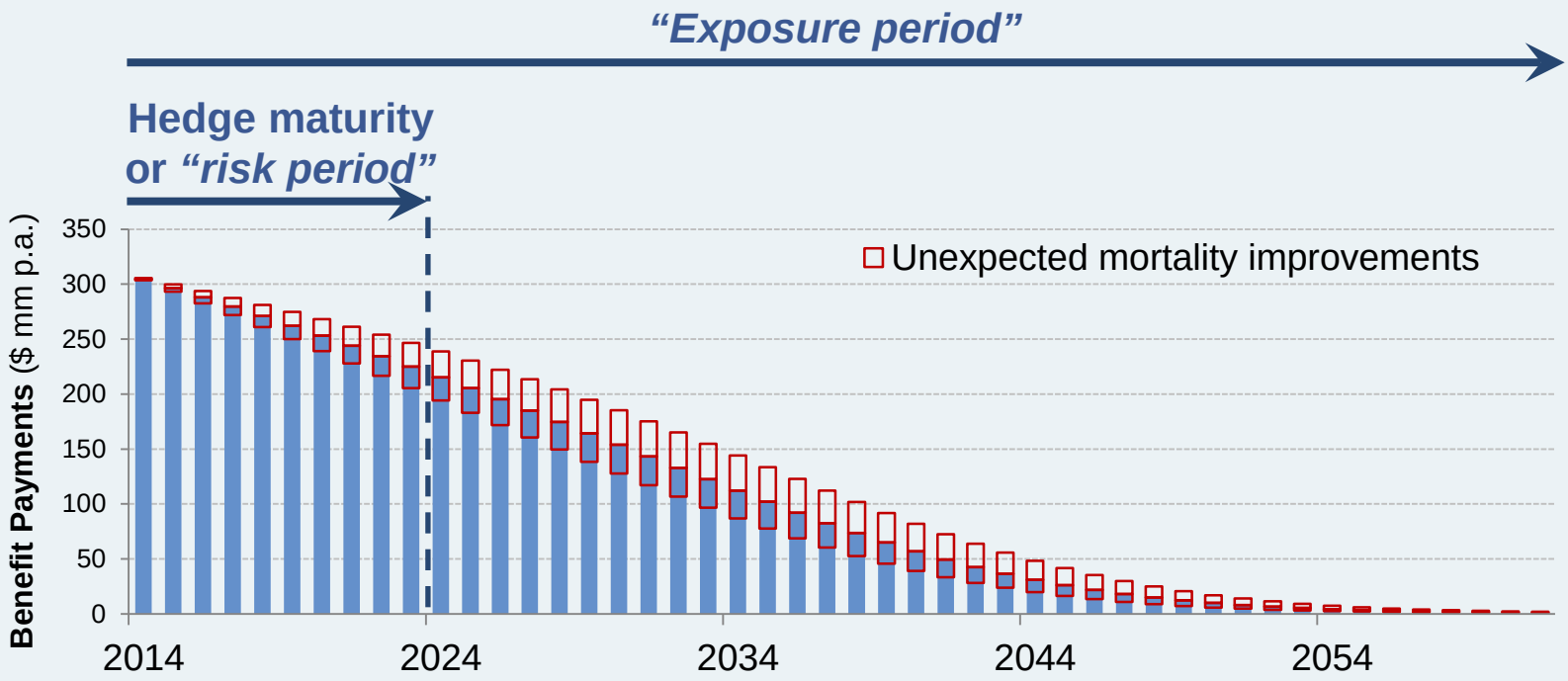
Source: "q-Forwards: Derivatives for transferring longevity and mortality risk", Guy Coughlan, David Epstein, Amit Sinha and Paul Honig, J.P. Morgan, 2007

This slide contains hypothetical information which may have inherent limitations.

