CLUB VITA

Zooming in on ZIP codes

Using socio-economic factors to tailor US pension plan longevity assumptions

How long retirees live is a key assumption when valuing pension promises. There is ever stronger evidence of variation in lifespan across US society[1]. Given that differences in life expectancy are recognized to be largely driven by lifestyle rather than genetic make-up, how can plan sponsors tailor their longevity assumptions to reflect the characteristics of their participants?

Club Vita has teamed up with Mercer to calibrate our "VitaCurves" longevity model to US pension plan participants. By harnessing the wealth of information captured by 'zooming in' on each participant's ZIP+4 code, together with other key factors such as gender, annuity amount and retirement health, Club Vita can capture the diversity of your pension plan's demographics, increasing the accuracy and efficiency of longevity modeling.

Our analysis identifies that data readily available in plan records explains differences in life expectancy at age 65 of over 8 years. Using the VitaCurves model to zoom in on the specific characteristics of individuals within pension plans results in increases and decreases of liabilities of up to 6% relative to the standard Society of Actuaries tables. With a reduction in liabilities on average, most plans may be unconsciously over-valuing their liabilities.

Introducing Club Vita

Club Vita is a club for pension plans to share data on how long people live. As with many things, the whole is far greater than the sum of its parts and each member of the Club gets far more out than they put in.

By pooling a 'big data' set from all contributing members, Club Vita can develop statistical longevity models far more accurate and predictive than would be possible by analyzing data from individual pension plans alone.

The size of the data set reduces the statistical noise. By collecting full, rich data, including ZIP+4, blue/white collar and affluence measures such as salary and pension amount, Club Vita can develop models that capture the true diversity of each pension plan.

In this paper we set out the details of the first calibration of our unique VitaCurves model for longevity.

If any of the technical terms in this paper are unfamiliar to you, you can find definitions and related terms in our online Lexicon of Longevity. Just visit www.clubvita.net/glossary and search for a term.

Club Vita needs you!

We're very excited about the first generation of the US VitaCurves model, but we are just getting started... Next on our list is to refine VitaCurves further, by exploring more potential ratings factors such as salary, retirement options, industry and marital status. We will also test whether there are any differences between public sector and multi-employer plans (differences in longevity between the public and private sectors in the UK and Canada were found to be less significant when affluence and ZIP code was used).

Then we will turn our attention to analyzing the historical trends in survival rates, split by socio-economic factors. The insights become more powerful with larger data volumes: our Club is much more powerful for all involved when individual plans collaborate to share data.

We'd like to invite all large pension plans (whether single-employer, multi-employer or public sector) to try out our Club by helping us build our data set, improve our VitaCurves model and enable further research and market development. If you'd like to know more, get in touch today.

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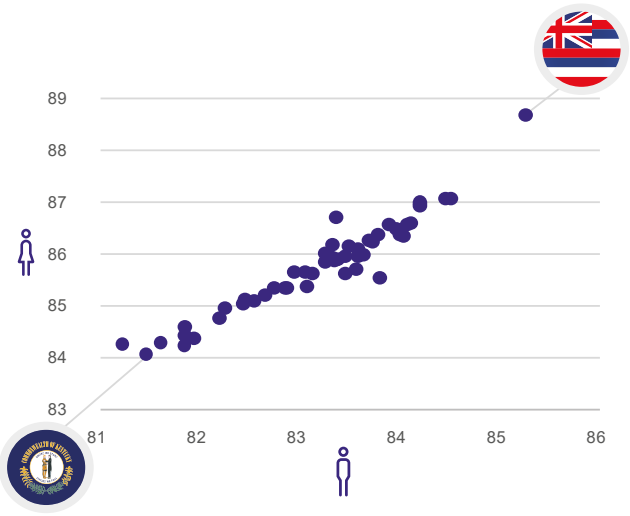
[1] See for example, https://www.cdc.gov/nchs/data/series/sr_02/sr02_181.pdf or https://jamanetwork.com/journals/jama/article-abstract/2513561

A diverse nation

The United States is a diverse nation made up of a wealth of people with distinctly different characteristics. This diversity is particularly noticeable when you analyze life expectancy.

