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Life Conference 2022

23–25 November, ACC Liverpool

#LifeConf22

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B2: Evolving the Longevity Risk Transfer Market

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Monique Groen, VB Risk Advisory
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Outline

1. Evolution of longevity risk transfer (LRT) market
2. Indemnity or Index?
3. The importance of the choice of index
4. Quantifying basis risk
5. Summary & Outlook

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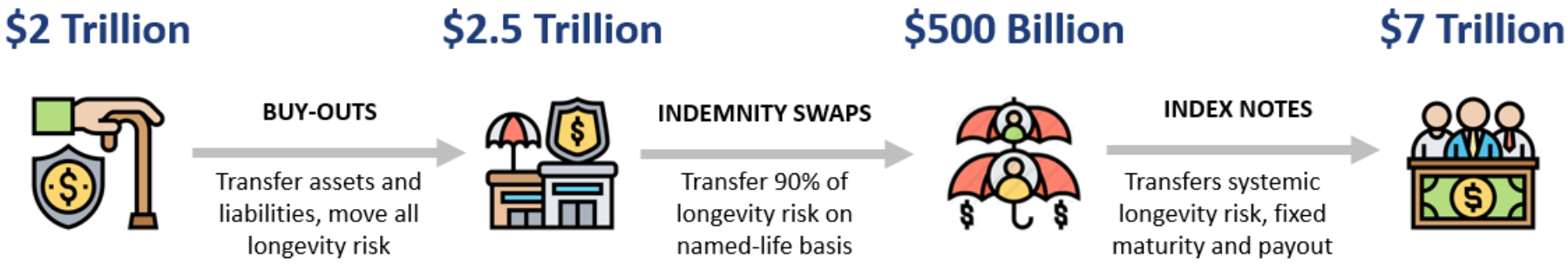
1 Evolution of longevity risk transfer (LRT) market

Where to place $12 Trillion of longevity risk?



PENSIONS

- Longevity is not diversified by size and demographics
- Longevity is uncompensated risk / distracts from business
- Not a good home for longevity risk – DB shifting to DC

INSURERS

- Can diversify idiosyncratic risk by consolidating pensions
- Some diversification against mortality and P&C risks
- Retain Administration, but de-risk to maintain capacity for buy-outs

REINSURERS

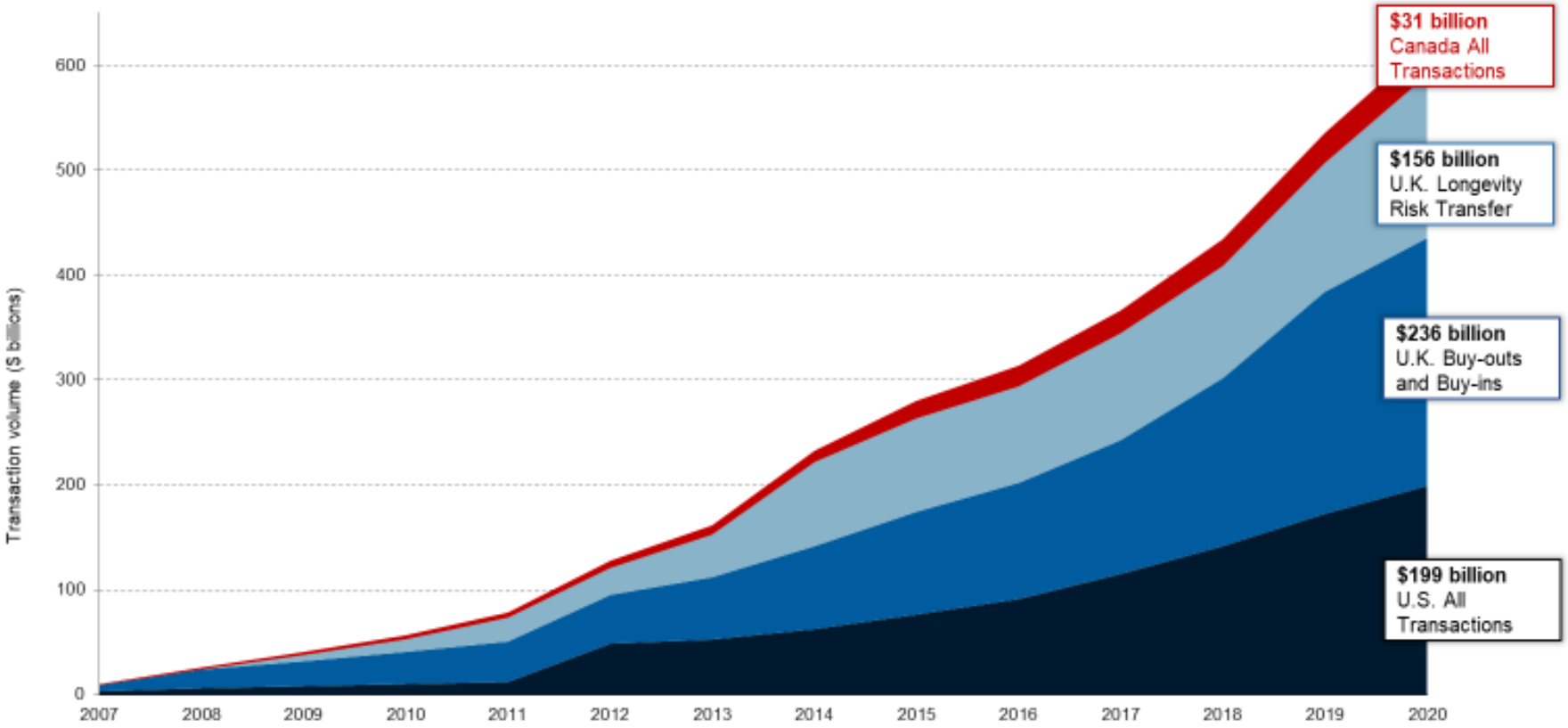
- Better diversification by size, geography and insurance risk
- Retain idiosyncratic risk given expertise in underwriting
- Transfer systemic risk, retain basis risk, which is diversifiable

CAPITAL MARKETS

- Longevity risk is uncorrelated with other asset classes
- Index longevity risk can be modeled by broad investor base
- Fixed downside and maturity, alternative fixed income

Source: Longitude Exchange

Growth of the longevity risk transfer market



Data in USD billions. Cumulative totals. From: Longevity Risk and Capital Markets: The 2019-20 Update by Blake, D and Cairns, A.
Sources: LIMRA, Hymans Robertson, LCP, WTW and Prudential Financial, Inc. (PFI) analysis of EY, 31 December 2020

- Decade of rapid growth
- Market starting to hit constraints:
  - asset sourcing
  - pricing resources
  - capital

What is the natural next step?

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Where are we on the “evolution” pathway

#	Stage	Characteristics of transactions	Characteristics of participants
1	Inefficient and illiquid market	Bespoke, OTC, highly customized	Specialized in specific market
2	Development and growth	Increased transaction volume	Broader participation but still specialized
3	Somewhat efficient and somewhat liquid, no secondary trading possible	More standardization of OTC transactions	Transactions widely adopted among market specific participants
4	Increasing efficiency, introduction of a marketplace	Standardized and on platform	Specialized capital market participants become involved
5	Efficient market with developing liquidity	Secondary trading starts	Wider adoption among capital market investors
6	Efficient and liquid market	Standardized, on-screen, all digitized processes	All financial institutions participating

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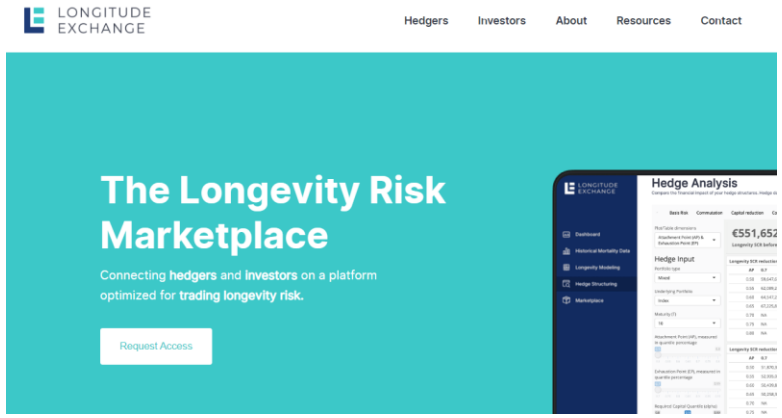
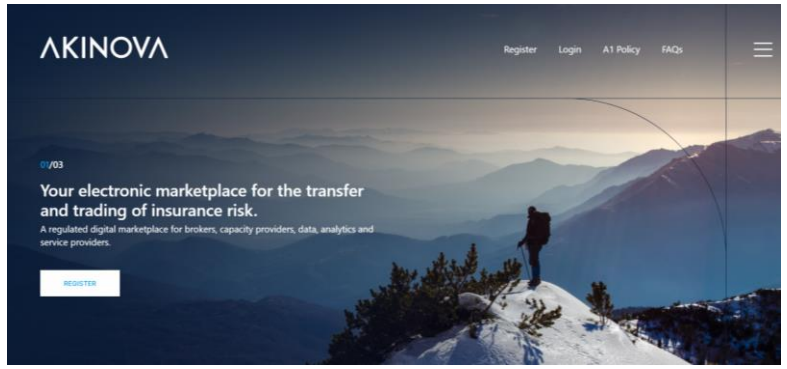
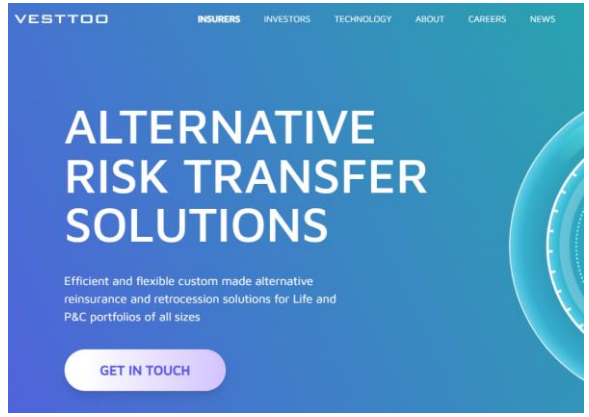
General market themes

The emergence of alternative providers







- Digital transaction processes
- Alternative sources of capital
- One to many, many to many
- Derivative and note formats

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What does a longevity trading platform look like?

Expansion of Market through Digitization

LONGITUDE EXCHANGE

DIY Toolbox for Hedgers & Investors

Purpose built Hedger customer journeys

The platform enables a digital process of risk and capital analysis, structure optimization and automated document creation.

Investor Toolbox lowers barrier to entry

Index format and (3rd party) tooling on the platform enables analysis of investment opportunity and removes need for complex underwriting skills.

