RESEARCH NOTE 21-08

Longevity improvement rates for US defined benefit pension plan participants: examining widening life expectancy inequality

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LONGEVITY IMPROVEMENT RATES FOR US DEFINED BENEFIT PENSION PLAN PARTICIPANTS

EXAMINING WIDENING LIFE EXPECTANCY INEQUALITY

EXECUTIVE SUMMARY

Inequality in life expectancy in the US is increasing. Recent analysis by the Society of Actuaries has shown that mortality improvements since the 1980s have been far greater for the counties with the highest socio-economic status in the US compared to those with the lowest. But how much will this growing inequality affect participants of defined benefit pension plans?

Club Vita's new research shows that defined benefit (DB) pension plan participants have recently experienced much higher mortality improvements than the general US population (around 0.8% per year higher among over 65-year-olds). If this continues, the existing gap between DB pension plan participants and the US population will widen by around 1 more year by the late 2020s.

This raises the question of whether improvement scales calibrated to population-level data (such as the Society of Actuaries' MP scale) should be adjusted when projecting mortality rates for DB pension plan participants.

This growing inequality also highlights the need to capture the diversity of individual experience when estimating baseline mortality rates for pension plans.

INTRODUCTION

Life expectancy has been increasing over recent decades. Life expectancy at birth has risen from 60.9 in 1933 to 79.2 in 2019[1]. Many early-life deaths from infectious diseases have been eradicated and by the year 2000, deaths from heart disease in later life had shrunk to less than half their level in 1950[2].

However, these increases in life expectancy have not been shared equally throughout society. Research from Harvard University[3] highlighted that the life expectancy gap between high and low income groups rose between 2001 and 2014.

More recently, the Society of Actuaries commissioned research to explore the variation in life expectancy in different counties of the US. For life expectancy at 65 (the most relevant measure for pension plans), the difference between the longest- and shortest-lived counties in the US was around 3 years in 2018[4]. Our own research on pension plan records has shown this difference can increase to over 8 years when zooming in to allow for differences between ZIP+4 neighborhoods and other socio-economic factors[5].

This inequality in life expectancy has not always been this big. Back in 1982, the difference between the longest- and shortest-lived counties was only around 0.5 years. Life expectancies of longer-lived people in the US have increased at a faster rate than life expectancies of shorter-lived people. Life expectancy inequality is increasing and the COVID-19 pandemic is likely to further grow this disparity.

Historically, the pension and insurance industry has relied on relatively limited differences in life expectancy. Current (baseline) mortality has traditionally been measured against a reference mortality table split by gender and possibly occupation; while the pace of life expectancy changes of the overall US population average has been relied on for projecting future improvements to mortality rates. Growing gaps in longevity across society has two very important implications for pension plans and insurance companies committed to paying people lifetime benefits:

1. **Understanding your pension plan participants' current mortality:** With a wider spectrum of life expectancies at age 65, methods for measuring current (baseline) mortality that were appropriate in the past may be missing important variations.

   For example, standard tables that rely on all participants within a pension plan to have similar life expectancies, or for pension plans on average to have similar longevity are likely to miss these variations and may not give an accurate picture of pension plan liabilities.

2. **Identifying an appropriate allowance for future mortality improvements:** If some people in society have seen faster rises in life expectancy (and so mortality improvements), who are they? Are those people participants of DB pension plans?

   Methods for measuring mortality improvements that were appropriate in the past may no longer be appropriate. In particular, practitioners should understand the pros and cons of using improvement scales that rely on overall US population averages to project improvements for participants of DB pension plans.

In this paper we review the important recent Society of Actuaries research that shows how life expectancy inequality has increased at the county level in the US. We then present results of our own research into the pace of improvement in life expectancy among DB pension plan participants.