Figure 1 shows the average life expectancy for men and women for each state in the US. Each state itself is made up of a diverse mix of people, but even so the state average life expectancies are very different from state to state, with over a four-year difference in life expectancy from Kentucky to Hawaii.

Figure 1:
Life expectancy from age 65 for different states (2016)



Source: Club Vita analysis of United States Mortality Database (https://usa.mortality.org/)

What is contributing to this diversity and how can pension plans account for it when setting their longevity assumptions?

Nurture, not nature

Many believe that longevity is passed down through the genes we inherit from our parents, but research suggests that only about 20% of the differences in life expectancy comes from our genes[2]. The rest is driven by external factors such as lifestyle and environment.

Some key characteristics that indicate how long someone will live include their level of education, whether they smoke, how much exercise they get, the type of job they have, how wealthy they are or even how much sleep they get. Many of these factors are not possible for pension plans to measure, however, we can use the data fields that pension plans do hold to create effective proxies.

How can pension plans capture this diversity?

The following drivers of longevity can be captured by data fields routinely held by pension plan record keepers:

Longevity driver	Data item used as a proxy
Lifestyle (level of education, propensity to smoke, etc)	ZIP code
Affluence	Ideally salary, otherwise pension amount
Retirement health	Disabled or normal health retirement
Occupation	Blue or white-collar worker

Categorizing participants using these different data fields (often referred to as "rating factors") gives us a granular method for understanding a pension plan's demographics. By comparing each participant to the experience of other participants in the Club Vita data set with similar characteristics, we can then derive a longevity assumption appropriate for valuing that participant within the plan.

Zooming in

We've seen that longevity varies state to state. This is largely driven by the different lifestyles of people living in different places. But can we zoom in further and capture more diversity using details about where people live?
Marketers have long appreciated that analyzing ZIP codes helps them spend their budgets more wisely. Pension plan sponsors can repurpose these techniques to refine their understanding of the longevity of their people.

[2] See for example,
https://www.ncbi.nlm.nih.gov/pubmed/9686488 or https://www.ncbi.nlm.nih.gov/pubmed/12537858

Capturing lifestyle effects using ZIP code

Where someone lives can tell us a lot about their lifestyle and therefore about how long they are expected to live. This information is encoded within the 9-digit ZIP code (commonly known as the ZIP+4 code), but how do we get to it? First, we repurpose some key principles used by marketers.

Marketing principle 1

People living in the same neighborhood have similar characteristics

People living in the same neighborhood tend to have similar characteristics (such as lifestyle, household size or level of education). We've picked out two such neighborhoods in the map below. It's worth noting that these areas are not very big, you only have to travel one block to find different types of people. The green and purple neighborhoods actually have very different characteristics despite both being in the same 5 digit ZIP code.

Marketing principle 2

Neighborhoods can be characterized by the types of people living there.

The characteristics of people living in the purple and green neighborhoods are very different. We have used a system which classifies every ZIP+4 code area in the US by the characteristics of the people living there. The neighborhoods in the map are described in the table below.

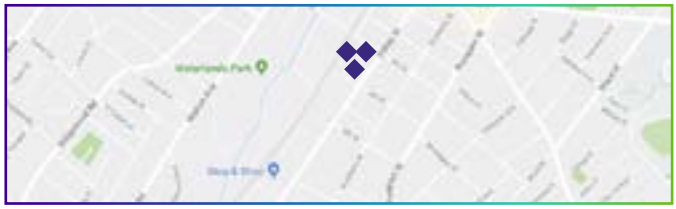
	Typical characteristics
High socio-economic area:	Average number of children; owning detached houses; nuclear families; higher education; below average unemployment; urban dwellers, work in financial, technological, management and public sectors.
Low socio-economic area:	Above average number of children; renting apartments; extended families; not or only graduated high school; high unemployment; urban dwellers, work in admin or hospitality sectors.