Freemium SaaS Model

Free Services

A suite of valuable longevity risk modeling and analysis tools provide value to market participants to the platform.

Premium Features

Certain analytical tools (e.g., customized capital models) and capabilities (e.g., extract analyses) may cost extra.

3rd Party Services

Brokers & Banks

Intermediaries use the platform, as more transactions and transaction types are opportunities to add value.

Service Providers

Third party modeling agencies (e.g., RMS, AIR), index providers (Club Vita), and transaction services (e.g., Dedomainia) available via the platform.

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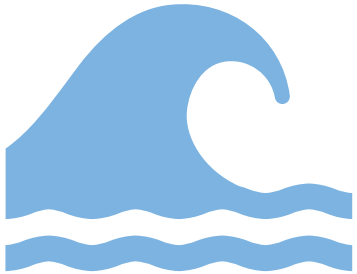
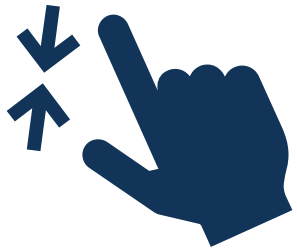
UK market themes

The post LDI "tsunami", pinch-points and novel needs needing novel outlets



- Greater enthusiasm for LRT?
- New wave of PRT ready pension schemes?



- Asset sourcing?
- Pricing actuaries?
- Capital?

- Deferred pensioners?
  (10 year PRT pricing "future")
- DC decumulation?
  (smoothing of mortality crediting in modern tontines)

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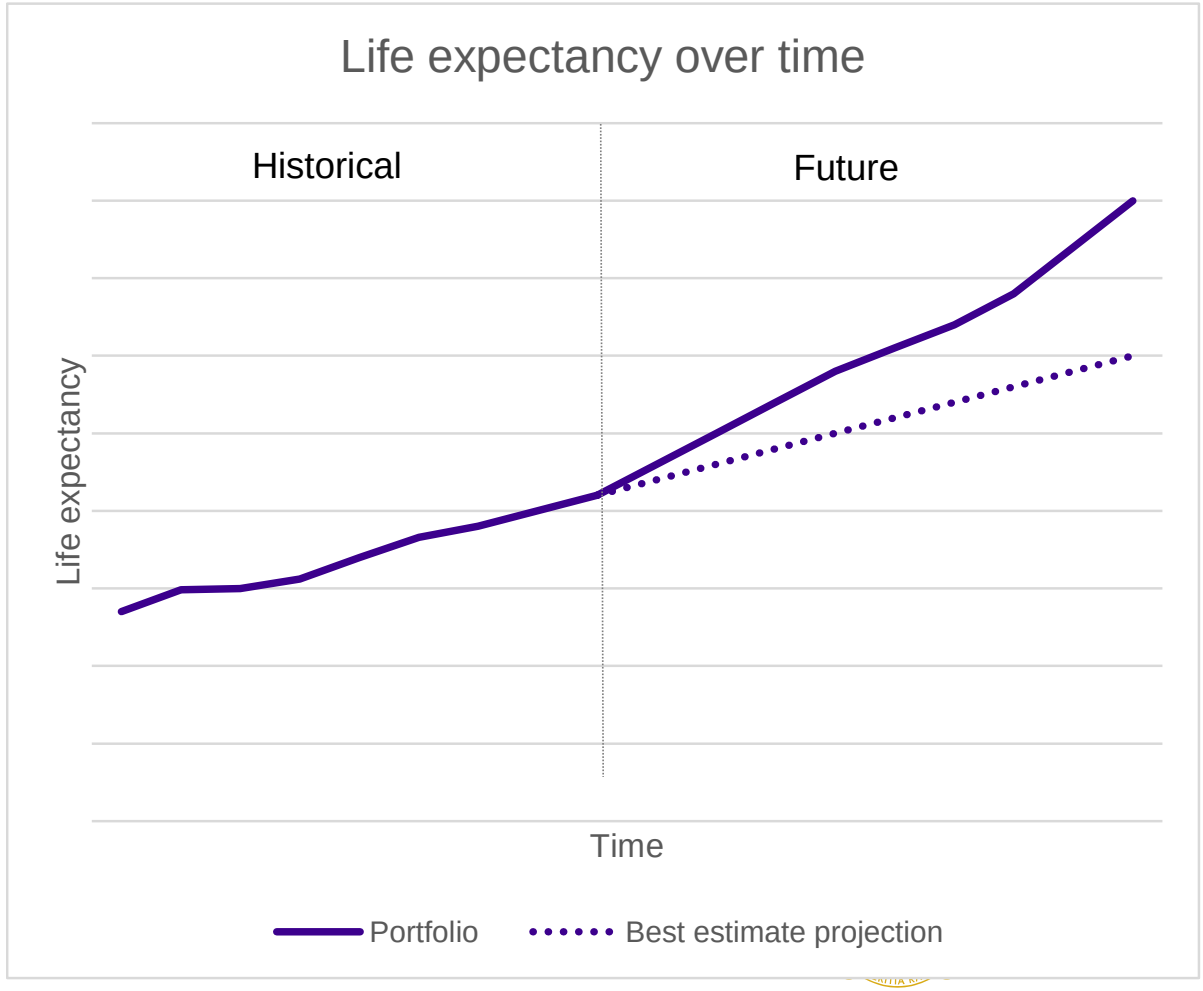
2 Indemnity or index?

Indemnity swaps

- For a given portfolio, assets are saved to make future payments assuming life expectancy follows the trend of projected life expectancy.
- There is a risk that future life expectancy diverges from the projection.
- An indemnity longevity swap will pay out to compensate for the difference between actual life expectancy and the projection.
- Based on cashflows in respect of a **group of named lives**

Bespoke nature limits standardisation



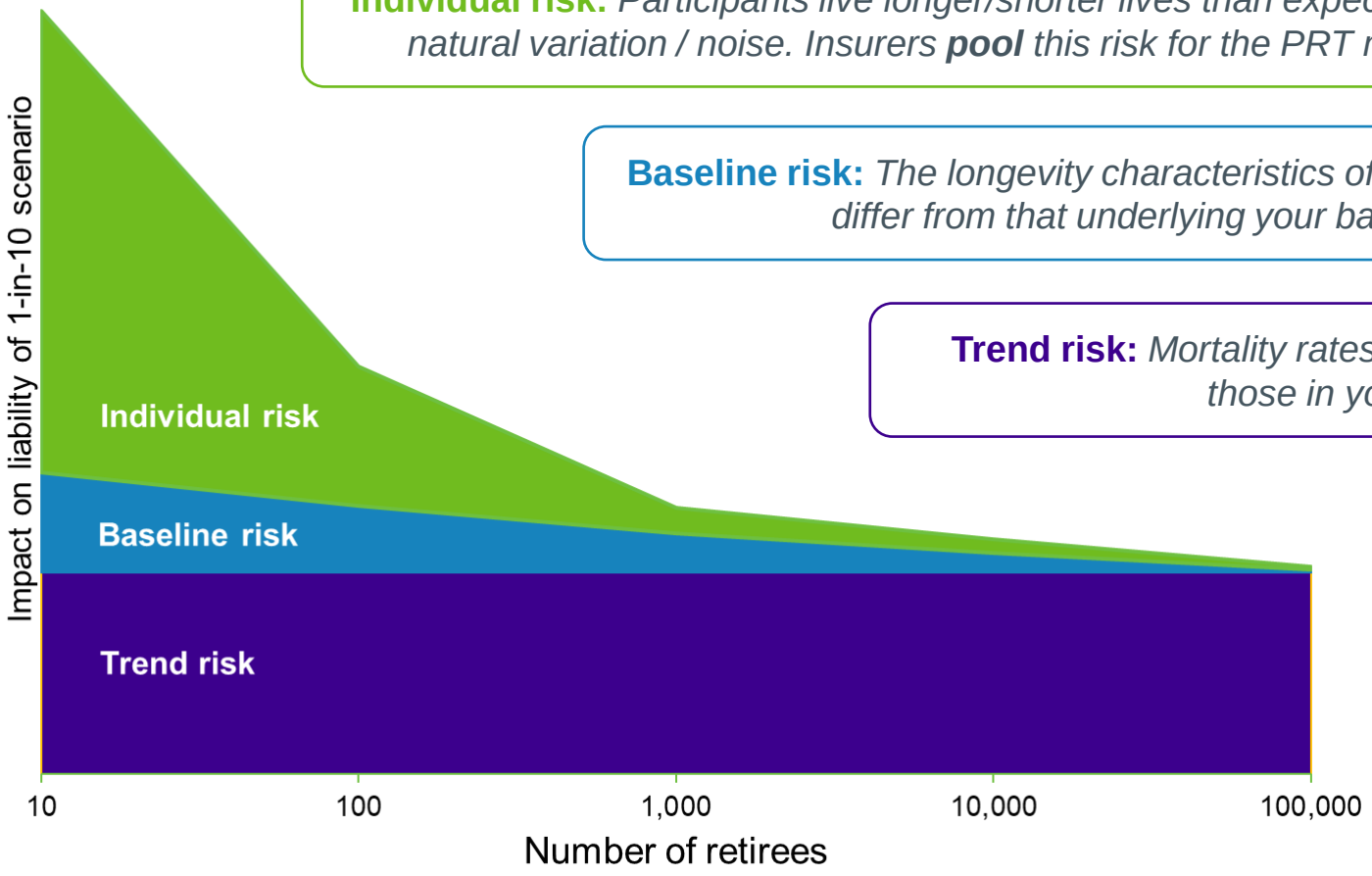
Components of longevity risk

Individual risk: *Participants live longer/shorter lives than expected due to natural variation / noise. Insurers **pool** this risk for the PRT market.*

Baseline risk: *The longevity characteristics of a pension scheme / PRT book differ from that underlying your baseline assumption*

Trend risk: *Mortality rates decrease/increase at different rates to those in your improvement scale.*

Systemic



Source: Club Vita internal analysis (stylised)