[1] From the Human Mortality Database: https://www.mortality.org/cgi-bin/hmd/country.php?cntr=USA&level=1

[2] https://www.prb.org/resources/u-s-trends-in-heart-disease-cancer-and-stroke/

[3] The Association Between Income and Life Expectancy in the United States, 2001-2014

[4] From Society of Actuaries analysis, measured by grouping counties into deciles based on socio-economic factors: https://www.soa.org/resources/research-reports/2020/us-mort-rate-socioeconomic/#excel

[5] https://www.clubvita.us/collaborative-research/zooming-in-on-zipcodes-whitepaper

INCREASING SOCIO-ECONOMIC INEQUALITY IN US LIFE EXPECTANCY

There is a growing body of work showing how the difference in life expectancy for different socio-economic groups in the US has been increasing over time. The most recent and comprehensive work on this subject was published by the Society of Actuaries (SoA) in 2020: Mortality by Socioeconomic Category in the United States[6] analyzes the differences in life expectancies of US counties grouped by a *Socio-economic Index Score (SIS)*.

The Socio-economic Index is based on factors such as educational attainment, income, unemployment rates, housing levels and employment type. Each US county is scored based on responses to the American Community Survey (ACS), ranked and grouped into deciles[7]. The research then computes and compares mortality rates for each decile, enabling an assessment of trends over time for different socio-economic groups in the US.

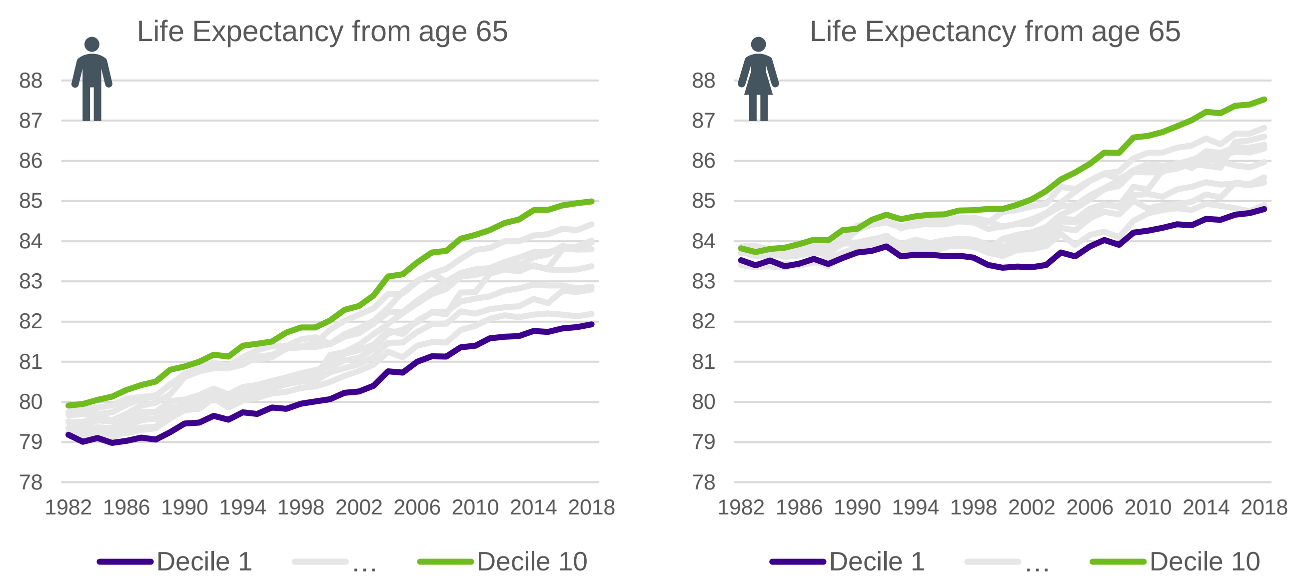
KEY FINDINGS IN THE SOA'S RESEARCH INTO SOCIO-ECONOMIC INEQUALITY

Life expectancy at age 65 is the most relevant measure for pension plans as it indicates how long an annuity would be payable for to a new retiree. The key findings for this measure (absent of any future changes in mortality rates) are captured in the chart below.

Over the last 40 years, improvements in life expectancy at 65 have been far greater for higher socio-economic groups and we see widening disparities over time. Back in 1982, there was very little difference between the highest and lowest socio-economic deciles of US counties (0.7 years for men and 0.3 years for women). By 2018 the gap between the highest and lowest socio-economic deciles had increased significantly to 3.1 years for men and 2.7 years for women.

