The Mortality Mystery

Key Takeaway
Mortality rates are hardly improving. Life expectancy forecasts are falling fast. At first this was considered an anomaly, then a flu related one-off, now a trend. However, from this tragedy comes an uncomfortable truth; reducing life expectancy forecasts releases hidden value in annuity back books. So much so that the value release could be worth 3.6% of Prudential, 8.7% of L&G and >11.0% of Aviva.

The Mortality Improvement Crisis
Although life expectancy has more than doubled since 1900, mortality improvements have collapsed since 2011, with annual improvements falling from >2.5% to <0.5%. Though the underlying causes remain contentious, in our view the slowdown is due to a combination of three factors:

- Heightened mortality amongst the elderly when the dominant flu strain is A(H3N2).
- Increased strain on social services and healthcare.
- Lower improvement rates from reduced heart disease fatalities, where since 2000 this has been a key driver of rising life expectancy. Future improvements must be found by reducing mortality from other conditions, most notably dementia.

Methodology Changes
Initially the slowdown in mortality improvements was perceived to be a one-off, prompting the market to largely look through the impact. However, with persistently low improvement rates now suggesting a trend, the CMI_2018 tables have seen an adjustment to the smoothing parameter (Sk), giving more weight to recent data.

Reserving Windfall
From the insurer’s perspective, as life insurance liabilities are the discounted annuity payments made over a customer’s lifetime, a reduction in life expectancy relative to the insurer’s assumptions leads to a reserve release (from reduced longevity risk). Below we show the acceleration in longevity releases at Aviva, L&G and Prudential, as well as our forecasts for the implementation of CMI_2018 and beyond.

Jefferies forecast of longevity releases from changing mortality assumptions (£m)

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Corporate Optionality
Given that the mortality assumption changes (without adjusting Sk) could be worth, relative to market cap, 4% of Prudential, 9% of L&G and 11% of Aviva, a key question is whether insurers will recognise the benefit, or absorb a proportion in reserve buffers. Although there have been calls to return capital, we urge insurers to remain cautious. In our view, the industry has a rare opportunity to lock in stronger balance sheets at a time with Brexit uncertainty, volatile financial markets and an economic boom that appears long in the tooth. Should insurers retain a large proportion of the benefits, management gain the option to smooth volatility, reducing risk to dividends.
The Mortality Crisis

"Mortality improvements have fallen off a cliff since 2011" - Tim Gordon, Chairman of the CMI Mortality Projections Committee and Risk Settlement Group Partner at Aon

Doubling life expectancy in just one century
Having increased 44 years in the 20th Century (from 32 to 76), life expectancy in the UK continued its rapid rate of improvement throughout the first decade of the 21st Century, due to improved healthcare, better working conditions and the reduction of smoking. However, since approximately the end of 2012, there has been a considerable slowdown, so that although the mortality rate is still reducing, the annual rate of improvement has collapsed from ~2.5% to just 0.5%.

Slowing mortality improvements: from an anomaly to a trend
While this technical regime shift was originally viewed as an anomaly and a case study in the importance of not overstating the materiality of volatile, short-term patterns; the subsequent recurrence of low annual improvements suggests that this is a trend. Below we plot the 5 year average of the UK annual mortality improvement percentage, demonstrating that the slowdown began in late 2011, dramatically shifting in 2015 and remaining at this depressed level since.

Exhibit 1 - Collapsing annual mortality improvements as seen in the 5 year average

With the magnitude of this divergence exceeding four standard deviations, it is difficult to overstate the materiality of this movement. Although the starting point differs, similar slowdowns have been observed in the US, Germany, Spain, France and Australia, reinforcing the trend’s materiality and reducing the possibility that this is an anomaly. Of the countries whose data is made available through the Human Mortality Database, only Japan, Norway and Finland have seen life expectancy accelerate in the last 6 years, which is unsurprising considering all three had recorded unusually low improvements in the preceding 6 years.