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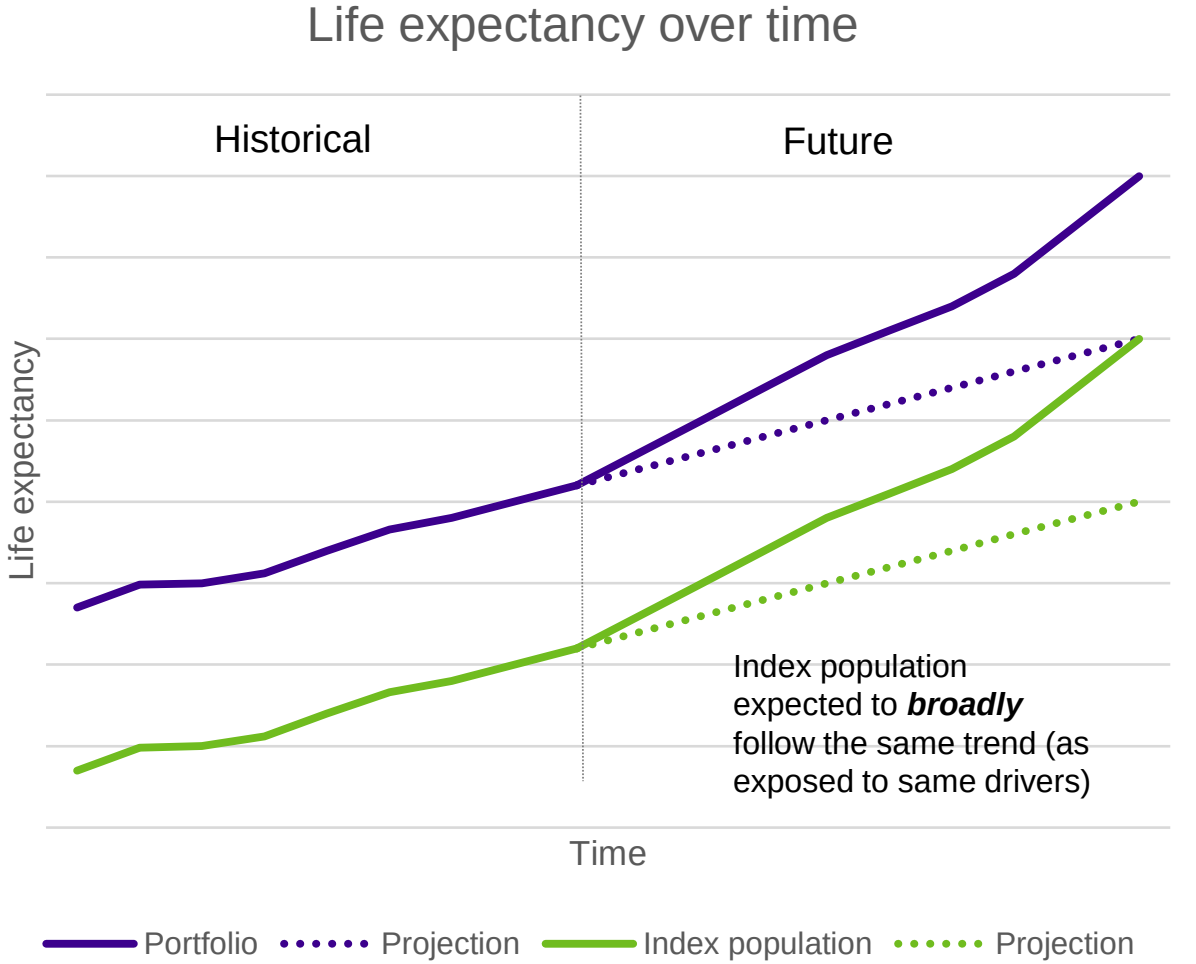
Why an index-based swap instead?

- An index based swap will pay out based on the difference between actual life expectancy and the projection of the index population.
- **Efficient:** Easier to track a reference (index) population than a named group of lives
- **Liquidity:** Standardisation means greater market participants:
  - **lower cost** to insurers/ reinsurers of providing LRT
  - **greater capital availability**
  - primary insurers focus on pooling individual risk / minimising baseline risk
- **Emerging market needs:** See demand in UK for:
  - Pension scheme deferred annuitants
  - Modern tontines / DC decumulation vehicles



Matching risk cedants to the capital markets

Can their differing needs be met from an index?

Capital Markets

- ✓ Timely
- ✓ Limited term
  - Commutation mechanisms
- ✓ Capped Exposure
  - Attachment / Detachment point

Risk Cedants

- Relevant
- Reliable

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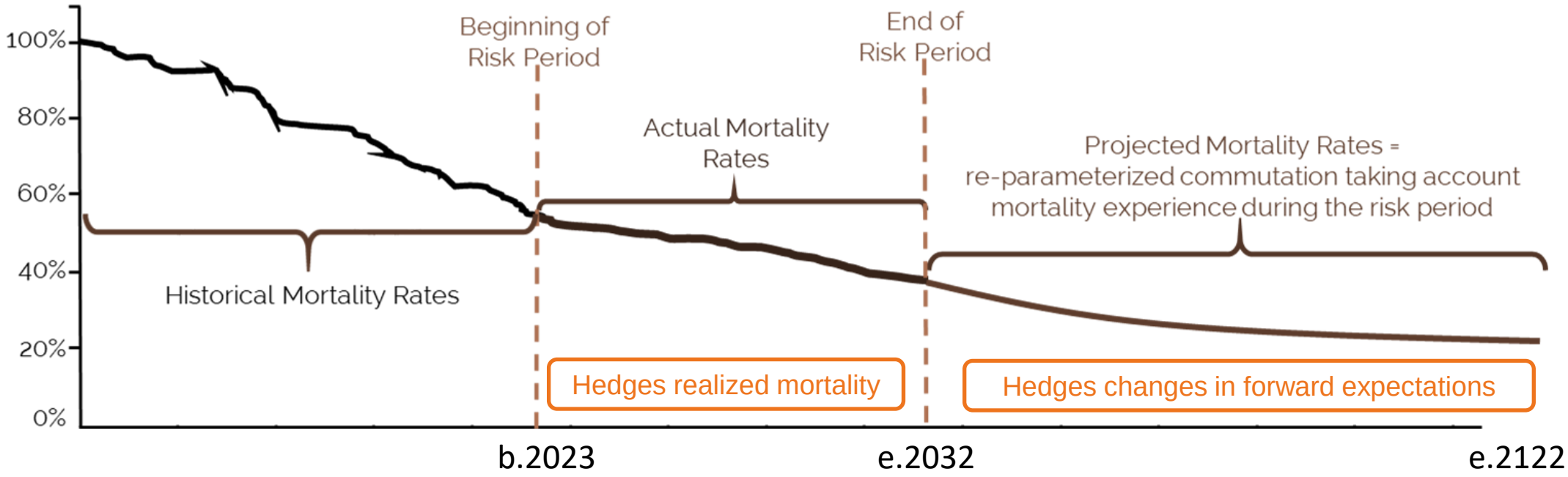
Hedging one hundred years of longevity risk

Converting to a limited term



The **instrument** is created using two components that cover a 100-year exposure period:

1. **Accumulated liability** over the **10-yr risk period** based on **actual reported mortality rates**
2. **Expected NPV of remaining liability** using a re-parameterized **commutation calculation**

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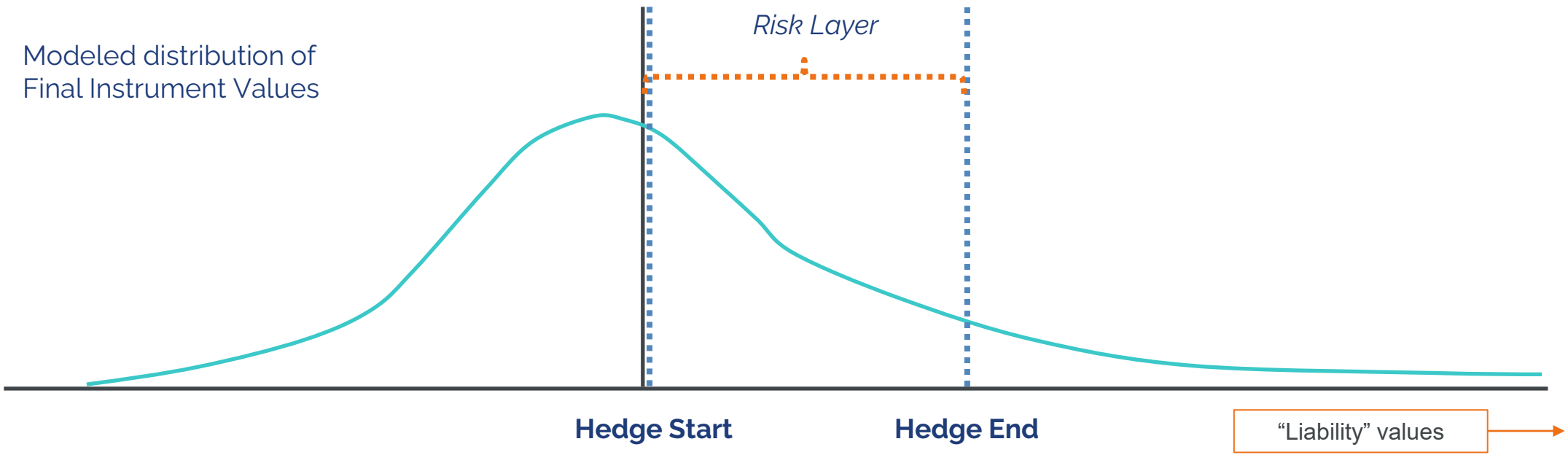
Hedging one hundred years of longevity risk

Ensuring capped exposure



Final Payout is determined by measuring the **Final Instrument Value relative to the Hedge Start and Hedge End points:**

- Index Hedge pays out 0% (to hedger) if Final Instrument Value is below the Hedge Start point
- Index Hedge pays out 0-100% of risk layer if Final Instrument Value is between the Hedge Start and Hedge End points
- Index Hedge pays out 100% of risk layer if the Final Instrument Value is above the Hedge End point.

How is a the longevity index instrument defined?

The hedger (typically an insurer or reinsurer) defines an instrument referencing an index by setting three inputs:

1 Exposure amounts

Portfolio exposure (annuity amounts) by gender and age:

	50	51	52	53	…	97	98	99	100
Male	$700	$750	$800	$900	…	$50	$25	$20	$10
Female	$200	$220	$240	$250	…	$10	$5	$2	$1

2 Experience ratios

A scalar applied to index to align with portfolio baseline line at t=0:

	50	51	52	53	…	97	98	99	100
Male	70%	71%	71%	72%	…	80%	80%	81%	81%
Female	60%	60%	62%	62%	…	75%	75%	75%	75%

3 Discount rate curve

Used to accrue/discount the amounts with interest to the end of the transaction

	2023	2024	2025	2026	…	2119	2120	2121	2122
Rate	4.00%	4.25%	4.50%	4.60%		5.50%	5.50%	5.50%	5.50%

How are instrument payoffs calculated?