This is important research that highlights increasing inequalities of life expectancy at a societal level. For pension

TRENDS IN (PERIOD) LIFE EXPECTANCY AT AGE 65 FOR US COUNTY DECILES BY SIS



Source: Club Vita graphics based on December 2020 version of SoA life tables by SIS decile as published on SoA website: https://www.soa.org/resources/research-reports/2020/us-mort-rate-socioeconomic/#excel

[6] https://www.soa.org/globalassets/assets/files/resources/research-report/2020/mort-socioeconomic-cat-report.pdf

[7] This is done separately for each edition of the ACS, so counties can change their rankings over time.

plans it also highlights the need to avoid a one-size-fits-all approach to mortality assumptions, both for current (baseline) mortality and for future improvement rates.

APPLICABILITY OF THIS WORK TO PENSION PLANS

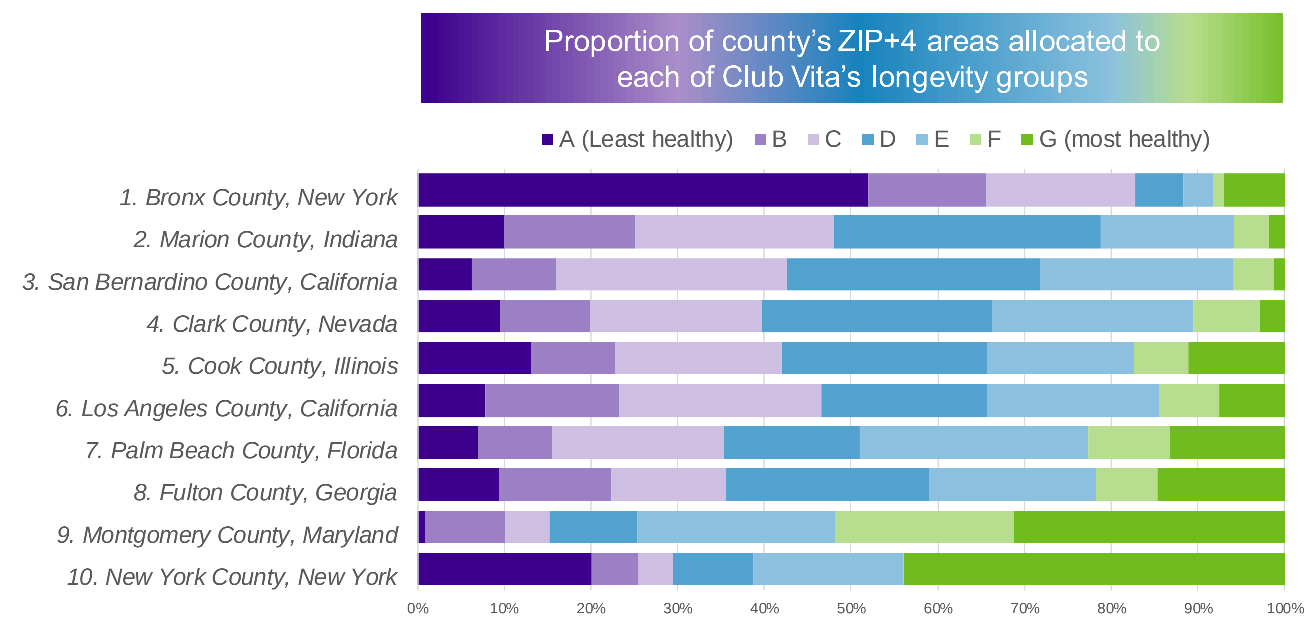
Despite the importance of this research in highlighting societal longevity trends, it is also limited by the use of county level averages in its analysis. Some counties in the US are home to millions of people (for example, Los Angeles county CA, Cook county IL and Harris county TX). Measuring the average socio-economics and mortality rates across counties will miss the diversity of individuals *within* each county. It fails to capture the growing longevity gap that could be occurring within each county and is therefore likely to underestimate significantly the actual inequalities present.