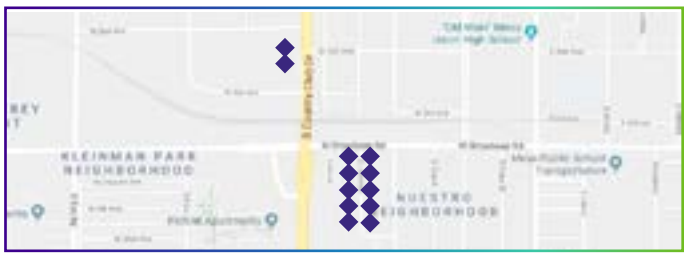
Marketing principle 3

Neighborhoods with the same characteristics appear all over the country.

Once a neighborhood has been classified using the characteristics of its residents, we find that there are many other neighborhoods with similar characteristics that appear all over the US. The maps below show neighborhoods in New Jersey, Alabama and Arizona that share the same lifestyle characteristics.

While there are over 46 million ZIP+4 codes in the US, this marketing classification puts each ZIP+4 code into one of 58 different types of neighborhoods.





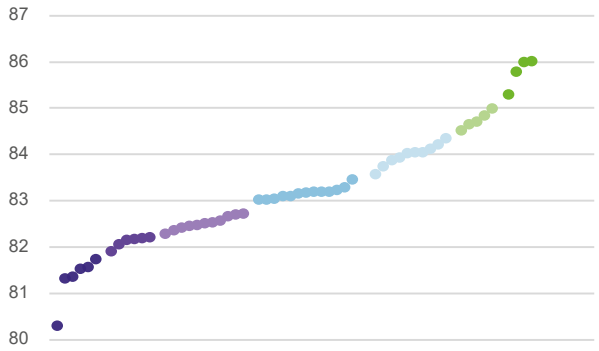
Longevity modeling principle:

Neighborhoods with similar characteristics have similar longevity

We analyze longevity experience data for people living in each of the different marketing groups and order them from shortest life expectancy to longest life expectancy. We then use a clustering algorithm to simplify the classification of ZIP+4 codes by combining the marketing groups that have similar longevity experience.

This process gives us 7 groups exhibiting distinct longevity experience for men (see Figure 2 to the right) and 6 for women. We color-code these "longevity groups" from purple to green as follows:

Figure 2:
Crude Life expectancy at age 65, men, split by marketing groups, colored by longevity group



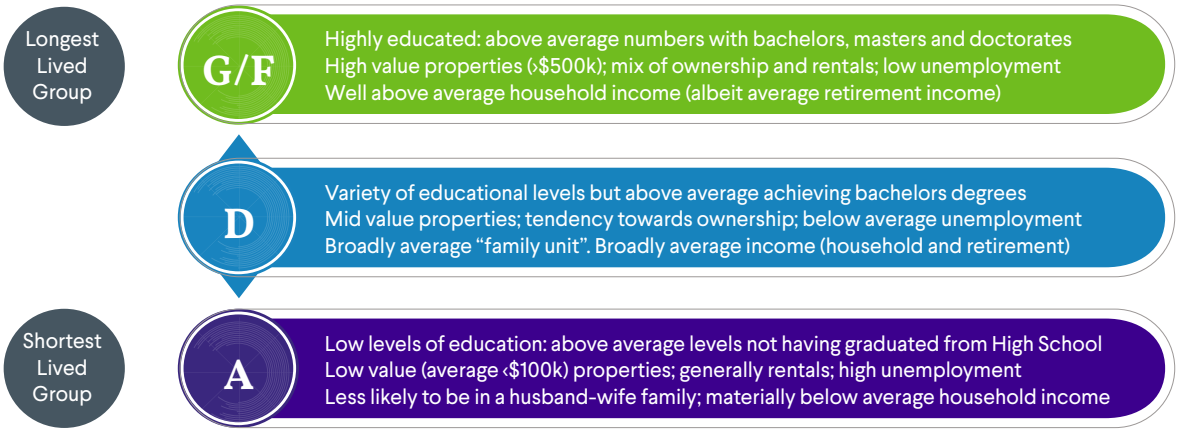
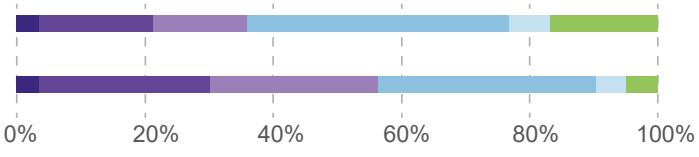