Payoffs during the "risk period"

1. **Mortality rates are reported** by data provider (e.g., Club Vita) for the risk period (e.g., 10 years).
   This is the only input (e.g., unknown) that goes into the calculation i.e. the only thing that needs to be modeled!
2. Reported mortality rates are **multiplied by the Experience Ratios.**
3. **Survival curve is built**, for each age and gender, to determine how much of that "cohort" was alive each year.
4. Survival curves are multiplied by the Exposure Amount to **determine the Synthetic Annuity Amount** each year.
5. Synthetic Annuity Amount for each age/gender/year is **accumulated with interest** to the end of the risk period

	2023	2024	2025	2026	2027	2028	2029	2030	2031	2032
q_x M50	2.00%	1.98%	1.99%	1.95%	2.01%	1.93%	1.97%	1.92%	1.93%	1.92%
Exper. Ratio	70%	70%	70%	70%	70%	70%	70%	70%	70%	70%
Adjusted q_x	1.40%	1.39%	1.39%	1.37%	1.41%	1.35%	1.38%	1.34%	1.35%	1.34%
Survival Curve	98.6%	97.2%	95.9%	94.6%	93.2%	92.0%	90.7%	89.5%	88.3%	87.1%
Exposure Amt.	$700	$700	$700	$700	$700	$700	$700	$700	$700	$700
Syn. Ann. Amt.	$690	$681	$671	$662	$653	$644	$635	$626	$618	$610
Accum. Factor	142%	137%	132%	127%	122%	117%	112%	108%	104%	100%
Inst. Amount	$982	$931	$883	$838	$794	$753	$714	$678	$643	$610

How are instrument payoffs calculated?

Commutation formula for payoffs after the "risk period"

The Expected NPV of the cash flows beyond the risk period is calculated using a commutation calculation:

1. A **longevity model is chosen (fixed)** by the hedger. Generally, a well-known model like the Lee-Carter model.
2. The **method for "re-parameterizing" the model** at the end of the risk period is chosen (and fixed).
3. At the end of the risk period, the **data reported over the risk period is used to re-parameterize the model**.
4. The model is then used to **project forward mortality rates** for each age and gender, generally out 100 years.
5. The projected mortality rates are **multiplied by the Experience Ratios**.
6. **Forward survival curves are built** to determine how much of that "cohort" is projected to be alive each year.
7. Survival curves are multiplied by the Exposure Amount to **determine the Synthetic Annuity Amount** each year.
8. Synthetic Annuity Amount for each age/gender/year is **discounted back to the end of the risk period**.

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Index based transactions

Some key features

- Index-based transactions reference **general-population mortality data** provided by national statistical agencies – like the Centers for Disease Control (CDC) – or **sub-population indices** provided by commercial index providers – like Club Vita.
- This transaction format is more appropriate capital markets investors because:
  - They can have a **finite payoff** (fixed maximum loss by virtue of payouts initiated at a certain "attachment" level of the index, and ceasing above a certain "detachment" level)
  - They have a **finite maturity** (certain end date)
  - They have a **commutation mechanism to make a settlement** at the end date for an extrapolation of trends beyond the maturity to meet cedants need for risk protection against the impact of emerging, and widening, longevity differentials
  - Based on publicly available data (**no information asymmetries**)
  - Based on relevant, published index data (**doesn't require life underwriting** skills)
  - **Longevity models are readily available** (e.g. available on Longitude platform for free)
  - **Liquidity may develop** over time (Longitude is enabling secondary trading)
  - Mark-to-Model calculations can be provided daily (**easier to mark books**)

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3 Understanding longevity risk

Historical trends are different for DB pensioners

The PRT market covers a "select" group of lives

			
♂	+0.3% p.a.	+0.8% p.a.	+0.5% p.a.
♀	+0.7% p.a.	+0.8% p.a.	+0.8% p.a.

Source: Club Vita analysis of DB pension plan data collated and analysed from each of UK, US and Canada.
Notes:
UK data Club Vita vs England & Wales population (as underpins CMI model). Annual improvements measured 2012-2014 to 2017-2019. Difference statistically significant.
US data Club Vita vs data underpinning SoA MP scale improvements. Annual improvements measured 2013-2015 to 2016-2018. Difference statistically significant for men.
CA data Club Vita vs StatCan. Annual improvements measured 2012-2014 to 2017-2018.
In all cases based on 65 to 95 year olds. Additional information and detail available on request from Club Vita.

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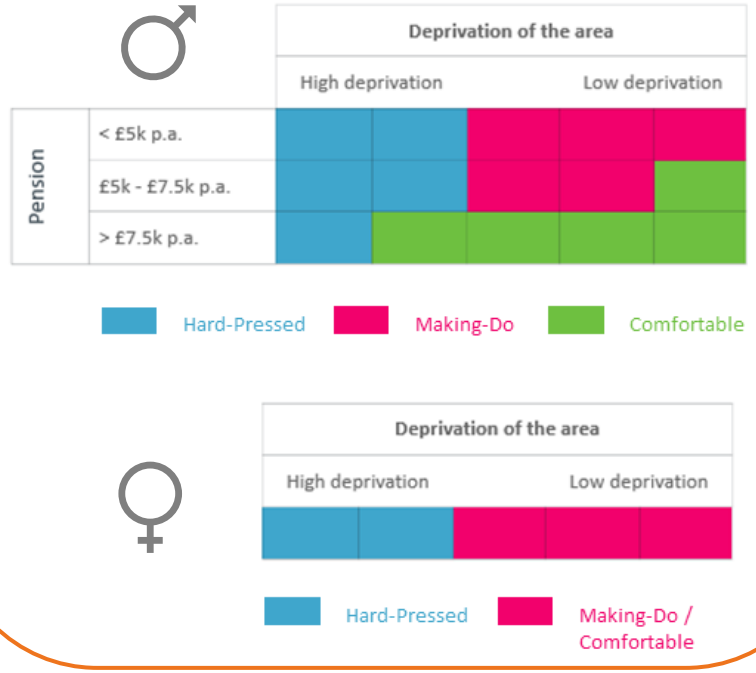
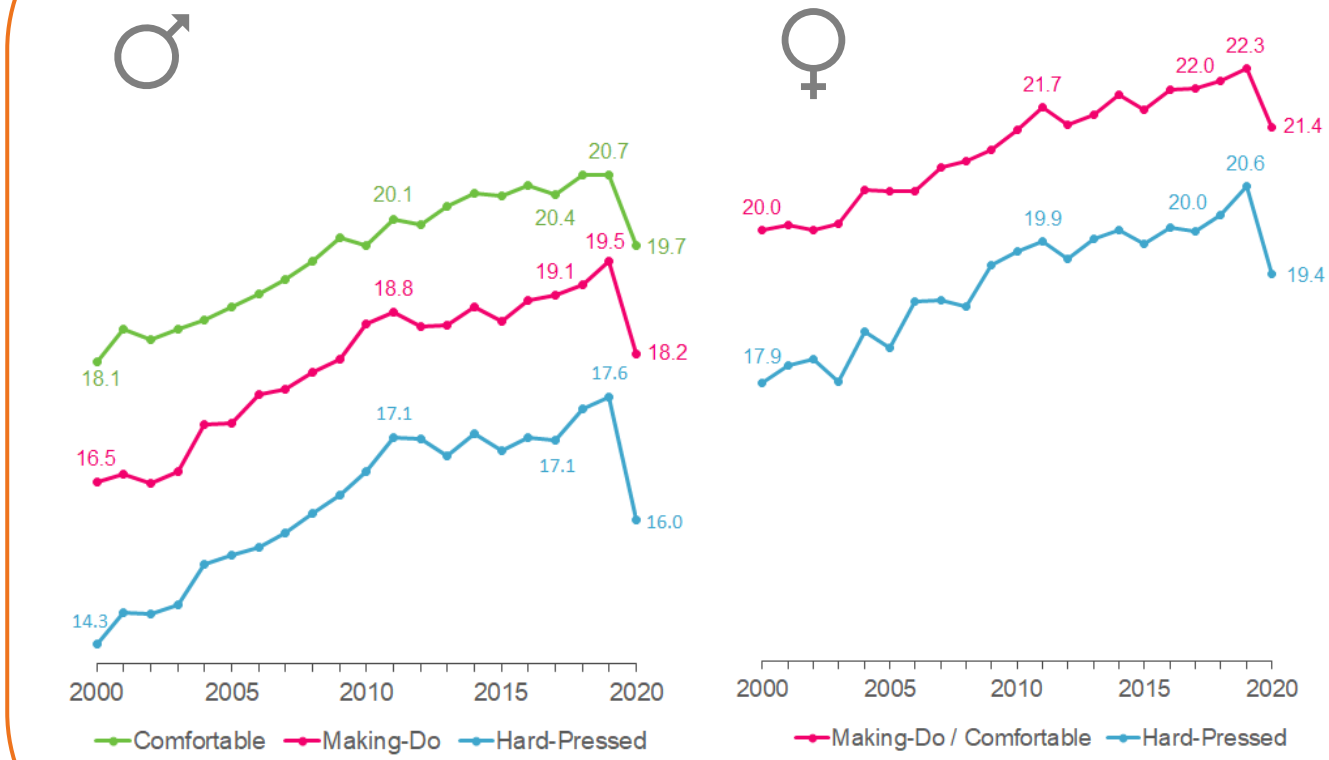
Historical trends vary by socio-economic group

Club Vita UK analysis

VITASEGMENTS

- Use small areas (postcodes)
- Two dimensional (postcode and individual pension) for men





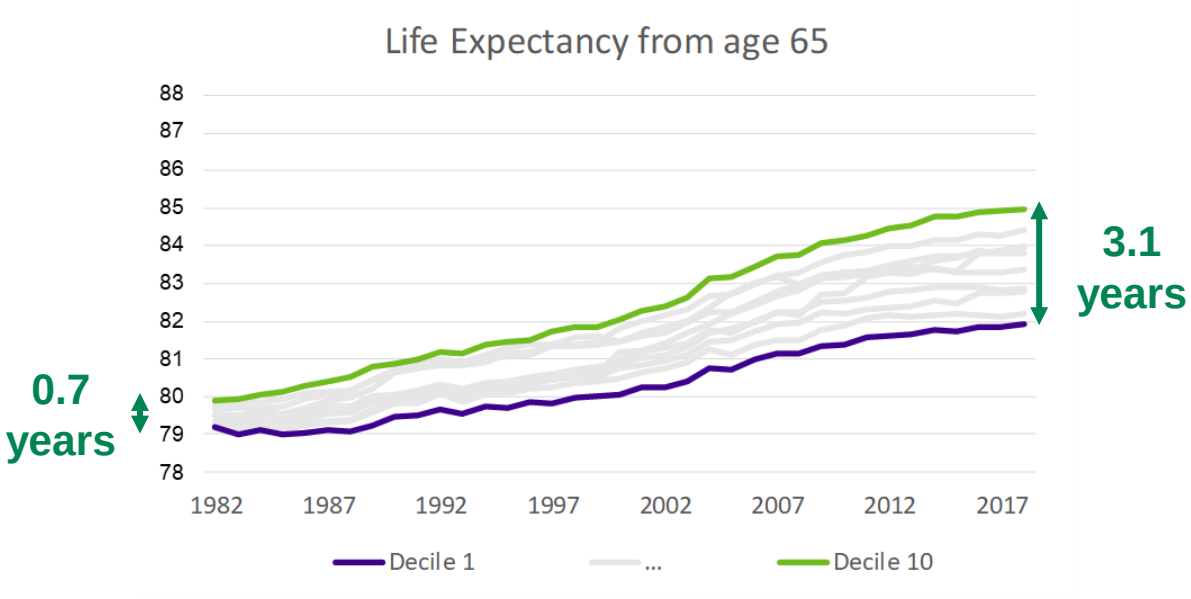
Source: Club Vita

Notes: Life expectancies from age 65 on a period basis for men and women. Based on Vita information as at August 2021