To illustrate this point we can use the groupings of US ZIP+4 codes created in Club Vita's *VitaCurves*[8] model. VitaCurves is a model for baseline mortality for US pension plans that captures differences in life expectancy using a number of predictors such as pension amount, type of work and ZIP+4 code. As part of the modeling process, we group all US ZIP+4 codes into "longevity groups" based on a number of socio-economic factors and common longevity experience, essentially grouping and ranking all ZIP+4 codes from A (low socio-economics) to F/G (high socio-economics).

In the chart below we have taken an example county from each of the deciles in the SoA's research and shown how the ZIP+4 codes within each example county break down into our socio-economic groups A to G.

The chart shows that the example county selected for each decile contains a wide diversity of socio-economic groups.

BREAKDOWN OF EXAMPLE COUNTIES FROM EACH DECILE OF SIS INTO CLUB VITA'S ZIP+4 MALE LONGEVITY GROUPS



Source: County deciles by SIS: as published on SoA website https://www.soa.org/resources/research-reports/2020/us-mort-rate-socioeconomic/#excel. Break down of ZIP+4 codes by county: Club Vita analysis using VitaCurves model.

[8] https://www.clubvita.us/collaborative-research/zooming-in-on-zipcodes-whitepaper

Bronx county in aggregate has a lower Socio-economic Index Score than New York County, but not everyone living in Bronx county will be from a low socio-economic group and not everybody living in New York County will be from a high socio-economic group. There will be individuals living in decile 1 that have higher life expectancy than some individuals living in decile 10 and vice versa.

Given the underlying diversity within each county, the increase in inequality in US life expectancy is likely to have been much greater.

RECENT IMPROVEMENTS IN LIFE EXPECTANCY FOR DEFINED BENEFIT PENSIONERS

Participants of DB pension plans may differ from the typical person in the US population. They have been healthy enough to be in regular employment, and with a paternalistic employer who offered a DB pension. For many this will also have meant employer-provided health coverage in the years prior to retirement, which in itself will mean these individuals are likely to be healthier when entering retirement. Further, many pension plan options such as lump sums, may be financially advantageous to those with health conditions that would limit their retirement years. This means DB pensioners are a 'select group', likely to have higher life expectancy than the US population as a whole, and potentially different rates of improvement over time. The key question we have sought to explore is:

Is life expectancy increasing more quickly for defined benefit pensioners than for the US population?

To answer this question, we analyzed a large data set of single-employer DB pension plan mortality data consisting of around 10,000 deaths per year over the period 2013 to 2018. A summary of the data set used, and the calculation methods can be found in the appendix.

KEY FINDINGS OF CLUB VITA'S RESEARCH INTO RECENT TRENDS IN LIFE EXPECTANCY FOR DB PENSIONERS

The charts on the next page show increases in life expectancy from age 65 for men and women over the period 2014-2017[9]. The green line shows the average life expectancy for the US population. The blue and purple lines show the average life expectancy for the data we have analyzed, the blue line capturing the average if all lives are weighted equally and the purple line if we weight each life by the level of pension benefit.