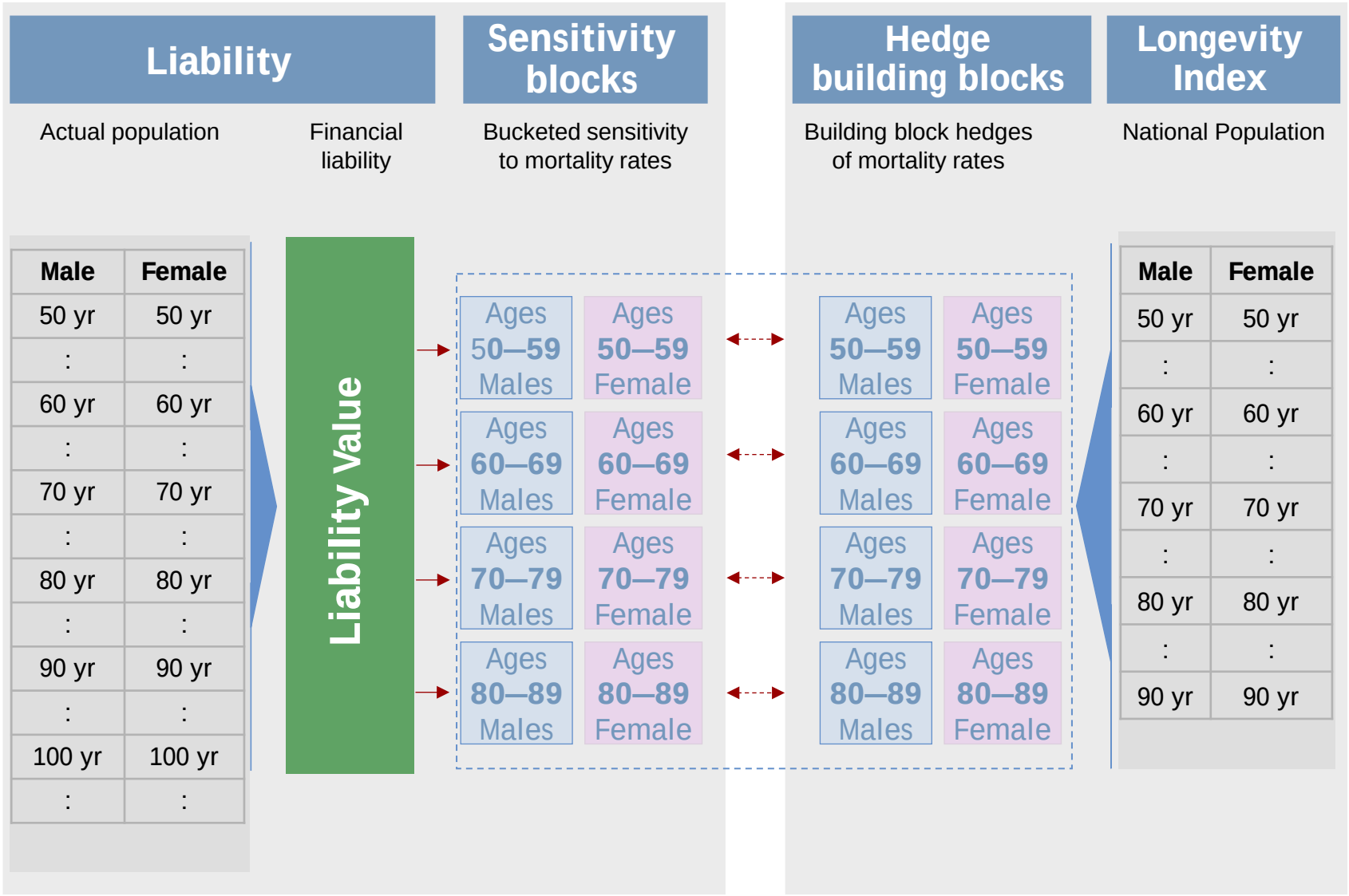
Any hedge of the liability value (as opposed to the cash flows) requires a "commutation" payment at maturity

- **Value hedges:**
  - Have a maturity – or *"risk period"* – less than the *"exposure period"*
  - Require the calculation of a *"commutation"* payment at maturity
    = change in value of liability due to actual mortality experience over the risk period
  - Based on a pre-agreed longevity model

Example of a 10-year value hedge



A portfolio of standardized building-block derivatives can hedge the mortality sensitivity of the liability