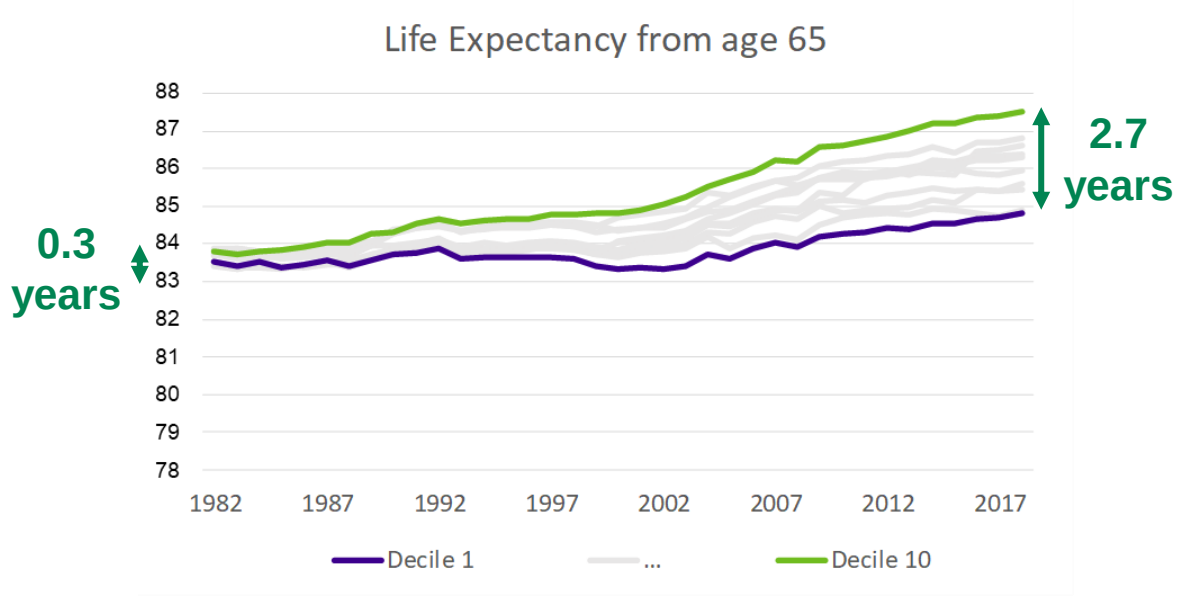
Historical trends vary by socio-economic group

Society of Actuaries: Mortality by Socioeconomic Category

Men



Women



Higher socio-economic groups seeing faster improvements than lower socio-economic groups

Notes: Club Vita graphics based on December 2020 version of SoA life tables by socio-economic decile as published on SoA website

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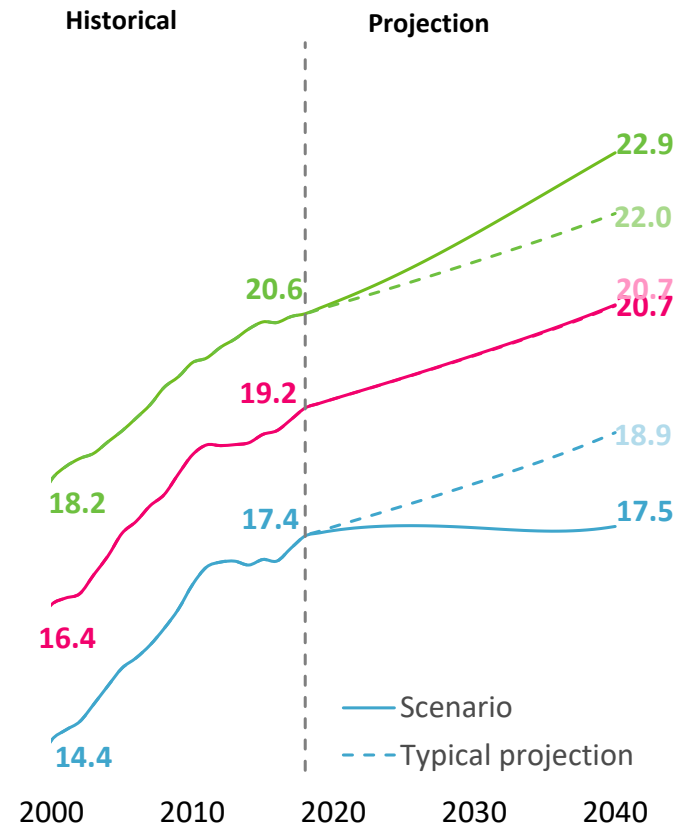
What if?...

Future scenarios with divergent longevity for socio-economic groups

Illustrative Scenario



Possible narrative

- Post 1950s birth generations show considerable socio-economic diversity in morbidity arising from considerable variations in diet and lifestyle during early/adult life
- Poorest are twice as likely at age 50 to have
  - Diabetes
  - Respiratory illness
- Historical data captures a population level "negative cohort effect" for these birth cohorts… …but is largely influenced by the AIDs pandemic
- Lifestyle effects result in faster improvements in the more affluent socio-economic groups / lower improvements amongst less affluent.
- This divergence may also be amplified by some of the post COVID effects including:
  - Pressures on health services (for those most reliant upon)
  - Recession & high inflation

Under such scenarios population index has (essentially) zero payoff.

Source: Club Vita (data as August 2021)
Notes: Historical ad projected life expectancies from age 65 shown on a period basis.

4 Quantifying basis risk

Matching risk cedants to the capital markets

Can their differing needs be met from an index?

Capital Markets

✓ Timely

✓ Limited term

- Commutation mechanisms

✓ Capped Exposure

- Attachment / Detachment point

Risk Cedants

Relevant

✓ Reliable

How big is basis risk?

What is “basis risk”?

Often used to cover multiple sources of risk

Demographic Basis Risk

Risk that the longevity characteristics of the index and the portfolio differ, leading to divergent trends over time.

Commutation Risk

Risk that the commutation payment does not adequately capture the actual pattern of divergent trends beyond end of term of instrument.

Structuring Risk

Reduced risk coverage e.g. from attachment and detachment points.

Traditionally referred to as “basis risk”

Focussing on this aspect today, *and quantification for a UK national population based index vs Club Vita segmented indices*

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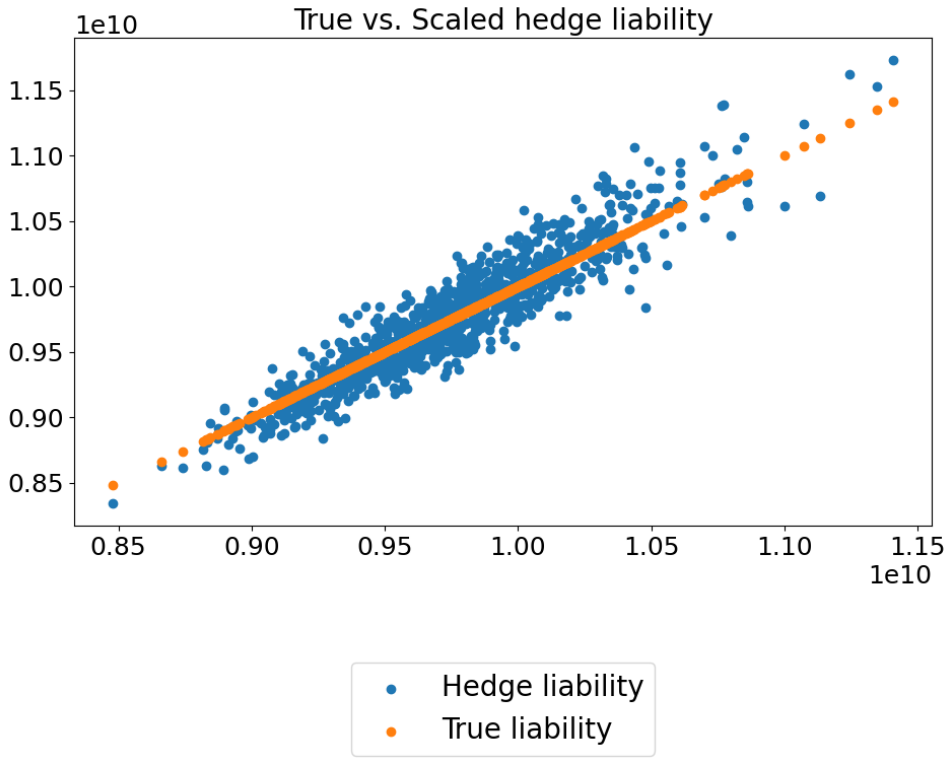
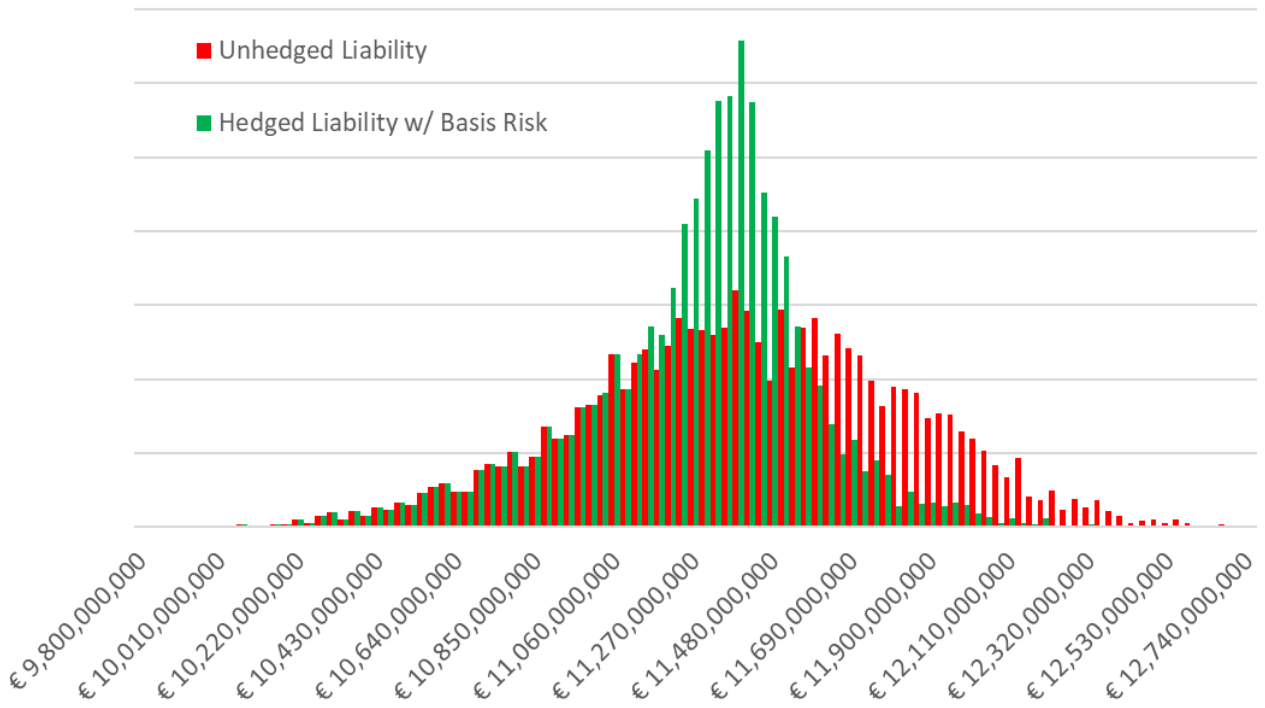
Basis risk illustrated graphically