Figure 1 showed how different states have different average life expectancies. For women, the states with the highest and lowest life expectancy are Hawaii and Kentucky. This does not mean that everyone in Hawaii has the longest life expectancy. In fact, we see the full range of longevity groups for both states, but Hawaii has more residents from the higher groups and Kentucky has more residents in the lower groups.

#*		Life expectancy at 65**	Longevity group split
1	Hawaii	88.7	
51	Kentucky	84.1	



* Life expectancy ranking out of 50 states and District of Columbia
** Source: United States Mortality Database, April 2019

Longevity or mortality?

Longevity and mortality are two sides of the same coin: longevity is the measure of how long people live and mortality is the measure of when people die. Longevity risk is the risk that people live longer lives than expected and mortality risk the risk that they live shorter lives. It is a key risk for pension plans: if participants live longer than expected, then more money will be needed to pay their benefits.

Many life insurers are exposed to both longevity and mortality risk: the balance between these risks helps to make insurers more secure.

However, plan sponsors are typically only exposed to longevity risk. American employers with post-retirement healthcare promises will have additional longevity risk.

At Club Vita, we prefer to think about living rather than dying, so we tend to use the term longevity more often. Further information on the technical terms of longevity can be found in our online Lexicon of Longevity.

Figure 3: The two steps to quantifying and then managing longevity uncertainty…

Step 1: Current ("baseline") longevity

- Accurately measure what is happening today. A 'snapshot' of the current situation; it may be different for different people.
- This gives a measure of how long people will live if nothing changes in the future.
- With a large data set, and an understanding of how it is relevant to your population, it is possible to get this calculation 'right'.

Step 2: Future changes to longevity

- Project how things will change in the future. For example, changes due to medical advances or differences in lifestyles.
- This allowance, especially in the long run, is much more subjective.
- By tailoring your baseline longevity, you can concentrate your efforts on proactively managing trend uncertainties.

The analysis in this paper addresses the baseline challenge (Step 1) by fitting Club Vita's VitaCurves methodology to US data. Over the coming months we propose to collect larger volumes of historical data to analyze historical trends in different socio-economic groups which will help with the setting of an appropriate allowance for future changes (Step 2).

Introducing VitaCurves

ZIP+4 codes allow us to capture large differences in life expectancy, but there are other factors, most notably income, that also lead to considerable variation of life expectancy. Club Vita's approach is to combine the effects of multiple factors including ZIP+4, pension amount and blue/white collar worker into a highly predictive model of current (or "baseline") longevity (for Step 1 in Figure 3). We call this model VitaCurves. The techniques we are describing here have been tried and tested in the UK[3] and Canada[4].

The starting point is the data set underlying our calculations.

- The size of our data set is key to make our calculations statistically significant.
- The more data we have, the more we can identify the signal through the noise.
- Our first-generation US VitaCurves model is built on a data set of over 800k retirees from a diverse portfolio of 108 large plans.
- The richness of our data set is key to capture the full diversity between different retirees.
- The more data fields we collect, the more diversity we can capture between retirees.
- Our first-generation US VitaCurves model uses the data fields: ZIP+4, pension amount, blue/white collar, first/second life, gender, disabled/normal health.

How do we build the VitaCurves model?

We split each data field into distinct 'buckets'. Each individual retiree in our data set will be characterized by how their data fits into each bucket.