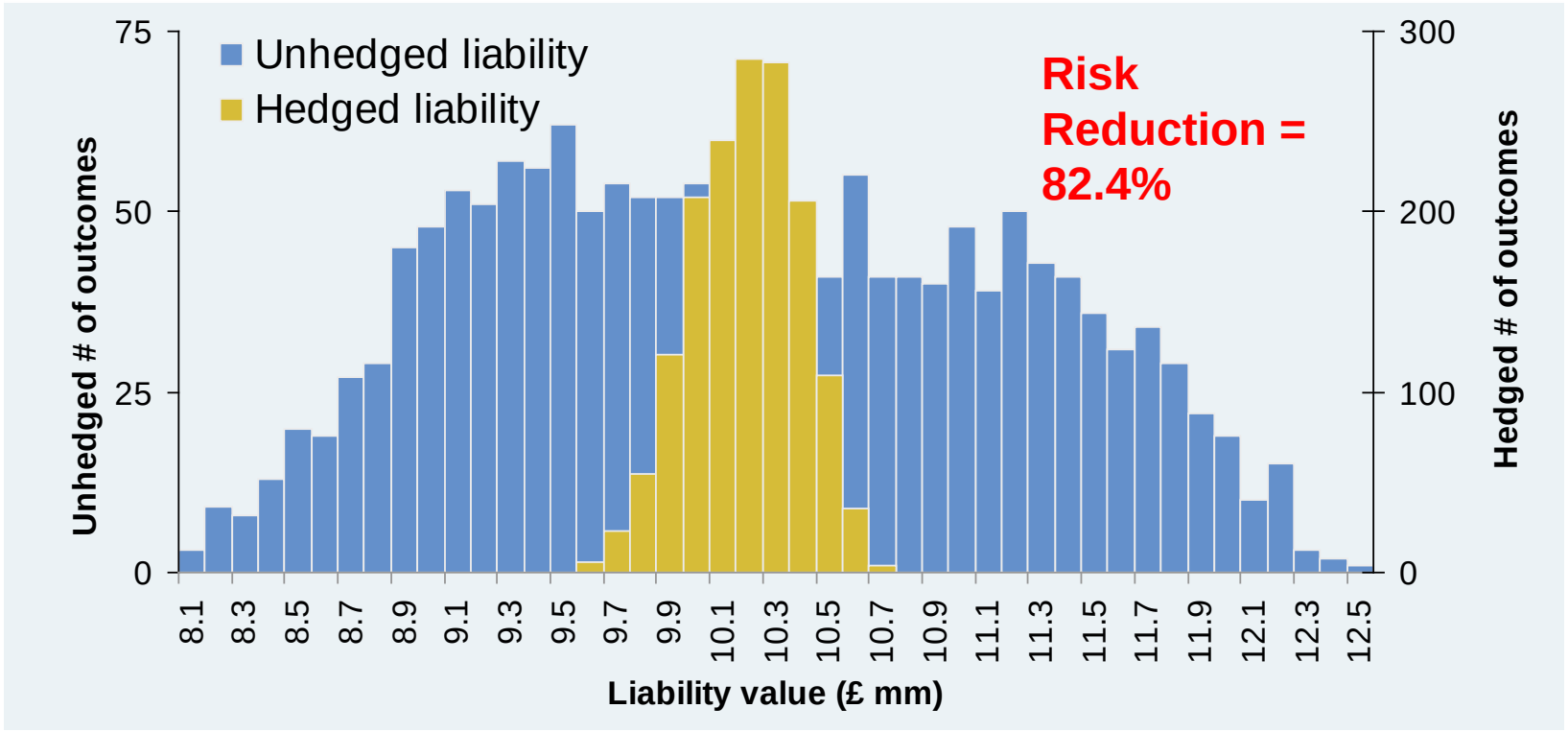


Match the mortality sensitivity of the liability to that of the hedge

Calibrated in this way, a q-Forward longevity index hedge can be highly effective

- **Example:**
  - Deferred pensioner liabilities for 55-year-olds
  - Longevity hedge based on national population index
  - Hedge of liability value at retirement

Distribution of liability value in 10 years: Before and after hedging



Source: "Longevity Hedging 101" Coughlan, Khalaf Allah, Ye, Kumar, Cairns, Blake & Dowd (2011)

Agenda

Other innovative products have been developed in capital markets format and executed by insurers

Examples of other innovative longevity hedging transactions

Date	Hedger	Counterparty	Transaction	Format	Value (millions)
Dec 2010	Swiss Re	N/A[1]	Longevity trend spread risk bond[2] (8-year maturity)	Capital markets	$50[3]
Feb 2012	Aegon	Deutsche Bank	Out-of-the-money longevity swap (20-year maturity)	Capital markets	€ 12,000
Dec 2013	Aegon	Société Générale	Out-of-the-money longevity swap (20-year maturity)	Capital markets	€ 1,400
Dec 2013	Deutsche Bank	ILS investor	Longevity Experience Option - LEO (10-year maturity)	Capital markets	"modest"
Aug 2014	Delta Lloyd	RGA Re	Index-based longevity swap (6-year maturity)	Capital markets	€ 12,000