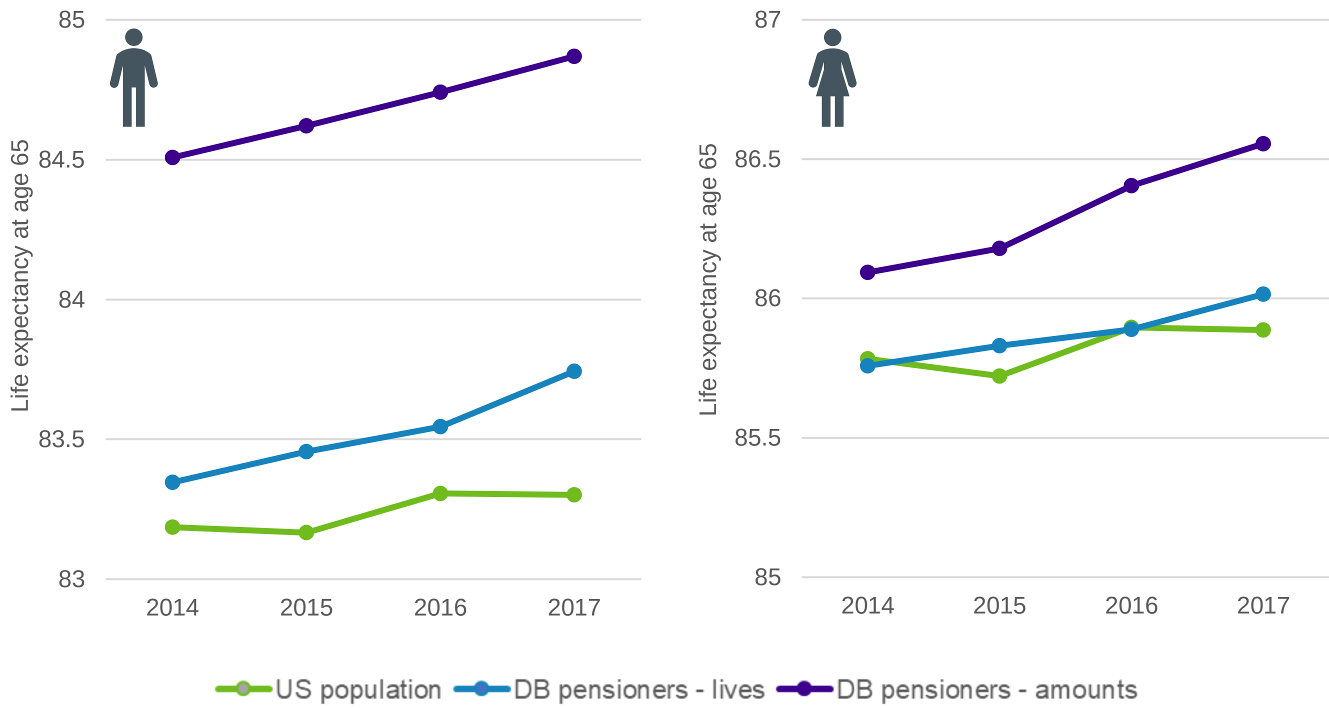
Key takeaways:

- The *difference* between the green and blue lines shows the beneficial effect of pension plan membership on longevity; participants in DB pension plans have longer life expectancies (although the effect is smaller for women than men).
- The *difference* between the blue and the purple lines shows the impact of affluence on life expectancy – more affluent pensioners, who will dominate pension plan liabilities, have longer life expectancies.

The pension plan lines have a *steeper slope* than the US population line, indicating that the pace of life expectancy has been faster for DB pension plan participants. This questions whether improvement scales based on overall US population level data are appropriate to use when valuing DB pension liabilities without adjustment.

[9] This is a shorter period than that covered by the data as we have calculated life expectancy for each year using mortality data over a three-year period to smooth out some year on year volatility.

LIFE EXPECTANCY AT AGE 65 – DB PENSIONERS VS US POPULATION



Source: Club Vita analysis 2021, details of data and methodology used in the appendix

HOW MUCH HIGHER HAVE MORTALITY IMPROVEMENTS BEEN IN PENSION PLANS?

To compare the improvement rates seen in pension plans with the US population we have compared the average mortality rates at the start of the period covered by our analysis (the three year period centered on 2014) with the average mortality rates at the end of the period covered by our analysis (the three year period centered on 2017). We have then calculated the annual rate of improvement (reduction) between 2014 and 2017. Since mortality rates vary by age, and the US population may have a different age profile to that of DB pension plan annuitants, we have calculated the average mortality rates based on a standard age profile. Known as age-standardized mortality rates (ASMRs) these are widely used as a means to calculate mortality rates in a consistent way between different populations to enable comparisons to be made.

The pension plan data we have used can also vary slightly from year to year by the pension plans covered (for example, some plans may transfer their obligations to an insurer and cease contributing to our data set). This can lead to variability of the socio-demographic mix of the data over time. To ensure any changes in mortality over time are improvements in mortality, rather than changes in the mix of individuals in the data, we have also standardized the mortality rates against a stable benefit distribution, known as age and benefit standardized morality rates (ABSMRs).

