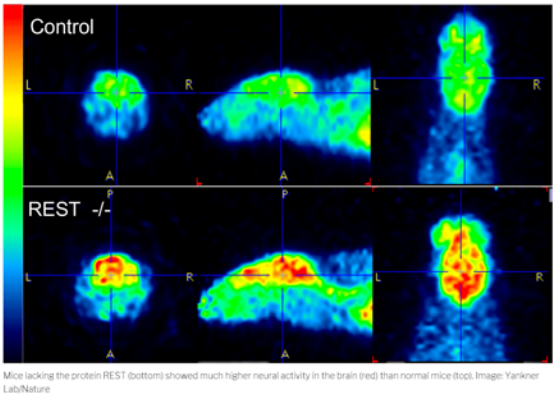
C2: Are we really all the same?
Evolving baseline and longevity improvement trends

Prepared for IFoA Highlights of the Life Conference

Steven Baxter, Head of Longevity Innovation & Research
Mark Sharkey, Head of Engagement
22nd November 2019

Apologies…
This talk may impact your longevity…



Mice lacking the protein REST (bottom) showed much higher neural activity in the brain (red) than normal mice (top). Image: Yankner Lab/Nature

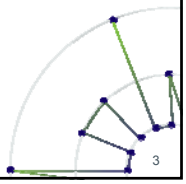
Source: https://hms.harvard.edu/news/new-player-human-aging

A tale of 3 countries

2008

2015

2019



PRT across 3 nations

Why socio-economics are of interest…

4

The big and the growing…

Respective PRT markets

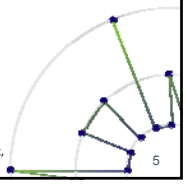
£24bn / £5bn

C$5bn / C$0bn

$27bn / $0bn

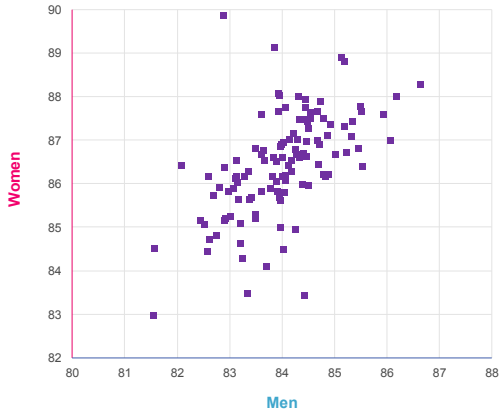
All three markets broadly doubled in size 2016-2018

All numbers relate to 2018. Numbers presented as buy-in + buyout / longevity swaps. Size of flags represent respective sizes of annual PRT markets allowing for exchange rates.
Sources: UK: Buy-outs, buy-ins and longevity hedging – H1 2019, Hymans Robertson; Canada: 2018 Pension Risk Transfer Report, Eckler; US: The U.S. Pension Risk Transfer Market, Willis Towers Watson



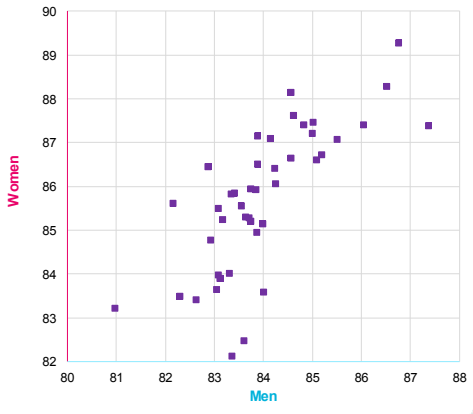
Not all pension plans are alike…

Expectation of life of a 65 year old in each scheme (2013-2017 data)