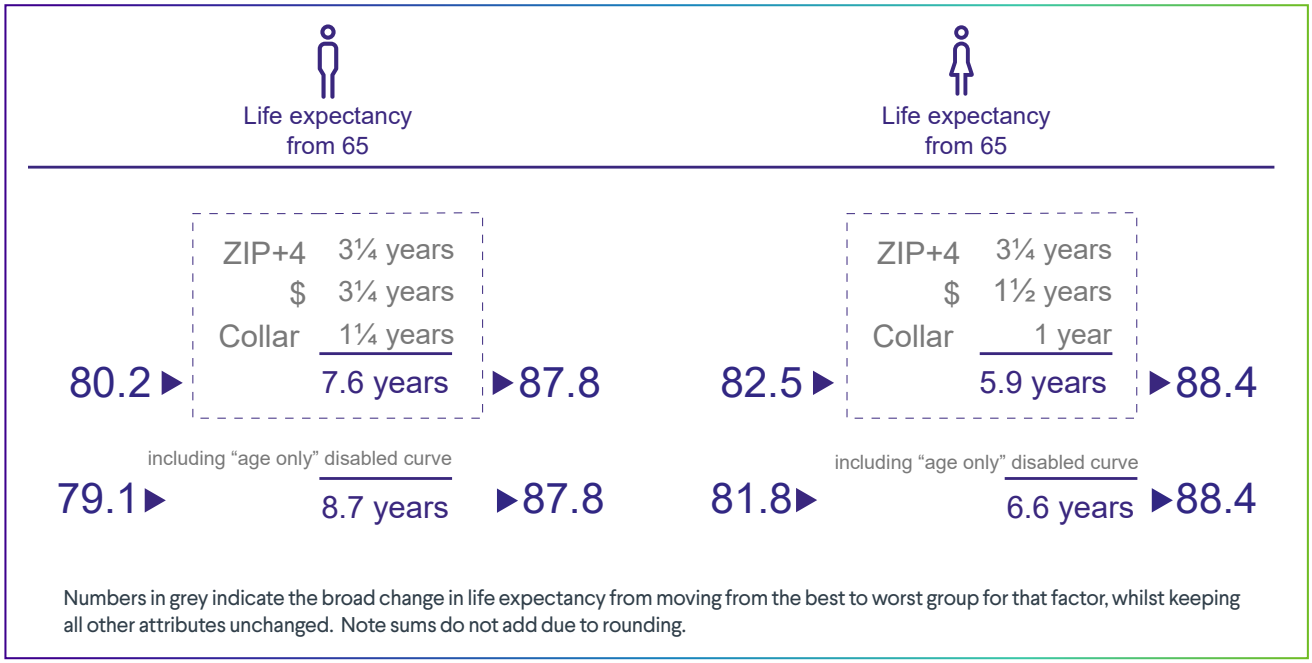
We apply a statistical technique called Generalized Linear Modeling to our data set to build up a picture of how each data field influences an individual's longevity. We use this technique to calculate an individual longevity assumption, or "VitaCurve", for each combination of our data fields. For our first-generation model, we generate 306 VitaCurves.

The first generation of VitaCurves captures a difference in life expectancy from 65 of 8.7 years for men and 6.6 years for women. We show on the next page how ZIP+4, annuity amount and collar type contribute to this diversity by indicating the broad change in life expectancy from moving from the best to worst group for that factor, whilst keeping all other attributes unchanged.

Data field	Retiree men	Retiree women
Pension amount	6 pension bands	3 pension bands
ZIP+4	7 longevity groups	6 longevity groups
Collar	Blue/white	Blue/white

[3] What longevity predictors should be allowed for when valuing pension scheme liabilities?

[4] https://www.cia-ica.ca/docs/default-source/2018/218068.pdf



Numbers in grey indicate the broad change in life expectancy from moving from the best to worst group for that factor, whilst keeping all other attributes unchanged. Note sums do not add due to rounding.