"If you’re a statistician, its time to fall off your chair" - Joseph Lu, Director at Legal & General

Longevity in the UK increased by 47 years over 1900-2011, as improved healthcare, working conditions and reduced smoking benefited public health

Mortality improvements have collapsed in the UK from 2.5% to 0.5% annually

Similar trends have been noted globally, reinforcing the materiality of this trend

Please see important disclosure information on pages 18 - 24 of this report.
Long-Term Mortality Improvements

Indexing annual data
Below we have used the CMI’s cumulative annual standardised mortality improvement (cSMRI) data to produce a multi-year time series / index of UK mortality improvements. Notably, since 2011 the volatility of improvements has been considerably higher and while it is understandable that 2012, 2013 and 2015 were initially viewed as anomalies, the shift (post the disappointing 2017 and 2018 years) now appears to be a trend.

Exhibit 2 - Cumulative mortality improvements (1st January 2011 = 100)

Using rolling annual improvement data, we produce a long term data series.

Technical regime shift
Turning this index series into a daily rolling average of the last five years, in order to smooth volatility, the sudden change becomes even more apparent and, to our mind, the strength of this technical regime shift is so strong that the idea that this is now a trend is irrefutable.

Exhibit 3 - Rolling 5 Year Average of cumulative mortality improvements

The 5 year average shows a sudden shift in the prevailing long-term trend.
Mind the gap!
Comparing realised improvements to the pre-2011 trend below, it is clear that the gap between previous expectations and reality is now highly material. Given that the industry reflex is to understate the most recent data in favour of longer term movements and the trend is only visible in the 5 year rolling average from 2015, we expect that the industry has only just begun to recognise the benefit from this trend divergence in reserves.

Exhibit 4 - Burgeoning gulf between pre-2012 and current mortality trend

Source: Unisex mortality improvements for ages 20-100, Continuous Mortality Investigation

Moreover, comparing our conclusions from the CMI data to the semi-annual reports of the Government Actuary’s Department (GAD) and the Office of National Statistics (ONS); it appears that our thoughts are in line with the professional consensus.

CMI data
Below we show the annual CMI improvement data for the last decade. As can be seen, the five worst years have been during the last seven years, being (in order of magnitude) 2015, 2012, 2017, 2018 and 2013. Note that each line represents the course of a year (in days), relative to the year that preceded it. Thus, where a line rises, the year is progressing better than the comparative period and where it falls, it has deteriorated.

Exhibit 5 - Five of the last seven years saw cumulative mortality improvements <0.3%

Source: Continuous Mortality Investigation

Realised mortality has probably diverged from reserving assumptions

Five of the last seven years saw little improvement in mortality rates

Please see important disclosure information on pages 18 - 24 of this report.
Moreover, although 2016 was relatively good with roughly a 3% mortality improvement, this figure comes from a lower base, as 2015 was the worst year ever. The 2014 year also saw adequate improvement, although given that this followed the first two consecutive years of the new trend, this was also from an arguably low base.

**Annus Mirabilis**

Below we isolate the 2009 year, being the best year of the last decade (also the earliest), with a 5% improvement in mortality rates. Moreover, the gradient of the slope was steady through the latter three quarters, indicating that 2009 was consistently better than 2008.

**Exhibit 6 - Cumulative deaths were nearly 5% lower in 2009 than 2008**

Source: Unisex mortality improvements for ages 20-100, Continuous Mortality Investigation

**Annus Horribilis**

We also isolate 2015, being the worst year on record, where mortality deteriorated 4%. Notably much of the year-on-year deterioration was recorded in the opening quarter, with the flat gradient of the slope indicating that deaths through the rest of 2015 were in line with the prior year.

**Exhibit 7 - Cumulative deaths were nearly 4% higher in 2015 than 2014.**

Source: Unisex mortality improvements for ages 20-100, Continuous Mortality Investigation
Tentative Improvements

Mortality worsened in 1Q 2018 but is tentatively recovering

Looking to the 2018 and early 2019 data, the beginning of 2018 was particularly poor, with very high winter deaths driving down life expectancy. However, the year saw a recovery over the three subsequent quarters that has continued into 2019.

Exhibit 8 - Mortality trends shifted after 1Q 2018 and continue to improve in 2019

Since 1Q 2018, mortality has begun to improve again, continuing into 2019

Winter deaths are critical

Given that four of the five worst years began with many more deaths in the first quarter than the preceding year, the underlying cause of the mortality improvement slowdown appears to be surges in winter deaths. Below are European weekly deaths since 2015 (courtesy of L&G) showing sudden spikes in deaths during the winter months. Notably, winter deaths remain high in 2019, although not as severe as in 2018 (Exhibits 8 and 9).