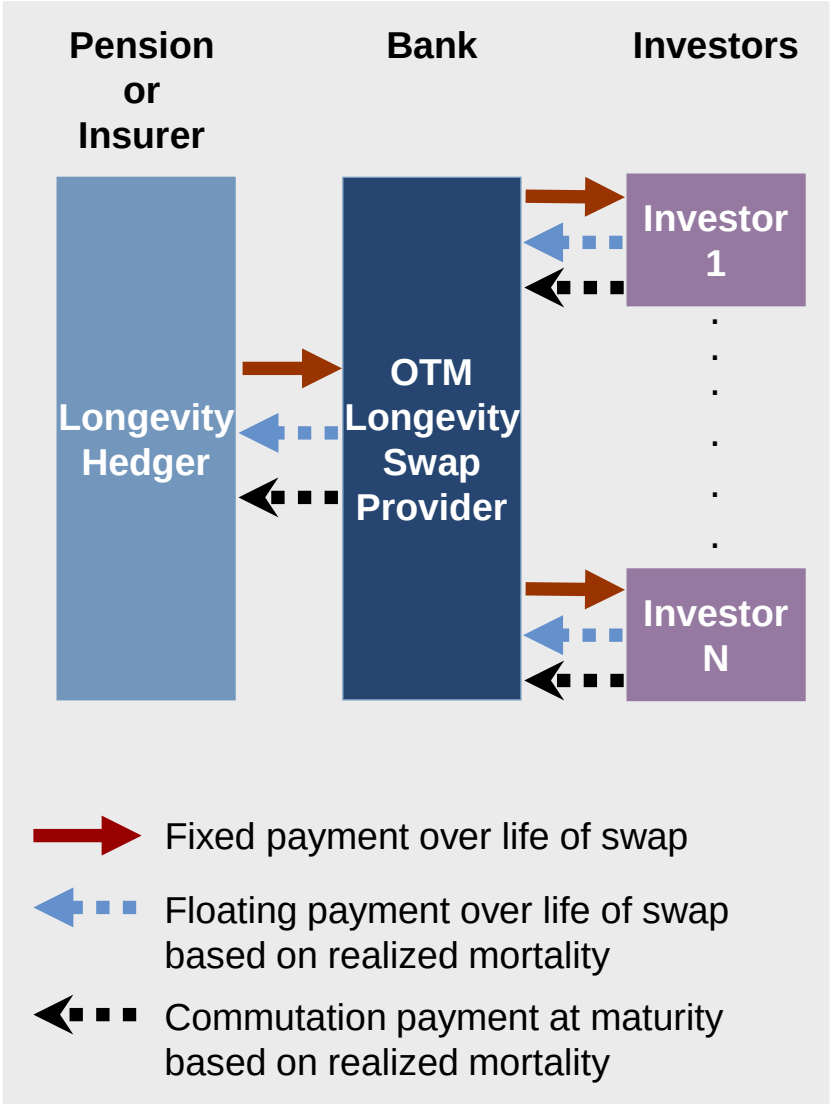
[1] No intermediary was involved.
[2] This is not really a longevity hedge like the others discussed in this presentation. It is linked to an index based on the difference in the rate of mortality improvement between older UK males (ages 75 to 85) and middle-aged US males (ages 55 to 65).
[3] Equivalent to risk transfer for a liability value of $500 - $800 million.

Source: "Swiss Re completes first longevity trend bond, transferring USD 50 million of longevity trend risk to the capital markets", Swiss Re News Release Dec 23, 2010.
"Deutsche agrees record longevity swap deal", efinancial news Feb 17, 2012. http://www.efinancialnews.com/story/2012-02-17/aegon-longevity-swap
"SG CIB completes longevity trade for Aegon", Risk Magazine, Dec 5, 2013. http://www.risk.net/risk-magazine/news/2317036/sg-cib-completes-longevity-trade-for-aegon
"Deutsche Bank longevity option platform closes debut deal", Trading Risk, Jan 17, 2014. http://www.trading-risk.com/deutsche-bank-longevity-option-platform-closes-debut-deal
"Delta Lloyd in EUR 12 billion index-based longevity swap with RGA Re", Aug 22, 2014. http://www.artemis.bm/blog/2014/08/22/delta-lloyd-in-eur-12-billion-index-based-longevity-swap-with-rga-re/