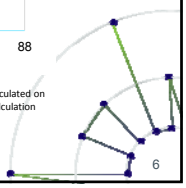


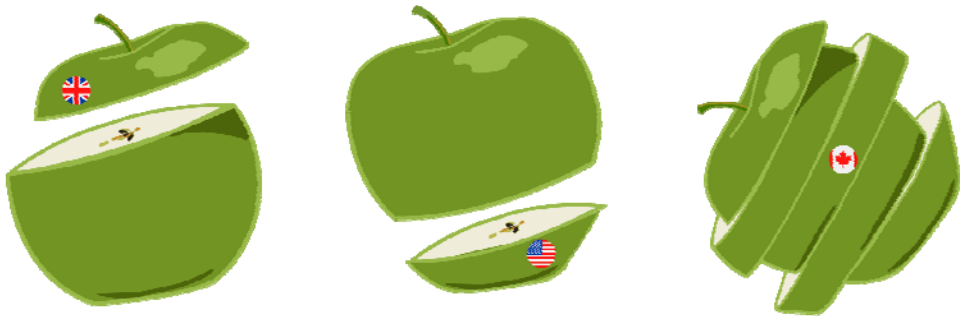
Source: Club Vita analysis of experience data from over 200 UK pension plans. Life expectancies calculated on a period basis and only shown for plans with sufficient data (volume and span of ages) to enable calculation of period life expectancy

Expectation of life of a 65 year old in each plan (2013-2017 data)



Source: Club Vita analysis of experience data from over 100 US pension plans. Life expectancies calculated on a period basis and only shown for plans with sufficient data (volume and span of ages) to enable calculation of period life expectancy





"Top", "bottom" and "thin" slicing

- Concentration of risk concerns[1]
- Segmentation often focusses on highest liabilities
- **Top slicing**

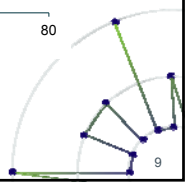
- PBGC levies contain significant fixed levy component[2]
- Segmentation often focusses on lowest pensions
- **Bottom slicing**

- Limits exist on protections on insurer solvency[3]
- Segmentation often focusses on quota sharing pensions
- **Thin slicing**

1. Typically 50% of a pension scheme's liabilities are concentrated in around 10-15% of the membership
2. The PBGC levy has a fixed and variable component. The fixed component is set at $83 for single-employer plans (2020 rate, see here)
3. Lifetime annuities are protected by Assuris (www.assuris.ca) upon insolvency of a life company. Protection is up to C$2,000 pm or 85% of the benefit amount, whichever is higher. ($2,0000 monthly limit only applies to buy-outs)

"Top", "bottom" and "thin" slicing

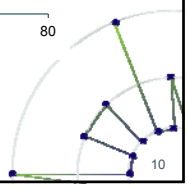
Source: Club Vita calculations based upon an illustrative UK pension scheme. Same illustrative scheme used for all three illustrations.



9

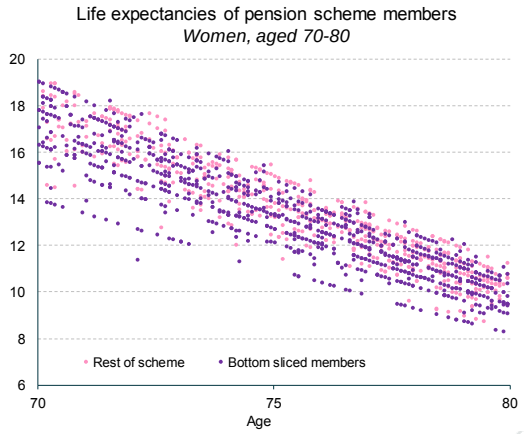
"Top", "bottom" and "thin" slicing

Source: Club Vita calculations based upon an illustrative UK pension scheme. Same illustrative scheme used for all three illustrations. Top slicing based on top 10% of pension amounts.

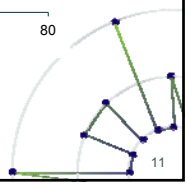


10

"Top", "bottom" and "thin" slicing



Source: Club Vita calculations based upon an illustrative UK pension scheme. Same illustrative scheme used for all three illustrations. Bottom slicing based on a annual pension amount below a certain level (£3,500 p.a.)



11

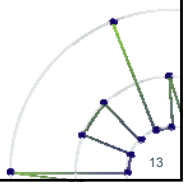
Socio-economic differences in baseline longevity

12

Modelling socio-economic differences
Using pension plan data from UK, US & Canada

			
Founded	2008	2015	2019
Key stats	**2.9m** UK pensioners **1 in 4** DB pension plan participants Over **230 pension plans** **1.4m** deaths Stretching back **25+ years**	**0.75m** Canadian pensioners **1 in 4** DB pension plan participants Over **60 pension plans** **200k** deaths Stretching back **20 years**	**0.8m** in payment participants Over **100 pension plans** **150k** deaths Stretching back **9 years**