Applying VitaCurves to your plan

1. Analyze each participant's individual characteristics using the data bucketing system
2. Assign a VitaCurve to each individual in your plan, matching the bucketing of their specific characteristics
3. Combine all the individual VitaCurves together to create an assumption for your plan as a whole.

The VitaCurves model captures the diverse range of experience of your participants and applies it to your plan in a streamlined and efficient way

Why ZIP+4 codes?

- On average, a 5-digit ZIP code covers around 7,800 people, but in many cases, they cover more than 100,000 residents.

79936 El Paso, TX Population 115k	90011 Los Angeles, CA Population 106k	60629 Chicago, IL Population 105k
90650 Norwalk, CA Population 105k	90201 Bell Gardens, CA Population 101k	

- These large areas cover a diverse mix of people. In fact, around 1/3 of all 5-digit ZIP codes contain addresses from at least six of our longevity groups.
- Simply taking the average life expectancy across such a diverse mix of people will lose a lot of information about how long individuals will live. This problem is solved using our system of grouping ZIP+4 codes with similar characteristics.

A view from a pension consultant and actuary:

"

How long people live is of crucial importance to pension plans; fundamentally, it underpins every funding and investment decision. A pension plan promises to pay a participant an income from the day they retire for the rest of their life. Without an accurate estimate of how long they will live, the plan sponsor will not know how much money to save to make the payments.

Club Vita's first US model, VitaCurves, will greatly increase the ability of US pension plans to accurately measure their baseline longevity. This can potentially benefit plans in several ways, such as reducing the possible occurrence of large jumps in liabilities coinciding with the infrequent release of standard tables; allowing more accurate cash flows to be generated to create more effective Liability Driven Investment (LDI) strategies; and in some instances, reducing the liabilities and expense booked on plan sponsor's financial statements.

This new model offers the prospect of potentially substantial liability reductions. Some plans' deficits could be materially reduced. If the 1% average reduction shown in Figure 4 was extrapolated across the whole of the US defined benefit private sector pension plan universe (with liabilities estimated at around $3.4 trillion[5]), deficits would be reduced by approximately $34 billion.

We are also particularly excited about the insights that the VitaCurves model will bring to Pension Risk Transfer (PRT) deals. VitaCurves gives a more accurate baseline longevity assumption for each individual participant of a pension plan. This granular level of detail can give plans a much better sense of the value of any PRT deal, open up new structuring strategies, and will even open up the possibility of doing longevity-only deals in the US. For example, if a plan is considering the purchase of annuities for a certain group of participants, we can now more accurately assess how long those participants are going to live, rather than assuming they all have similar longevity characteristics to everyone else in the plan. This can give plan sponsors stronger confidence in identifying good value PRT deals and in their understanding of remaining plan demographics.

Mercer is proud to team up with Club Vita to calibrate their first model in the US and to be the first US advisor to offer access to Club Vita's analytics and models to all of our clients. We anticipate that using Club Vita's models will greatly help our clients.

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Bruce Cadenhead
Global Chief Actuary,
Mercer