Out-of-the-money (OTM) longevity swap

- **Longevity protection:** only for large increases in life expectancy
  - Protection kicks in at an *attachment* point
  - Protection is capped at an *exhaustion* or *detachment* point
- **Payments:** Two types of payments:
  - Exchanges fixed and floating payments over the life of the swap as for a regular longevity swap
  - Makes a "commutation" payment at maturity based on realized increases in life expectancy beyond a certain level

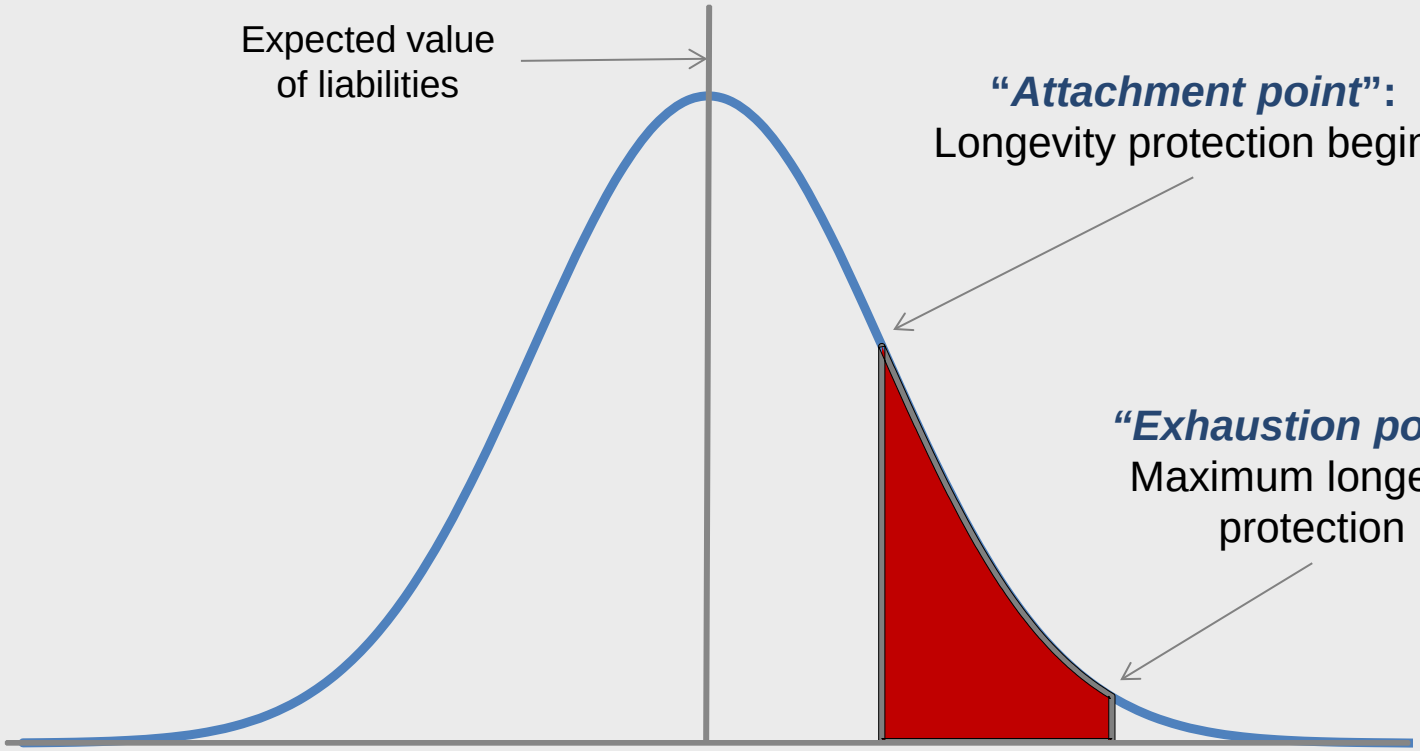
Out-of-the-money longevity swap structure