Exhibit 9 - Europe has experienced substantial surges in winter deaths since 2015

Winter deaths have been a key driver of the trend shift

Source: Unisex mortality improvements for ages 20-100, Continuous Mortality Investigation

Source: Legal & General, CMI Conference 2019

Please see important disclosure information on pages 18 - 24 of this report.
Underlying Causes

Flu and Pneumonia were responsible for the Annus Horribilis (2015)

Given that the primary cause of seasonal mortality variations is the spread of infectious disease (such as flu), this was naturally one of the first suggested causes.

As discussed, 2015 was the worst year on record, sparking the still ongoing debate. Through that winter of 2014-2015, although there were a moderate number of flu cases, the UK Surveillance report noted that A(H3N2) disproportionately affected the elderly, leading to "levels of excess mortality significantly higher than the last notable significant H3N2 season of 2008 to 2009". EuroMOMO (European Monitoring of Excess Mortality) calculated that in the 2014-2015 flu season, there were 217,000 excess deaths in Europe, with Portugal, Hungary, Spain, the Netherlands and the UK being the worst affected.

As the winter of 2015-2016 was within the expected range and mortality improvements for 2016 were near 3%, it appeared that flu was the underlying cause of the anomaly and that there was no need to be especially concerned.

Exhibit 10 - Flu in 2014-2015 was in line with pandemic flu in 2008-2009

Source: UK Government - Surveillance of influenza and other respiratory viruses

Flu may be the underlying cause in 2017 and 2018

However, with both 2017 and 2018 showing a repetition of low mortality improvements, it has become increasingly consensual to view this as a trend. Unlike before, when this was considered an anomaly, there is no universal consensus as to the underlying cause. Flu remains a contender, as the recurrence of A(H3N2) as the dominant strain in the winters of 2016-2017 and 2017-2018 correlates with higher deaths.

Exhibit 11 - A(H3N2) appears to be associated with high death tolls

Source: UK Government - Surveillance of influenza and other respiratory viruses
**From a Deprivation Paradox to Austerity & Inequality**

Nevertheless, aside from flu, another suggested cause has been widening inequality. Prior to 2010, some had highlighted a *deprivation paradox*, where the socio-economically disadvantaged parts of the population benefited from greater mortality improvements, despite their relative disadvantage. At the time it was argued that improving the quality and availability of high quality healthcare was driving material improvements amongst those who depend on it the most.

Exhibit 12 - Mortality improvements in different socio-economic groups

![Chart showing mortality improvements by socio-economic group](source: Hannover Re, CMI Conference)

Since 2010 though, the mortality improvement gap between socioeconomic groups has begun to widen again, arguably because as austerity has weighed on public services, the mortality rate amongst those that rely on them has remained elevated.

Exhibit 13 - The difference between correlation and causation is contentious

![Chart showing correlation vs causation](source: Just Group, Institute for Fiscal Studies (IFS) and ONS data, CMI Conference)

Such conclusions however remain highly contentious. While some actuaries highlight the apparent correlation between Government spending and mortality, it is important to emphasise that the statistical correlation is not conclusive. Correlation is not causation and, more broadly, as we have already highlighted that this trend spreads across national boundaries (to varying degrees), it seems most likely that this is just one contributing factor rather than a root cause.

Austerity may have a higher impact on those that rely on public services

Correlation is not causation

Please see important disclosure information on pages 18 - 24 of this report.
Hearts and Minds

Analysing the causes of death over the last two decades, we note that although the top five causes of death have been consistent, it is clear that there have been staggering mortality improvements by reducing heart disease deaths (especially in men). However, from 2010/11 onwards, the rate of heart disease improvement has begun to decelerate, an unsurprising development given the extent of the improvements already achieved. As such, further improvements will most likely need to be found elsewhere.

Mortality improvements prior to 2010 were disproportionately from fewer heart disease deaths

As the cohort most affected by the slowdown in improvements has been the elderly, we have isolated below the primary cause of death amongst individuals aged 80 and above. In this data set, the improvements from heart disease pale in comparison to a sharp uptick in Dementia and Alzheimer’s. Though we do accept that this could be partially linked to better understanding and diagnosis by the NHS, it appears unlikely in our view that this explains all of the movement.