MERCER

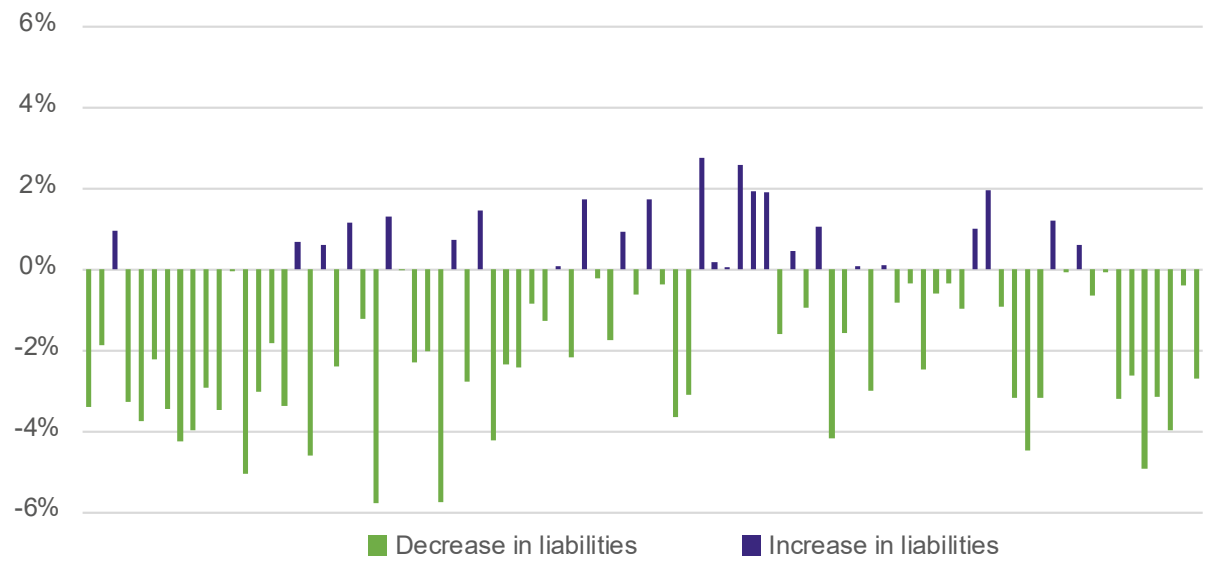
[5] https://fred.stlouisfed.org/series/BOGZ1FL574190043Q

How much does the value of pension promises change?

The data set used for this initial calibration came from a diverse collection of over 100 large pension plans, from a range of different industries and locations. It can also be used to study the impact on individual plans. Figure 4 shows that, when comparing to our best estimate of the plans' current longevity assumption, the change in the value of liabilities ranges from a 3% rise to a 6% fall. The winners (shown by the green bars below) outnumber the losers (shown by purple bars) by roughly two to one.

Overall, plans would enjoy an average reduction of around 1% off their liabilities, assuming no change to the allowance for future improvements (step two in Figure 3). We suspect that this hidden overvaluation is largely attributable to the pension industry's existing tables needing to be projected forward over several years to the current date. The RP06 tables were based on data centered in 2006 and whilst they have been updated in line with national US population data and projected changes in longevity, these updates have not captured the actual pace of change in sub-sections of the US population. In contrast, the VitaCurves model is based on data centered in 2015.

Figure 4:
Impact of moving from RP06 to 9 digit ZIP US VitaCurves (both MP18 improvements)



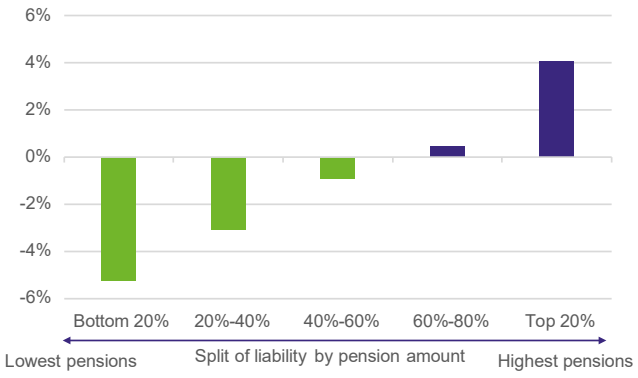
Calculation approach: For each plan in our data set we have calculated the plan's liabilities using both VitaCurves and the Society of Actuaries RP06 base tables. We assumed plans would use RP06 tables best matched to the collar type of the plan. We assumed MP18 mortality projection scale for future improvements and 4% discount rate and excluded any surviving spouses' pensions that may commence after retirees die in the future. We have not shown results for plans in our data set for which we did not have sufficiently good quality ZIP+4 data.

The power of individual assumptions

Not only does VitaCurves allow you to capture the diversity of your plan when setting your longevity assumptions, it also lets you value participants with individualized longevity assumptions. This could have a significant effect when assessing the value of a pension risk transfer deal.