The resulting improvements for men and women are:

	Annual improvements in ABSMR (2014-2017)	
	US Population	**Pension Plans**
	0.6%	**1.4%** (±0.6%)
	0.5%	**1.3%** (±0.9%)

It is striking from this table that pension plan participants have experienced materially higher improvements in mortality rates in recent years.

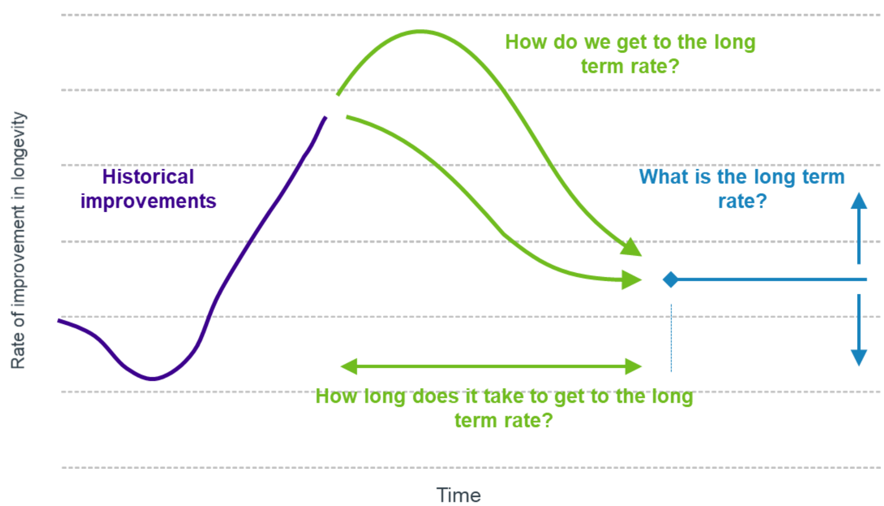
From 2014-2017, DB pensioners have seen more than double the rate of annual improvements in mortality rates than the US population

The plus/minus values shown in the pension plans column indicates the width of a 95% confidence interval around our results. For men the result is clearly significantly different for the US population[10].

ADJUSTING IMPROVEMENT SCALES TO REFLECT THIS INSIGHT

The most common improvement scale used for projecting future mortality rates in the US is the SoA's Mortality Improvement Scale MP-2020[11]. This scale is calibrated to US population data and uses an approach of determining the current rate of annual improvement in mortality rate at each age (initial rates) and blending these into a long-term rate[12]. This approach is stylized below[13]:

STYLIZED IMPROVEMENT MODEL STRUCTURE



Source: Club Vita stylized graphic

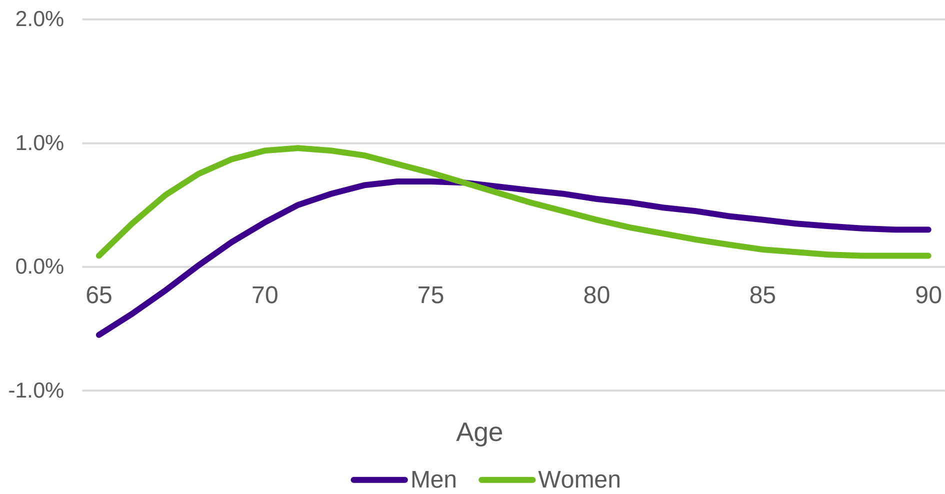
[10] The confidence interval for women is wider than for men reflecting the lower data annuitant volumes available for women. (We have excluded surviving beneficiaries as they tend to have elevated mortality vs annuitants and so can distort the analysis.)