Dementia as a proportion of deaths among the elderly is materially rising

This pronounced surge in the proportion of deaths among the elderly attributed to mental disorders may suggest that the mental health of this cohort has deteriorated. Though possible, we suspect that what the data now reflects is a survivorship bias, whereby the population was always susceptible to these conditions but it was not visible as most died of other causes first. This argument is strengthened by the fact that the proportion of deaths from dementia and Alzheimer’s has risen most amongst women, who typically live longer than men anyway. Could it be that men are no less susceptible to these conditions but die before these conditions become prevalent?

Please see important disclosure information on pages 18 - 24 of this report.
A Multi-Facetted Problem

In our view, the cause of the slowdown is disappointingly complex, making it a difficult problem to fix. In summary:

- Mortality improvements over from 1900-2011 have more than doubled life expectancy and led to an ageing UK population.
- In years where the dominant flu strain is A(H3N2), such as 2015 and 2017, the current cohort of individuals over the age of 80 appears to suffer heightened mortality.
- The increased strain of an ageing population on social services and healthcare, accentuated by budget pressures, makes it difficult to realise further improvements.
- The remarkable success in reducing heart disease related fatalities since 2000 has largely been realised, just as the reduction in smoking did in the 1990’s. Consequently, the next material block to a longer lifespan appears to be dementia and Alzheimer’s.

Methodology Changes

Smoothing factors

Given the extent of the slowdown, the CMI have made material model adjustments in order to better capture the trend. These began in earnest with the CMI_2016 model, which adjusted the shape of the long term rate and, for the first time, incorporated a period smoothing parameter (Sk) to control the responsiveness to recent data.

In terms of the impact of model changes on reserving, below we demonstrate the reserving impact on a hypothetical £10bn of liabilities from each model. Notably:

- **Mortality Improvements slowing.** Each CMI model since 2011 has shown a reduction in liabilities due to the slowdown in longevity improvements.
- **Momentum is increasing.** The momentum of the slowdown has steadily increased, with each table having a larger impact than the one that proceeded it.
- **The smoothing factor is now extrapolating the trend.** When compared to older models, the addition of the period smoothing factor initially dampened improvement volatility. However, since 2013, the smoothing factor has actually accentuated the impact.

Exhibit 18 - Reserving impact (£m) of each model shift on £10bn of liabilities

![Exhibit 18](image-url)

Source: Lloyds Banking Group, CMI Conference 2017

The mortality improvement slowdown is caused by a variety of inter-linked trends

Each successive CMI model since 2011 has been more material than the last
Shifting smoothing factors

By comparison to previous model changes, CMI_2017 saw relatively minor changes and was business as usual in terms of methodology. The most recently published CMI_2018 though has seen both a sharp reduction in life expectancy (as previously discussed) and a methodological change by reducing the period smoothing factor (Sk) from 7.5 to 7.0. The hypothetical impact on a £10bn block of liabilities is shown below, with the new, reduced value of 7.0 being less smoothed than before, leading to more volatility and increased emphasis on recent data points.

Exhibit 19 - Reserving impact (£m) of Sk values on £10bn of liabilities

![Chart showing the impact of Sk values on £10bn of liabilities]

Source: Lloyds Banking Group, CMI Conference 2017

"A" new type of adjustment

In addition to reducing the period smoothing parameter (introduced in CMI_2016), the CMI_2018 model has introduced a completely new extended parameter, known as "A". This is the "initial addition to mortality improvement" and allows users to adjust initial mortality improvements without adjusting the Sk parameter (which is more difficult). Specifically this adjustment allows users to adjust the CMI tables for their own subset of the wider UK population to take into account specific cohorts or socio-economic groups.

Ultimately the CMI expects that this will become the main method that users will use to adjust the model as it is far easier to use and a more simple adjustment. Generally the CMI is cautious about how the insurers and pension funds use the model because:

- **CMI tables are a best estimate.** Contrary to some expectations, the tables are not prudent. As the CMI’s role is to produce “high quality, impartial analysis”, it naturally follows that the model is a best estimate view and it is the job of everyone else (insurers, pension funds and actuaries) to manage how this flows into reserves.

- **Any adjustment introduces bias.** Using the CMI tables presents the actuarial community with a conundrum. On the one hand, the proprietary data on any one insurer or pension fund is not statistically significant in the context of the population, meaning that using the CMI data is essential. On the other hand, the CMI tables are a generalised view of the total population and do not represent the specific cohorts any one user is attempting to model.