For example, participants with higher pensions will have a longer life expectancy than participants with lower pensions. If you use the same assumption to value all participants in your plan, you will overvalue those with low pensions and undervalue those with high pensions. Figure 5 shows the effect on liability values for different quintiles of participants for an example plan of moving from their current assumption to using VitaCurves.

Figure 5: Individual assumptions vs 'average assumption'



Source: Club Vita; for an example US plan, the effect on quintiles of liabilities of moving from assumed funding assumption to individual VitaCurves for baseline longevity

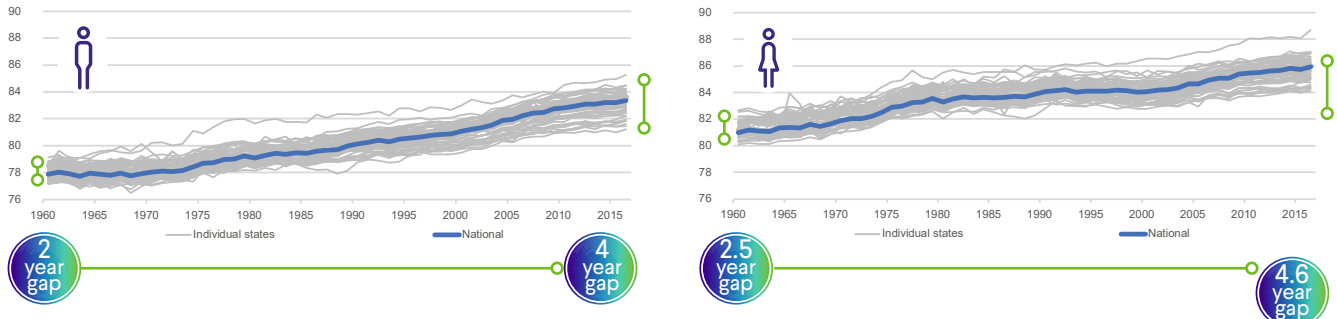
Longevity, it is a changin'

As we discussed in Figure 3, nailing down an accurate baseline assumption is the first step to understanding your plan's longevity risk. The second step is to understand how longevity is changing over time. There are various things driving changes in longevity, including medical advances, changes in diet and levels of exercise, smoking and alcohol consumption. Many of these effects are not experienced uniformly across society.

Looking again at the simplified situation of state level statistics we can see that improvements have not been experienced uniformly in different states. Figures 6 and 7 show how life expectancy (measured from age 65) has changed between 1960 and 2016: the blue line represents the USA average, and each grey line represents an individual state. We can see that a 2-year gap in life expectancy experienced in the 1960s has opened up to over a 4-year gap in life expectancy in recent years.

Club Vita's research in the UK[6] has shown that life expectancy has recently been increasing at a faster rate for more well-off retirees. This phenomenon has been mirrored in the US, with research showing that between 2001 and 2014, life expectancy has increased more for those with higher income[7]. Club Vita can help you consider these socio-economic differences when thinking about longevity improvement scales.

Figures 6 & 7: Life expectancy from 65



Source: Club Vita analysis of US state life expectancy data from the United States Mortality Database (https://usa.mortality.org/)

[6] https://www.clubvita.co.uk/collaborative-research/trends

[7] https://jamanetwork.com/journals/jama/article-abstract/2513561

Details on the underlying data

The VitaCurves model described in this paper was calibrated to a data set containing 815,000 in force lives and over 160,000 deaths. The model was calibrated to the experience over the period 2014-2016. Further details of the data set and the validations applied can be found in the technical supporting documents.
https://www.clubvita.us/zooming-in-on-zip-codes

Details on the modeling methodology

Further technical details on the modeling methodology can be found in the technical supporting documents.
https://www.clubvita.us/zooming-in-on-zip-codes

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Reliances and limitations

This paper and its supporting documents complies with the relevant Actuarial Standards Board's Actuarial Standards of Practice (ASOP) and the Financial Reporting Council's Technical Actuarial Standards (TAS) 100.