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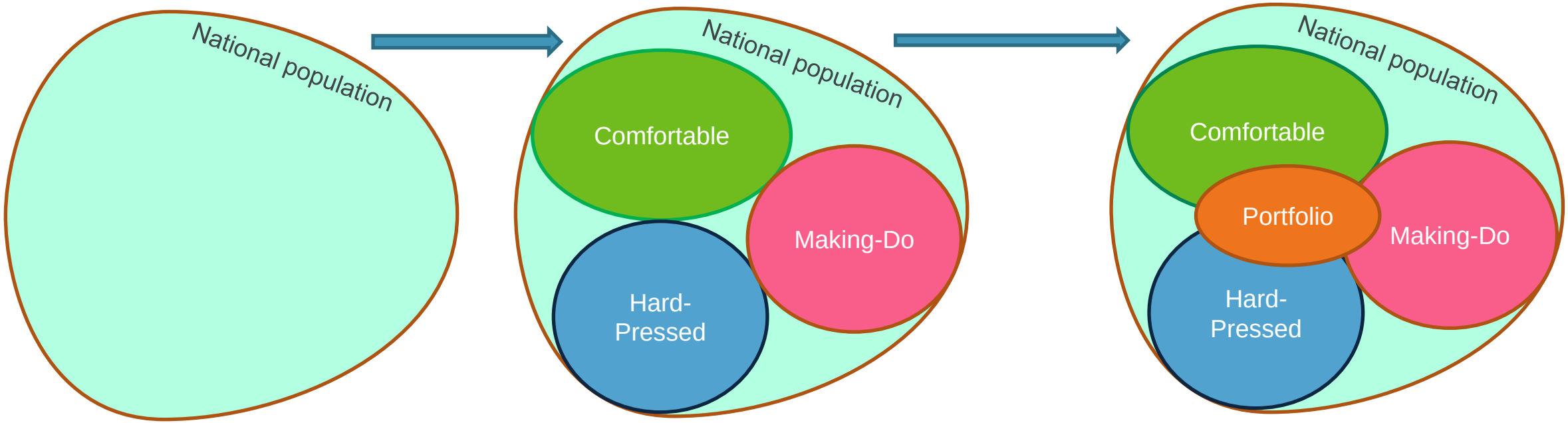
A 3-Tiered Mortality Model

Introducing the M7-M5-M5 model



Tier 1
National population
[M7 model]

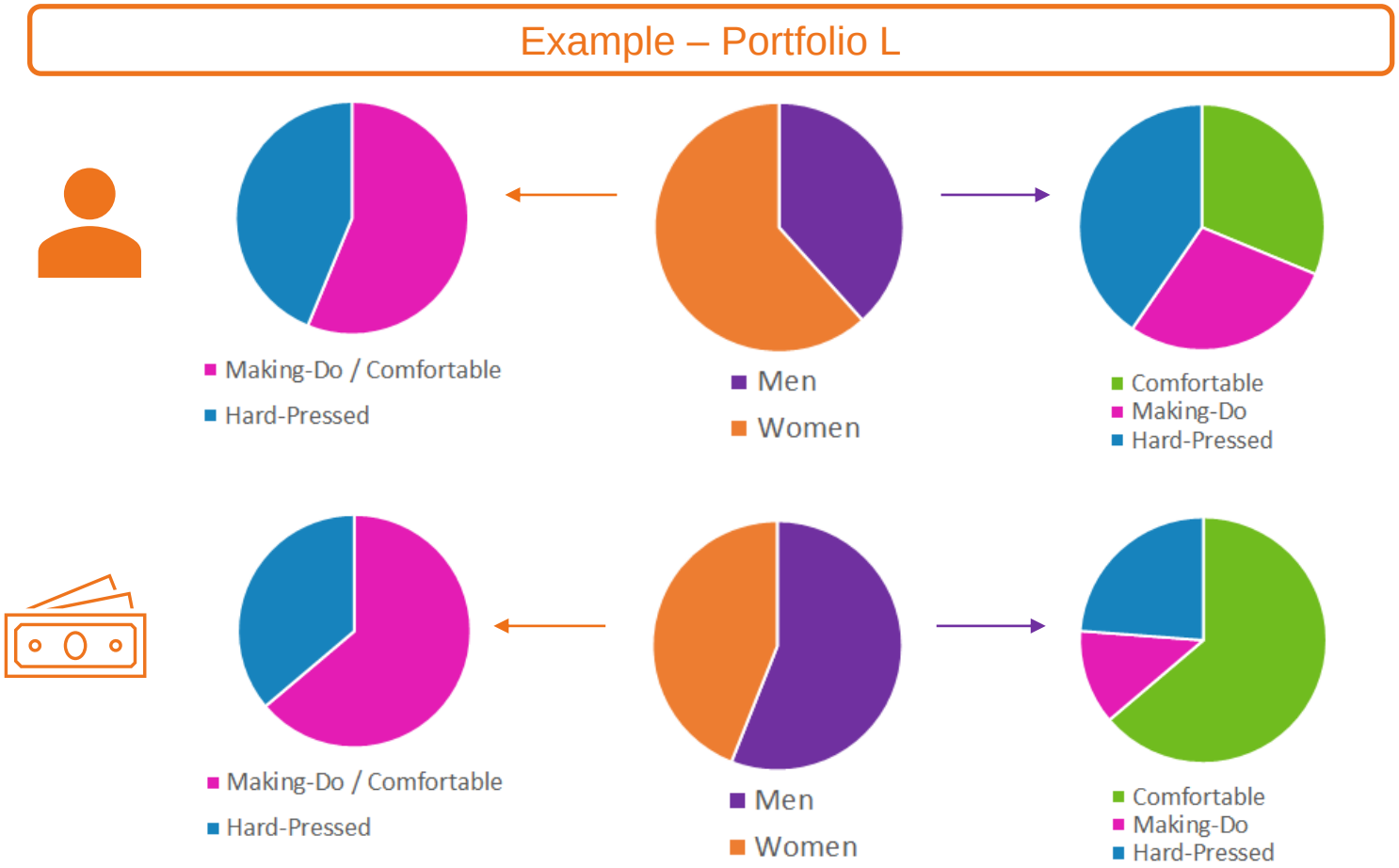
Tier 2
Club Vita Segments modelled as sub-populations of the national population
[Difference in mortality between "VitaSegments" and national population modelled using M5]

Tier 3
Portfolio modelled against a weighted average of the experience of each VitaSegment, in proportion to the profile of the portfolio
[Difference in mortality modelled using M5]

Example portfolios

Realistic portfolios used for analysis

- **Realistic** portfolios
- **Sampled** from within Club Vita dataset
- Each have 55,000 lives
- Designed to **capture variations in the socio-demographic mix** of pension plans
- Can be combined to create larger sample portfolios e.g. insurer blocks



Source: Portfolios created by Club Vita as realistic large PRT portfolios. Each of size 55,000 lives (pensioners and in payment dependants).