CMI_2018 also allows users to make an initial adjustment to better reflect cohorts other than the wider population.

Please see important disclosure information on pages 18 - 24 of this report.
Historical Context

"The actuaries were asleep at the wheel, missing the latest population cohort coming through and thus reserves had to increase" - Joseph Lu, Director at Legal & General

Understating mortality improvements - up until the trend changed in 2011

It is perhaps surprising, given the actuarial profession's reputation (or preoccupation) for prudence, to find the industry responding relatively quickly to this emerging trend, especially given the long track record of under-estimating previous mortality trends. This is shown below in the Office of National Statistics (ONS) data, where forecasts consistently under-projected long-term life expectancy. In fact, no forecast has ever over-projected life expectancy more than 12 years ahead and typically the industry has understated life expectancy at birth by 3 years for females and nearly 5 years for males by the time they are just 25.

The actuarial profession has responded surprisingly swiftly to the regime shift, relative to historical responsiveness.

Exhibit 20 - Expectation of Life at Birth (EOLB) of UK Females

Exhibit 21 - Expectation of Life at Birth (EOLB) of UK Males

Source: Office of National Statistics (ONS)

The industry track record for projecting deaths has been even worse, even failing to recognise the correct direction of travel on occasion. In fairness, this is more challenging as the number of deaths is distorted by immigration, which complicates the forecasts.

Exhibit 22 - Actual and projected UK deaths

Source: Office of National Statistics (ONS)

Nevertheless, the industry appears to be determined to respond more rapidly in this instance than before. A cynic may argue that this reflects the fact that this is a favourable earnings trend (unlike previous trends), or is an extension of the apparent long-term professional bias of understating life expectancy. In our view though, this responsiveness is more due to the increased availability of high quality population data (such as via the ONS, Club Vita and the ABI).

Arguably the profession can respond quicker as the quality of data is better than during previous regime shifts.

Please see important disclosure information on pages 18 - 24 of this report.
Reserving Windfall

Company level impact
From the insurer’s perspective, as the life insurance liabilities represent the discounted annuity payments made over a customer’s lifetime, a reduction in their life expectancy relative to the insurer’s assumptions leads to a reserve release - an earnings benefit. Forecasting the impact on individual insurers though is complicated by three factors:

• **Insured cohorts.** As the insured population is likely to be weighted towards higher socio-economic groups than the general population, it seems likely that they will have experienced better mortality increases than the CMI tables suggest. Given the lack of published data by individual insurers, it is impossible for investors to assess the relative exposure to different cohorts, ages and sexes, making any assessment of the benefit from the mortality improvement slowdown a high level estimate at best.

• **Assumptions.** Given this difference between the tables and the insured population, we expect that although insurers will adjust their Sk (smoothing) factor in line with CMI_2018 (from 7.5 to 7.0), they will also use the new “A” assumption to partially offset the benefit (for prudence). In addition, as the “A” assumption is completely new to the CMI tables, there is no industry consensus on the range of reasonable assumptions. We expect this to be a key question for management when the insurers ultimately move to CMI_2018 (in FY2019 for most, or FY2020 for L&G and Prudential).

• **IFRS prudence.** Finally, as IFRS regulations allow insurers to present their reserves using reasonable estimates, the amount of reserves released under IFRS depends to a large extent on management prudence. Most actuarial estimates have a wide range of reasonable assumptions but where relatively small changes have material impacts, the IFRS results become something of a self-marked exam by management. Note that the reason all life insurers use the CMI as a base case (and then make adjustments) is because the size of their insured populations is not statistically significant.

Calculating the potential benefit of CMI_2018

These caveats aside, we attempt to estimate the potential benefit from the movement to the CMI_2018 tables. In order to do this, we calculate a rough correlation between the financial impact of previous changes to the tables and the impact on Life Expectancy. Below we show both variables, the reserve impact of recent CMI table changes on a hypothetical £10bn of liabilities and the change in assumed Life Expectancy.

**Exhibit 23 - Reserve release (£m) per £10bn of liabilities**

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Source: Lloyds Banking Group, CMI Conference 2017

**Exhibit 24 - Mortality variation between differing actuarial models**

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Impact on Life Expectancy (Unisex) for those aged 65 to 85+ when moving from CMI_2014 to CMI_2016: -3.63%

Source: CMI Conference 2017

Though disclosures are inconsistent and incomplete we attempt to calculate an approximate sensitivity.