[11] https://www.soa.org/globalassets/assets/files/resources/experience-studies/2020/mortality-improvement-scale-mp-2020.pdf Updates to this scale are released each year. Note that slightly different population data underpins that scale to the data used in the SoA county level study. We have used the county level study results to compute the age standardized mortality rates and improvements shown in the table earlier.

[12] This long-term rate is pre-specified in the model and varies with age, declining rapidly at the oldest ages. The pre-specified level is based on long term historical rates observed in Social Security data.

[13] The SoA MP scale separates improvement rates by those which vary over time by age (age-period) and those which may be specific to a birth cohort. A similar approach to the stylized diagram is applied in both directions. The SoA had just prior to publication of this note released an updated Mortality Improvements Model (MIM) which offers some addition flexibilities, including for the user to specify some features of the progression from the initial rates to the long-term rate.

MP-2020 “INITIAL RATES”



Source of MP20 initial rates (shown for 2016): https://www.soa.org/globalassets/assets/files/resources/experience-studies/2020/mortality-improvement-scale-mp-2020.pdf

The initial rates from the most recent edition of the model, the MP-2020 scale, are shown in the chart above.

There are several ways that the insights from our analysis could potentially be used to adjust population-based improvement scales like the MP-2020 series:

- **Assuming the gap between DB pension plans and the population is short lived:** This would be consistent with increasing the initial rates in MP-2020 by around 0.75% - 1% to align with our results above.

  A 1% increase to initial rates increases cohort life expectancy at age 65 by around 0.5 to 1 year, or around a 2-4% increase in present value of liabilities depending on the level of net discount rate.

- **Assuming the inequality in improvements will persist for many years:** This would suggest increasing both the initial and long-term rates by around 0.75% - 1% in MP-2020.

  A 1% increase in both initial and long-term rates would result in an increase in cohort life expectancy from 65 of around 1 to 2 years, or around a 4-8% increase in present value of liabilities.

Of course, it is also possible for the observed disparity in improvements between DB pensioners and the general US population to reduce in the future. Ongoing monitoring of the emerging data will allow us to stay informed about any changes to ongoing trends.

CONCLUSIONS

Longevity improvements are being felt very differently across different sections of society. Members of DB pension plans have seen much faster improvements in mortality rates than the general population over recent years.

This has two very important implications for pension plans and insurance companies committed to paying people lifetime benefits:

1. **Understanding your pension plan participants' current mortality:** With a wider spectrum of life expectancies at age 65, methods for measuring current (baseline) mortality that were appropriate in the past, may be missing important variations.

   For example, standard tables that rely on participants within pension plans to have similar life expectancies, or for pensions plans on average to have similar longevity are likely to miss these variations and may not give an accurate picture of pension plan liabilities.

2. **Identifying an appropriate allowance for future mortality improvements:** If some people in society have seen faster rises in life expectancy (and so mortality improvements), who are they? And are those people participants of DB pension plans?

   Methods for measuring mortality improvements that were appropriate in the past, may no longer be appropriate. In particular, improvement scales that use a US population-wide average to project improvements for participants of DB pension plans.

As the Club Vita data set grows, we intend to update this analysis to incorporate a longer historical period, to reduce the confidence intervals around our results and to explore differences in mortality improvements between more granular socio-economic groups.

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APPENDIX

DATA

Our analysis is based upon data pooled from US single-employer defined benefit pension plans sourced from the Mercer Longevity Database (“MILES”) dataset.

We have restricted this dataset to those records where we are able to reliably map both current annuitants and historical deaths to the county level SIS scores used in the SoA study (to enable comparisons to be made). In addition we have limited the data to plans which contribute to the dataset both in the early (pre 2016) and last years (2019) to avoid the potential for plan entries / exits to cause a false impression of a “jump up” or “jump down” in mortality. We have also focused on the annuitant data throughout.