Example portfolios

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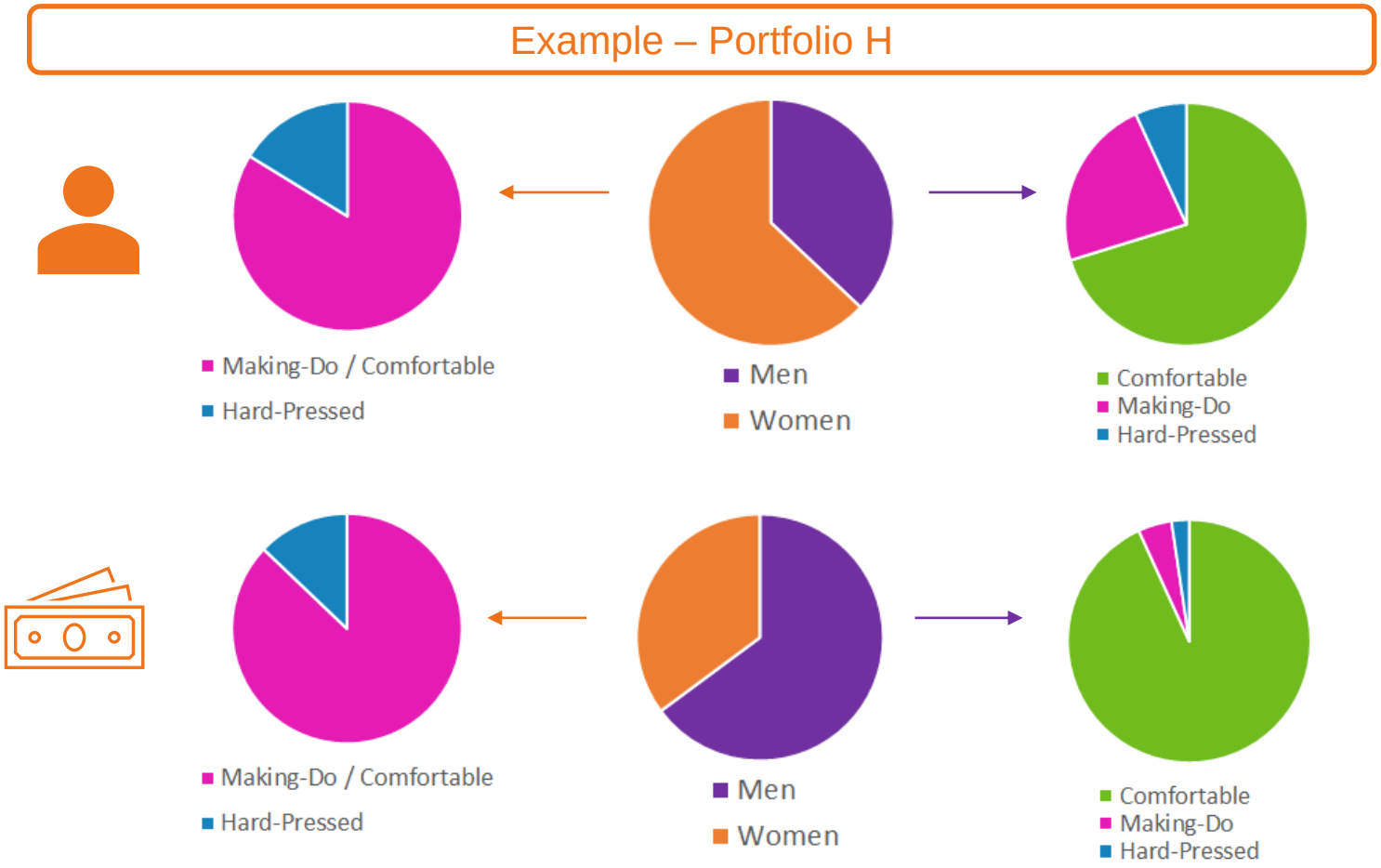
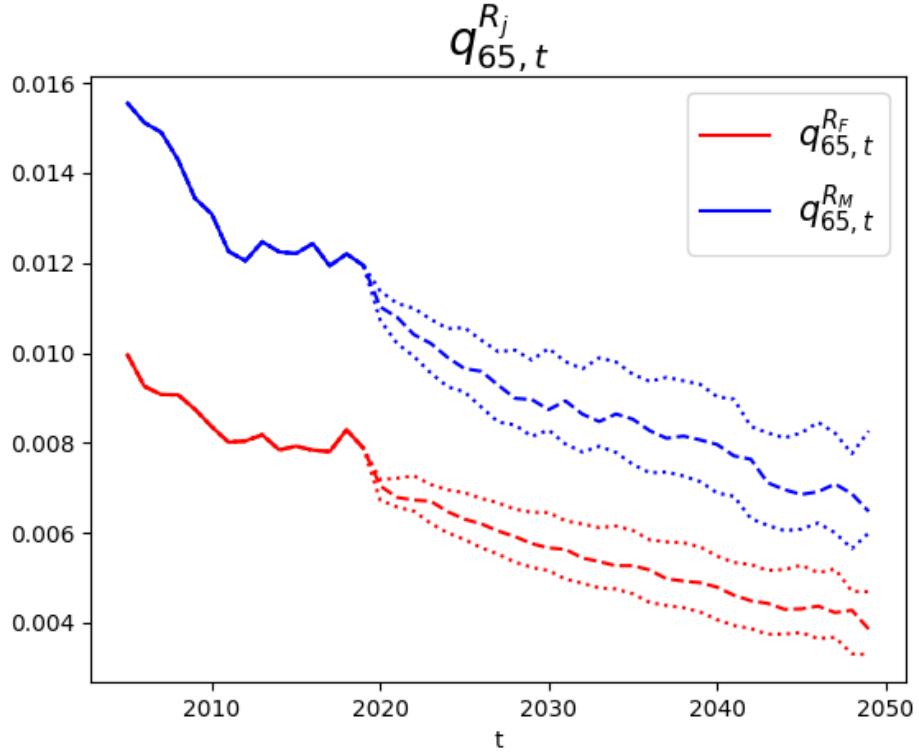


Source: Portfolios created by Club Vita as realistic large PRT portfolios. Each of size 55,000 lives (pensioners and in payment dependants).

Projected mortality

UK national population – central + simulated forecast

- National population (UK)
- Data sourced from HMD
- $q_{x,t}^{(R_j)}$: one-year death probability of gender j in the U.K. at age x in year t
- 2.5% and 97.5% quantiles (based on 10k simulations) of simulated $q_{x,t}^{(R_j)}$



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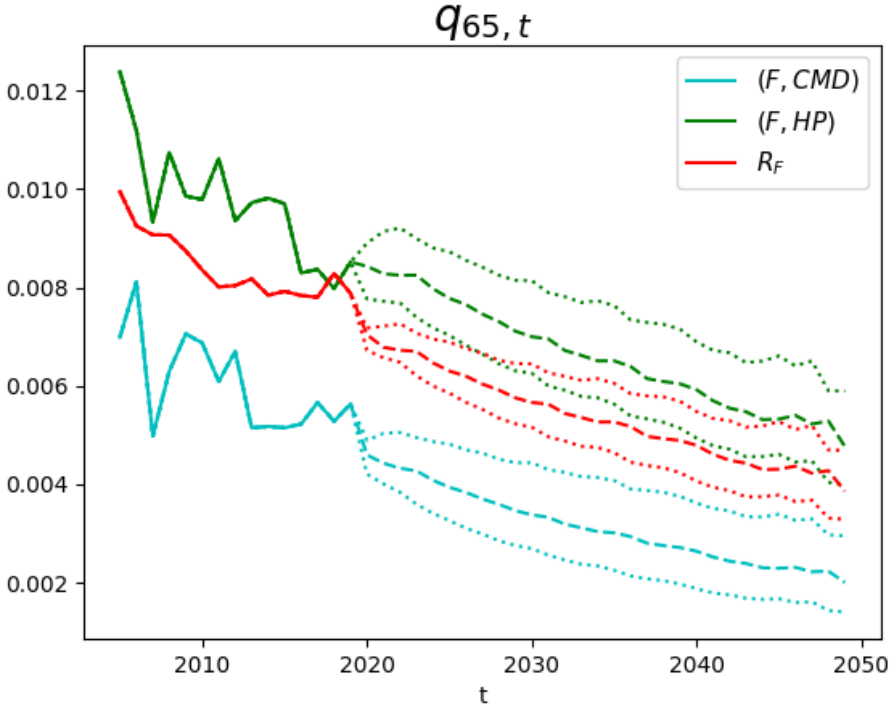
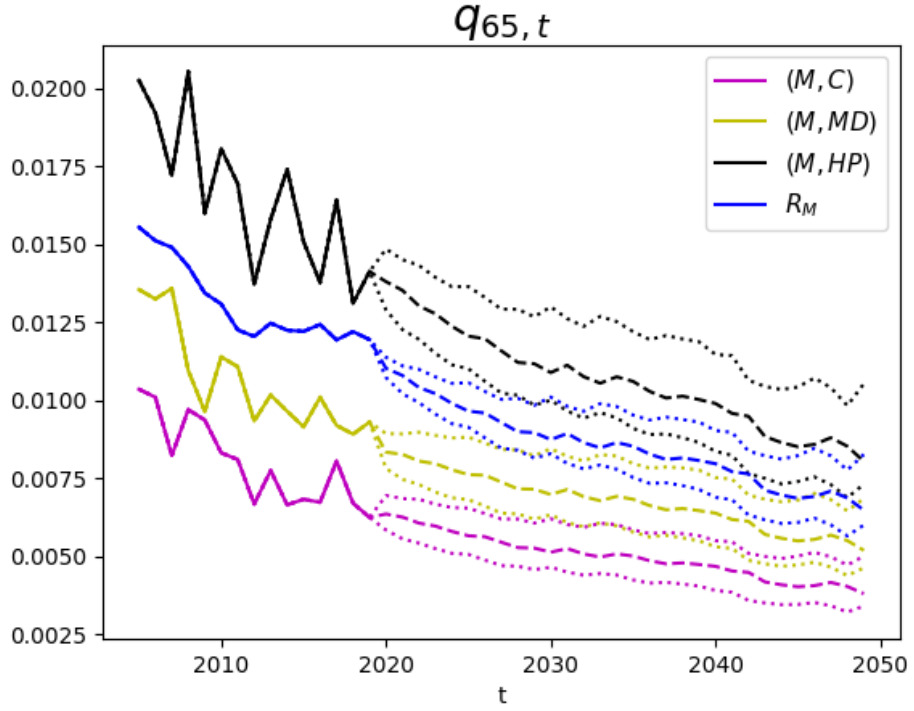
Source: Longitude Exchange modelling using data from Club Vita and Human Mortality Database.

Projected mortality

Club Vita's VitaSegments – central + simulated forecast

- 2.5% and 97.5% quantiles (based on 10k simulations) of simulated mortality
- National U.K. population + five socio-economic subgroups





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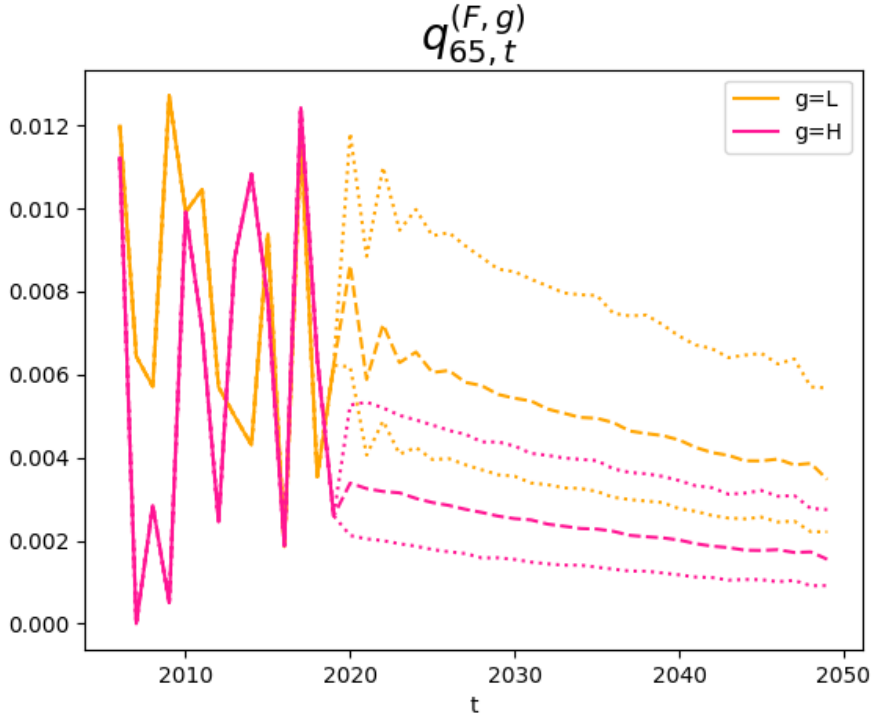
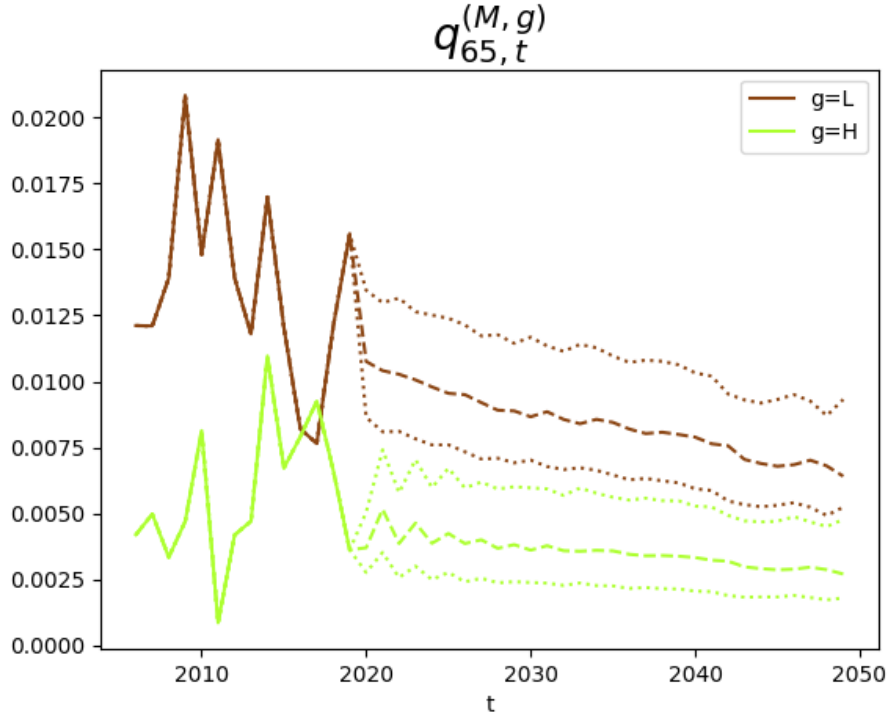
Source: Longitude Exchange modelling using data from Club Vita and Human Mortality Database.