Life reserves are the discounted annuity payments over the customer’s lifetime, so reduced life expectancy assumptions are favourable for reserves.
Earnings sensitivity to life expectancy assumptions in CMI_2018

By our calculations, we estimate that each 1% movement in the average Life Expectancy of those aged over 65 equates to £106m of reserve releases per £10bn of liabilities. Though this is clearly a rough guide rather than a robust calculation, it does provide a useful baseline from which to base an assumption. If we multiply this by the 6 month reduction in life expectancy (equivalent to 2.12%) for over 65’s recorded by CMI_2018, this implies a release of £226m per £10bn of liabilities.

Consequently, based on our analysis, UK life insurers could experience a reduction in their annuity liabilities of 2.26% as a result of the CMI_2018 tables. This is marginally more cautious than the 2.50% widely quoted in the press releases of insurance broker’s, accountancy firms and the actuarial organisations. Of this potential benefit, we make a further adjustment to account for the fact that the insured population is likely to be healthier than the general population, by multiplying the 2.26% by an arbitrary 80%, reducing it to 1.70% (therefore reflecting any insurer’s use of the new “A” assumption). Of this 1.70%, we then presume that each company releases just 75% of the benefits in the IFRS accounts (absorbing the remainder within actuarial buffers).

As such, although our calculations are by necessity over-simplified (due to lack of data), we expect they are relatively prudent, having limited the benefit more than once. Overall, this leaves each company with a disclosed CMI_2018 related benefit of:

- **Aviva**: £1,276m of reserve releases from CMI_2018, when adopted in 2019.
- **Legal & General**: £877m of reserve releases from CMI_2018, when adopted in 2020.
- **Prudential**: £935m of reserve releases from CMI_2018, when adopted in 2020.

Calculating the potential benefit of CMI_2019 and beyond

For future CMI tables, we have up until now presumed that there are no model changes, favourable or otherwise. However, given that we regard the slowdown as a broader trend, we now forecast future CMI table results.

As per EuroMOMO (the European Monitoring of Excess Mortality), 2019 has thus far developed as another year of high winter mortality. Nevertheless, where 2018 started especially badly in 1Q, the year-on-year comparative remains favourable. At this stage, we therefore presume that where the reserving benefit from CMI_2018 is expected to be 1.7% for the listed UK life insurers, the benefit from CMI_2019 is expected to be 1.2% (~70% of prior year). From here we forecast the favourable development to rapidly fade, having a negligible impact by CMI_2022.

Exhibit 25 - Releases from mortality assumption variances (£m)

Exhibit 26 - Releases from mortality assumptions and Ss (£m)

Source: Jefferies, Company Data
Forecasting the earnings profile of mortality assumption changes

Below we highlight our forecasts of releases from the mortality improvement slowdown. Note that while the industry generally recognises new CMI models with a one year delay, Legal & General and Prudential have opted for a two year delay. As such, though peers will recognise CMI_2018 in FY2019, L&G and Prudential will wait until FY2020.

Total longevity reserve releases due to changing mortality assumptions could reach £9.3bn over 2016-2023

Exhibit 27 - Forecast of UK Life Insurance mortality assumption changes (£m)

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<td>2023F</td>
<td>54</td>
<td>92</td>
<td>98</td>
<td>244</td>
</tr>
<tr>
<td>Total (2019-2023)</td>
<td>2,179</td>
<td>1,904</td>
<td>2,008</td>
<td>6,091</td>
</tr>
</tbody>
</table>

Mortality Reserve Releases by Financial Year

<table>
<thead>
<tr>
<th>Year</th>
<th>Aviva</th>
<th>Legal &amp; General</th>
<th>Prudential</th>
<th>Total</th>
</tr>
</thead>
<tbody>
<tr>
<td>2016</td>
<td>370</td>
<td>-</td>
<td>-</td>
<td>370</td>
</tr>
<tr>
<td>2017</td>
<td>710</td>
<td>332</td>
<td>204</td>
<td>1,246</td>
</tr>
<tr>
<td>2018</td>
<td>728</td>
<td>433</td>
<td>441</td>
<td>1,602</td>
</tr>
<tr>
<td>2019F</td>
<td>638</td>
<td>444</td>
<td>452</td>
<td>1,534</td>
</tr>
<tr>
<td>2020F</td>
<td>447</td>
<td>877</td>
<td>935</td>
<td>1,352</td>
</tr>
<tr>
<td>2021F</td>
<td>268</td>
<td>307</td>
<td>327</td>
<td>902</td>
</tr>
<tr>
<td>2022F</td>
<td>134</td>
<td>184</td>
<td>196</td>
<td>514</td>
</tr>
<tr>
<td>2023F</td>
<td>54</td>
<td>92</td>
<td>98</td>
<td>244</td>
</tr>
<tr>
<td>Total (2019-2023)</td>
<td>1,541</td>
<td>1,466</td>
<td>1,541</td>
<td>4,547</td>
</tr>
</tbody>
</table>