Source: PGA

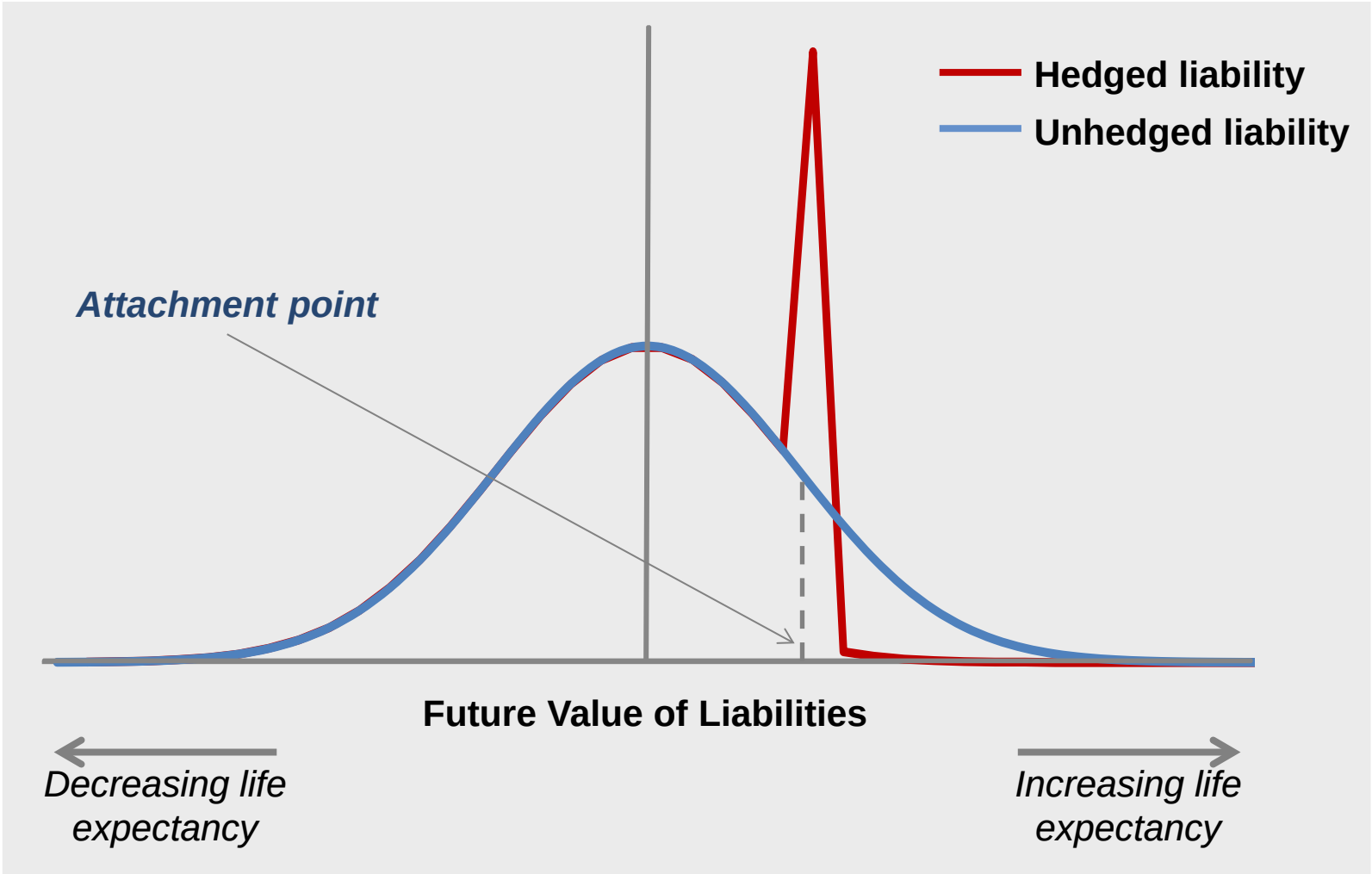
The out-of-the-money longevity swap provides a hedge against high mortality improvements

Distribution of future liability value showing longevity protection



The out-of-the-money longevity swap significantly reduces tail risk and the economic capital requirement

Distribution of liability value: Before and after hedging



Agenda

Conclusions

- **The market for pure longevity risk transfer has grown slowly since 2008**
  - Insurance companies were the first hedgers
  - Investment banks were intermediaries for capital markets longevity swaps
  - Pension plans entered the market 18-months later in mid-2009

- **Since birth there has been significant product innovation**
  - Insurance vs capital markets
  - Longevity swaps vs q-Forwards
  - Index-based hedges vs actual lives
  - Value hedges vs cash flow hedges
  - Out-of-the-money versions to hedge tail risk
  - Basis-risk minimization
  - Investor-friendly products for the capital markets

The challenge:
To develop standardization to raise liquidity and grow the market