A geographical and industry diverse dataset in each country



CLUB VITA

13

Building a model for longevity
Generalised linear modelling

The predictors j are the longevity group (A to G as determined by ZIP+4), annuity amount and collar type

Main effect for each predictor: Additions depending on the value taken by each predictor j (can be negative)

Controls for mortality rate variations between calendar years, and is 0 for central year

$$logit(q_x|values\ of\ predictors, j) = \sum_i a_i x^i + \sum_j b_j + \sum_{i,j} c_{ij} x^{-i} + \text{YOE}$$

$$logit(q_x) = \ln\left(\frac{q_x}{1-q_x}\right)$$

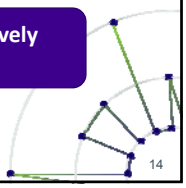
Main age function: A polynomial in age, x, with a small number of terms (typically 3 or 4) where i takes values in range $[-4, -3, \ldots, 3, 4]$

"Interaction" terms, whereby there is a small number of terms of the polynomial in age, x, which depend on the value taken by the predictor

Parsimony principle: A simpler model with few rather than many parameters is favored over comparatively complex ones, provided they fit the data about equally well.

Source: Club Vita, for more information see UK paper in BAJ, Canadian Inst. Actuaries paper, US Modelling Technical Paper.

CLUB VITA



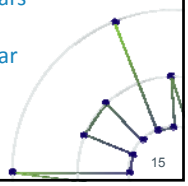
14

Not all pension plan participants are alike

Men, life expectancy from age 65

Total Spread	10.4 years	7.1 years	8.7 years
Retirement health	2½ - 3 years		
"Normal" health annuitants	8 years	6.7 years	7.7 years
Lifestyle	c. 4¼ years	c. 2¾ years	c. 3¼ years
Affluence	c. 3½ years	c. 2 years	c. 3¼ years
Occupation	c. ¼ year	c. 1¼ year	c. 1¼ year

Club Vita factor based modelling (GLMs). Effects shown are the impact of changing one rating factor in isolation. Precise impacts depend on order of changing variables and so above reflects broad quantum and therefore relative importance of each variable. In general a more affluent person will tend to have greater propensity to a healthier lifestyle and so the above effects do not reflect the impact as measured on a univariate basis. Estimate for impact of retirement health is omitted for Canada and US as currently the ill health / disabled retiree group not split out by additional rating factors.



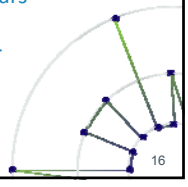
15

Not all pension plan participants are alike

Women, life expectancy from age 65

Total Spread	8.7 years	7.5 years	6.8 years
Retirement health	c. 3 years		
"Normal" health annuitants	5.7 years	5.7 years	5.9 years
Lifestyle	c. 4½ years	c. 3½ years	c. 3½ years
Affluence	c. ½ year	c. 2½ years	c. 1½ years
Occupation	c. ½ year		c. 1 year

Club Vita factor based modelling (GLMs). Effects shown are the impact of changing one rating factor in isolation. Precise impacts depend on order of changing variables and so above reflects broad quantum and therefore relative importance of each variable. In general a more affluent person will tend to have greater propensity to a healthier lifestyle and so the above effects do not reflect the impact as measured on a univariate basis. Estimate for impact of retirement health is omitted for Canada and US as currently the ill health / disabled retiree group not split out by additional rating factors.

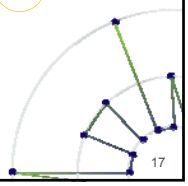


16

International comparisons

				
1	ZIP / postcode predictive	✓	✓	✓
2	Salary more predictive than annuity amount (men)	✓	✓	?
3	Public / private sector **not** predictive	✓	✓	?
4	Affluence *currently* less predictive for women than men	✓	✗	✓
5	Joint / single life annuity predictive		✓	?