The charts below show data volumes underpinning the analysis in this paper.

SUMMARY OF METHODS USED

CALCULATION OF OBSERVED MORTALITY RATES

For each year, gender, and as applicable SIS group, we have calculated crude, observed mortality rates (q_x) based on age nearest birthday at 1 January of the calendar year. We have relied on the exposures and deaths supplied in Mercer’s MILES dataset for this purpose. These are generally calculated on a lives basis, except for the all-plan amounts based life expectancies where the exposures and deaths have been multiplied by the benefit amount to provide amounts based mortality.

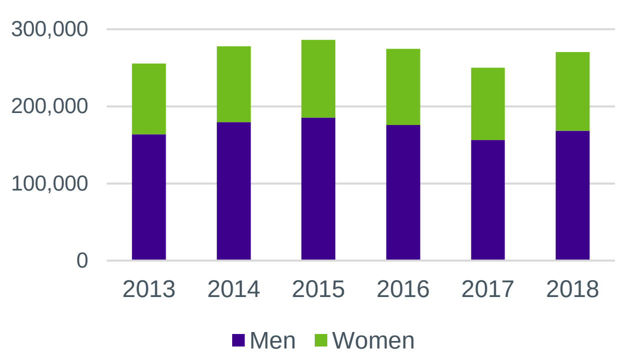
In order to control for the potential variation in benefit amounts over time these crude mortality rates are computed from each of three benefit amount bands (broad terciles of distribution of benefits in 2016, specific to men and women). For each year, gender and as applicable SIS group, benefit standardized mortality rates are then calculated as weighted average across benefit groups based on 2016 weightings

In order to smooth out volatility from year to year we take a three-year average of the resulting mortality rates and treat these as applying in the middle year [14].

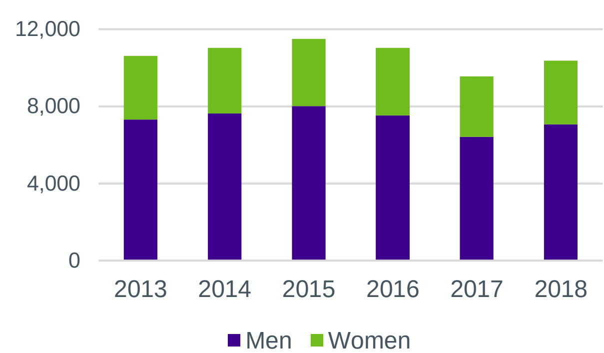
SMOOTHING MORTALITY RATES BY AGE

The resulting mortality rates for each calendar year are smoothed across ages 65-95 using a Gompertz formula, fitted using least squares optimization.

EXPOSED TO RISK BY CALENDAR YEAR



DEATHS BY CALENDAR YEAR



[14] Alternatives such as computing a mortality rate from the three year exposures and deaths were also considered. The three year average of the mortality rates is more robust to changes in the composition of the data year on year, avoiding risk of distortions to the improvement rates.

EXTENDING THE MORTALITY RATES TO OLDER AGES

In order to compute life expectancies, we need to have mortality rates (life tables) which extend beyond the oldest ages with robust data in the MILES dataset (broadly above age 95). Our extensions to older ages use a consistent approach to that used in the SoA analysis to ensure comparability in our results. A Kannisto model is fitted to the data for ages 80 upwards and we blend into this model linearly between ages 85 and 95, fully relying on it for ages above 95[15]. An ultimate age of 110 is used in the life table for consistency with the 110+ top age in the life tables accompanying the SoA research.

AGE STANDARDIZATION

Age standardization has been performed using the American Community Survey 2010 population age profile.

LIFE EXPECTANCIES

Life expectancies for DB annuitants use usual methods of computing life expectancy from q_x values. Life expectancies for population level data taken directly from the published life tables accompanying SoA data.

RELIANCES & LIMITATIONS

[15] Note that we deliberately use the Gompertz rather than the Kannisto model to smooth over the ages where we have most data as it provides a better fit. The Kannisto model is most suited to the fitting at the oldest ages.