Projected mortality

Portfolios – central + simulated forecast

- 2.5% and 97.5% quantiles (based on 10k simulations) of simulated mortality
- Two gender-specific portfolios
- Amounts-based simulation





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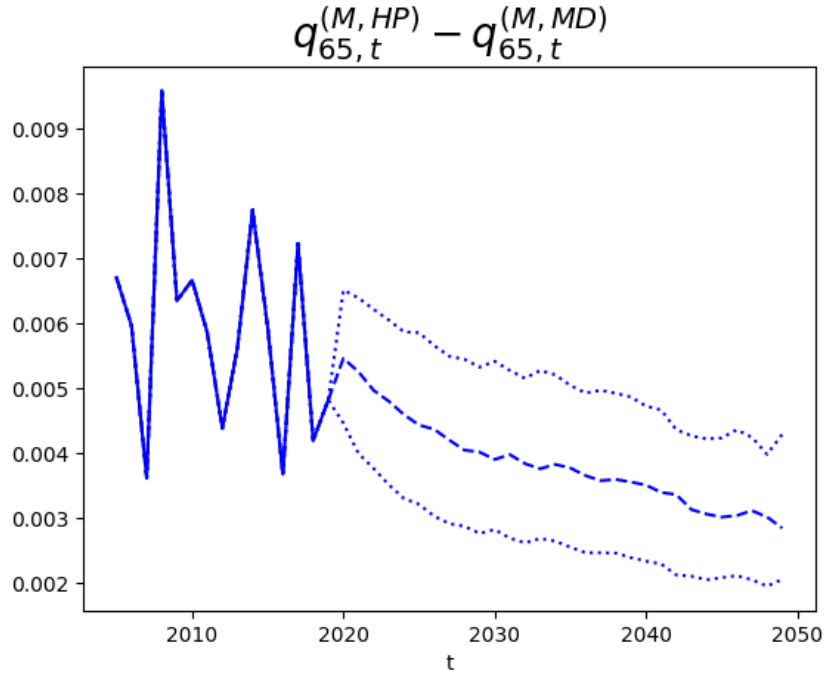
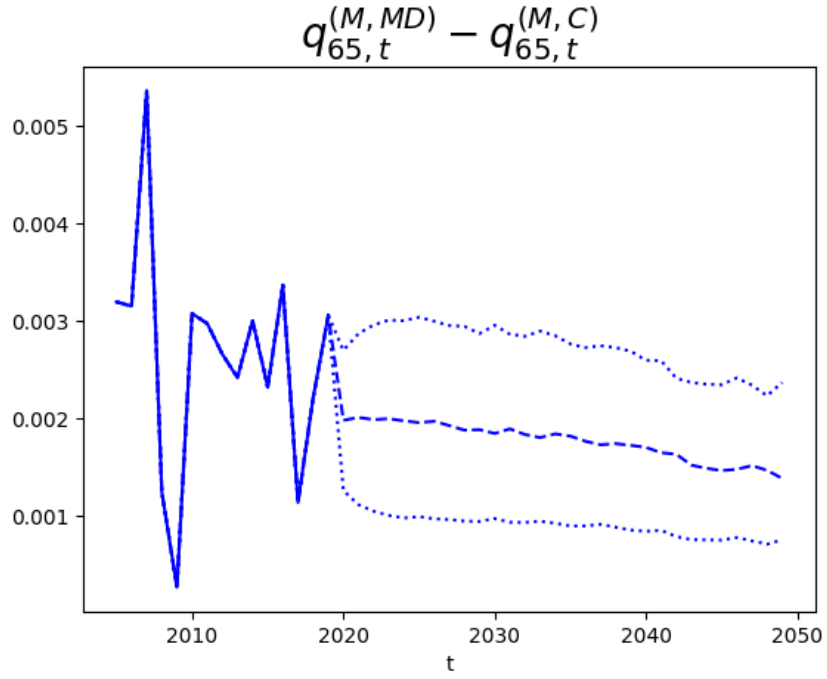
Source: Longitude Exchange modelling using data from Club Vita and Human Mortality Database.

Consistency of simulated mortality of sub-groups

- We have confirmed internal consistency of the model by analysing 2.5% and 97.5% quantiles (based on 10k simulations) of simulated differences in mortality
- Examples:
  - Difference between male subgroup HP and MD
  - Difference between male subgroup MD and C





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Source: Longitude Exchange modelling using data from Club Vita and Human Mortality Database.

Approach to assessing hedge effectiveness

- Calculate the risk reduction from implementing the hedge
- Compare risk metrics before and after the hedge is in place
- Comparison between weighted Club Vita indices and ONS-index
- Perfect hedge if hedge effectiveness equals 100%

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Hedge Effectiveness Results

Index based swap without commutation

1 Hedge effectiveness of up to **90%** can be achieved

	Risk metric	Club Vita (weighted combination)	ONS index	Absolute improvement	Relative improvement
Portfolio H	StDev	87%	79%	8%	39%
	TVaR 99%	89%	79%	10%	47%
Portfolio L	StDev	89%	83%	6%	34%
	TVaR 99%	90%	83%	7%	42%

2 Consistent with (top end) of previous studies which looked at range of time series approaches.

3 Using Club Vita index typically removes **one third to half** of residual risk.

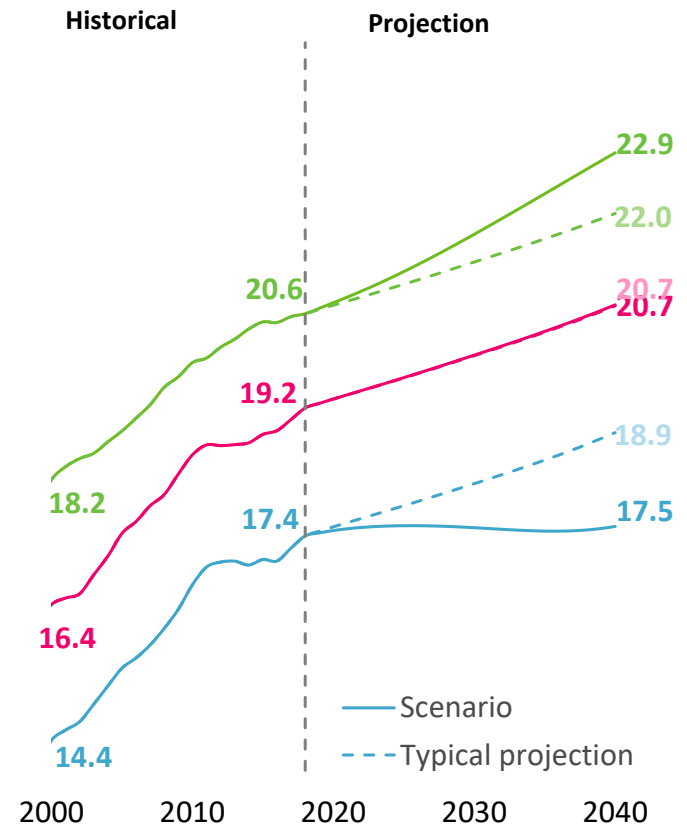
Expect this result to be replicated under alternative time series approaches.

Source: Longitude Exchange modelling using data from Club Vita and Human Mortality Database.

Returning to our "what if"?...

Future scenarios with divergent longevity for socio-economic groups

Scenario



Payoffs

- Based on a Best-Estimate Liability of £2bn we obtain the following Indemnity and Index Hedge payoffs under the "what-if" scenario for Portfolio H
- Indemnity Swap payoff = £43.1m
- ONS Hedge payoff = £0m
- Club Vita weighted index hedge payoff = £42.7m

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Source: Longitude Exchange modelling using data from Club Vita and Human Mortality Database.

Next steps of our analysis

Assess implications of other sources of risk on hedge effectiveness / structuring

✓ **Demographic Basis Risk**

Risk that the longevity characteristics of the index and the portfolio differ, leading to divergent trends over time.

? **Commutation Risk**

Risk that the commutation payment does not adequately capture the actual pattern of divergent trends beyond end of term of instrument.

? **Structuring Risk**

Reduced risk coverage e.g. from attachment and detachment points.

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5 Summary & Outlook

Summary slide

We are on track with the requirements for the next step in the evolution of the longevity market:

- New type of business models are currently being developed aimed at increasing ***efficiency*** and the introduction of a ***marketplace***
- Index-based instruments allow for ***standardization*** and can be constructed through the ***use of digital platform***
- Hedge effectiveness of these more standardized instruments is such that hedgers can use them to attract ***involvement of general capital market participants***

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Thank you

For questions after the event:

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Questions

Comments

Expressions of individual views by members of the Institute and Faculty of Actuaries and its staff are encouraged.

The views expressed in this presentation are those of the presenter.

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