Notes:
- "?" denotes we have not yet been be able to test this and so yet to confirm the translation to the USA of this insight. However, we very strongly suspect that we will find salary and JL/SL predictive.
- Joint / single life is not relevant in context of UK DB pension plans owing to statutory obligations on providing a survivors pension

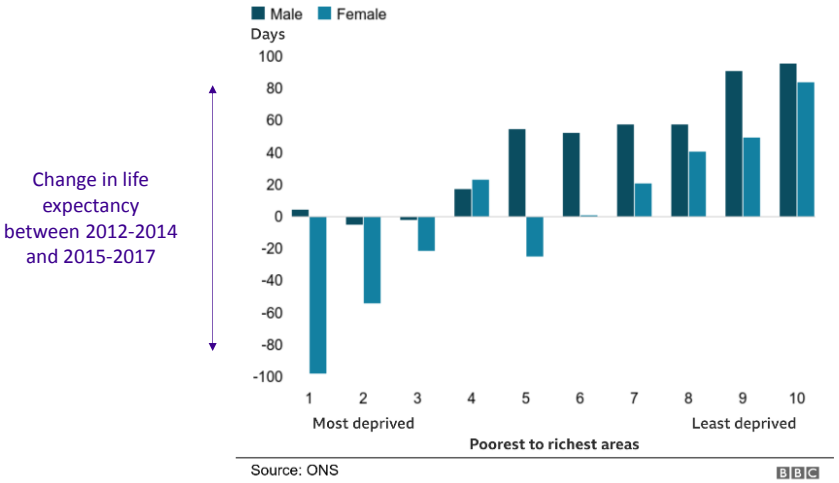


17

Socio-economic differences in longevity improvements

18

Mortality improvements by socio-economics
UK population



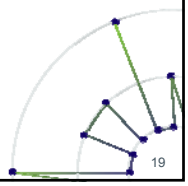
Change in life expectancy between 2012-2014 and 2015-2017

Longevity gap widened by

3 months

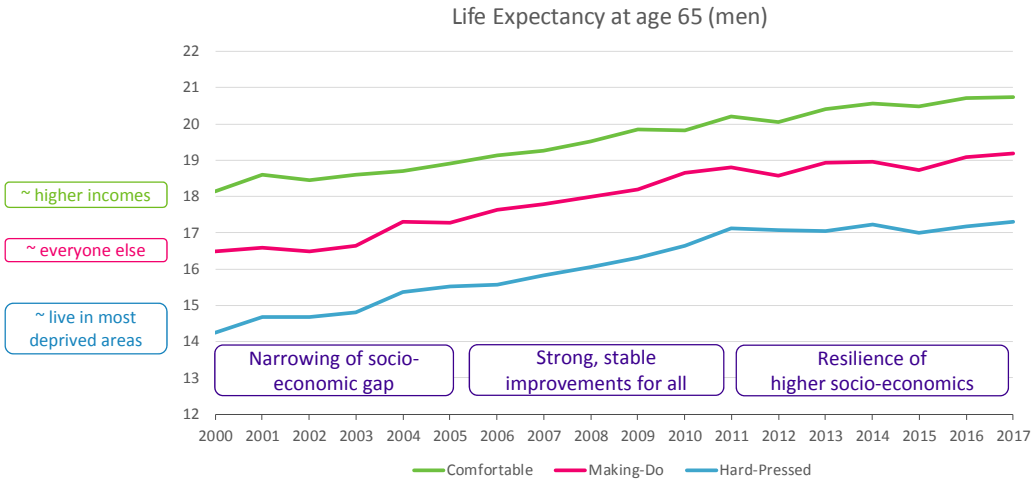
6 months

Source: BBC News version (https://www.bbc.co.uk/news/health-47721167) of ONS data analysis published on 27 March 2019
https://www.ons.gov.uk/peoplepopulationandcommunity/healthandsocialcare/healthinequalities/bulletins/healthstatelifeexpectanciesbyindexofmultipledeprivationimd/2015to2017



19

Mortality improvements by socio-economics
UK pension plans



c.1.5%-2% p.a.

~ higher incomes

~ everyone else

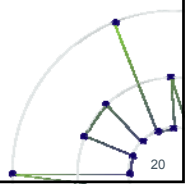
~ live in most deprived areas

Narrowing of socio-economic gap

Strong, stable improvements for all

Resilience of higher socio-economics

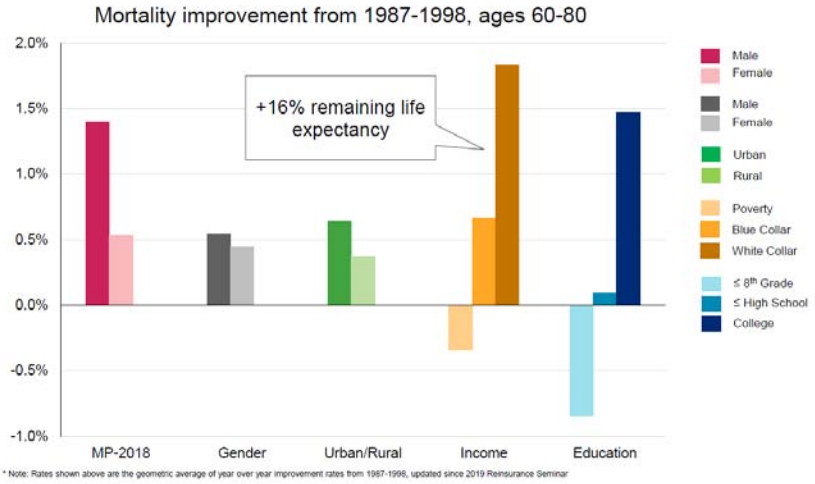
Source: Club Vita, Longevity Trends: Does one size fit all?
https://www.clubvita.co.uk/assets/images/general/170623_16_PLSA-Longevity-model.pdf



20

US socio-economic differences in improvements

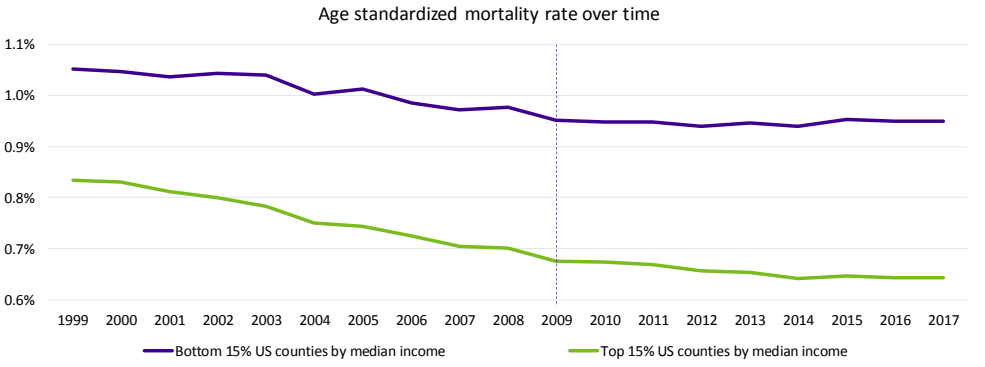
1987-1998: Strong socio-economic differences



Source: Mark Sprong, Oliver Wyman presentation to Society of Actuaries annual conference, October 2019, and based on data from the National Longitudinal Mortality Study. Reproduced with authors permission.

US socio-economic differences in improvements

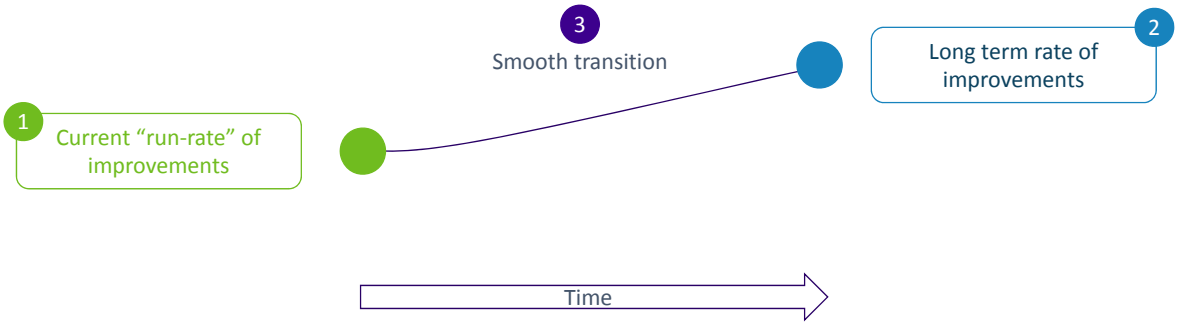
1999 onwards: Mortality fallen fastest amongst highest incomes



Annualised mortality improvements	1999-2009	2009-2017
Bottom 15% of counties by income	1.0% p.a.	0.0% p.a.
Top 15% of counties by income	2.1% p.a.	0.6% p.a.

Source: Club Vita calculations based on Society of Actuaries U.S. Population Mortality Observations, 2019

3 countries, one model?



3 countries, one model?

Initial rates (IR)	Fit APCI model to log of population mortality with user defined level of smoothing (S_κ)	Whittaker-Henderson smoothing of log of population mortality *2 year step-back*	Whittaker-Henderson smoothing of A/E ratios of log of population mortality *2 year step-back*
Cubics in..	Age-Period (AP) Cohort (C)	Age-Period (AP) Cohort (C)	Age-Period (AP)
Long term rate (LTR)	AP: User defined C: 0%	AP & C: 1% *(Default)*	AP: 1% *(Default)*
Tapering of LTR	Decline from age 85 to 0% at 110 AP only	Decline from age 85 to 0.85% at age 95 and 0% at age 115	Decline from age 90 to 0.2% at age 100 and 0% at age 105
Convergence period (CP)	AP: Variable – max 20 years C: Variable - max 40 years	AP: 10 years C: 20 years	20 years
Constraints	IRs; LTR and 0 slope at CP *plus* Direction of Travel *or* Proportion remaining at mid-point	IRs; LTR; slope 0 at start and at CP	IRs; LTR; 0 slope at CP Implied slope at start (subj to max)
Other		Improvements held constant (by age) beyond 20 years	Improvements held constant (by age) beyond 20 years

CMI framework common across countries; US & Canada based on pre CMI-2016 approach

Source: Club Vita summary of key features of core/default version of the model in each country. Note that UK includes richer advanced options including addition to initial improvements / constant addition to improvements.

Reflecting socio-economics in improvements

Building into the CMI framework

1 Current "run-rate" of improvements

3 Smooth transition

2 Long term rate of improvements

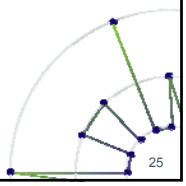
Allowance: Waves of convergence and divergence?

Allowance: Can socio-economic differences persist over longer term?

SEG	2011-2016 "run rate"
Comfortable	1.5% (±0.4%)
Making-Do	1.1% (±0.3%)
Hard-Pressed	0.7% (±0.3%)

Time

CLUB VITA



25

Reflecting socio-economics in improvements

Developments in US

Historical differences

Background and Purpose

Mortality improvement is an important assumption for projecting future liability cashflows and has a material financial impact on a company. Mortality improvement is a hot topic in the industry and companies show significant interest in understanding the key factors that differentiate mortality improvement. The focus of this research is to gain a better understanding of the following main drivers of mortality improvement:

- Socioeconomic level (Marital status, occupation, income, education)
- Gender
- Attained age
- Geographical and Demographical differences
- Cause of death
- Calendar year
- Birth-year cohort

Note that the above list is not meant to be exhaustive but merely examples of proposed factors that may be researched. The research will focus on the most impactful factors.

The purpose of this project is to assess how mortality improvement varies by the key elements listed above and identify other possible factors.

The conclusions reached from this study will assist direct insurers and reinsurers in setting their mortality improvement assumption.

Research Objective

The SOA Reinsurance Research Section is seeking researchers to review and analyze general population data. The researcher(s) will identify how mortality improvement varies by the key drivers and how these results derived from the population mortality analysis apply to the insured population. The researcher(s) will prepare a comprehensive report describing their model and their findings including plausible mortality improvement range as it applies to each group as well as describing how this research complements the existing research on this subject. This report will be made available to the SOA membership.

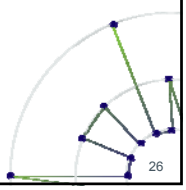
Source: https://www.soa.org/research/opportunities/2019-mortality-improvement-trend/

Projection modelling

1 Approach to "calibrating" RPEC (CMI) model to reflect SEG composition

2 CoD projection tool

CLUB VITA



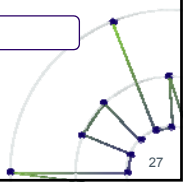
26

In summary
Evolving assumptions

Baseline	Improvements

• **Plan participant level assumption** now viable
• Automatically captures:
  • Generational variations
  • Different life expectancies amongst different sub-populations (e.g. "high" PBGC premium vs annuity participants)
	• Portfolio level SEG adjustments made to *population-based* improvements
	• Easy to capture current run-rate in existing modelling approaches
	• Care needed in subjective assumptions for the medium and long term improvements

Widely used	Widely used
Increasingly used	*Emerging*
Early adopters	*Emerging*



27

Thank you

28