Model Adjustment of Sk by Financial Year

<table>
<thead>
<tr>
<th>Year</th>
<th>Aviva</th>
<th>Legal &amp; General</th>
<th>Prudential</th>
<th>Total</th>
</tr>
</thead>
<tbody>
<tr>
<td>2016</td>
<td>-</td>
<td>-</td>
<td>-</td>
<td>-</td>
</tr>
<tr>
<td>2017</td>
<td>-</td>
<td>-</td>
<td>-</td>
<td>-</td>
</tr>
<tr>
<td>2018</td>
<td>-</td>
<td>-</td>
<td>-</td>
<td>-</td>
</tr>
<tr>
<td>2019F</td>
<td>638</td>
<td>-</td>
<td>-</td>
<td>638</td>
</tr>
<tr>
<td>2020F</td>
<td>-</td>
<td>-</td>
<td>-</td>
<td>-</td>
</tr>
<tr>
<td>2021F</td>
<td>-</td>
<td>-</td>
<td>-</td>
<td>-</td>
</tr>
<tr>
<td>2022F</td>
<td>-</td>
<td>-</td>
<td>-</td>
<td>-</td>
</tr>
<tr>
<td>2023F</td>
<td>-</td>
<td>-</td>
<td>-</td>
<td>-</td>
</tr>
<tr>
<td>Total (2019-2023)</td>
<td>638</td>
<td>-</td>
<td>-</td>
<td>638</td>
</tr>
</tbody>
</table>

Valuing mortality assumption changes

When it comes to valuing the benefit from changing mortality assumptions, we believe that the market will place a relatively low value on these earnings, for three reasons:

- **Long dated assumptions.** Firstly, these earnings come from assumptions that drive the assessment of liabilities that could have a duration of more than 20 years, so the reasonableness of one model over another will not be confirmed until long after the earnings benefit has been recognised.

- **Intangible benefit.** Secondly, changing assumptions does not create additional cash flow in the near term. Moving the underlying assumptions does not create a higher investment return or limit annuity payments, it just reflects a different expectation of future cash flows and in turn creating capital.

- **Reversible.** Thirdly, the accounting standards give insurers a high degree of flexibility over their reserving assumptions. As such, material IFRS reserve movements can be expanded, contracted or reversed by management with relative ease. To our mind, it seems unlikely that the market will value an earnings benefit that could be easily retracted in future years, especially given the industry’s track record for forecasting.

Nonetheless, as we expect the IFRS earnings impact of the slowdown on just the three largest listed UK life insurers (Aviva, L&G and Prudential) to be £9.3bn over 2016-2023, these earnings should not be overlooked entirely. Up until now, we have considered the value of these earnings to be limited as we originally considered these to be a one-off (not a trend) and they cannot be easily forecast. However, given their acceleration since 2016 and now the addition of the Sk (smoothing parameter) change, we can no longer overlook the benefit.

We expect that the market will place a low valuation on long-dated, intangible earnings that could be reversed

The mortality slowdown has already led to £3.2bn of releases at Aviva, L&G and Prudential over 2016-2018

Please see important disclosure information on pages 18 - 24 of this report.
Attaching a multiple to the mortality trend

When valuing this earnings stream, we use a discounted cash flow (DCF) valuation of the mortality changes. We do not value the releases from moving the smoothing parameter, as we view this as a one-off benefit.

Although we previously noted that a change in assumptions would not create any additional cash flow (it does not affect claims or investments directly), it does lead to an earnings and capital benefit, which can be repatriated to shareholders. Consequently, as these earnings have a non-cash source, it is really the capital benefit we are valuing in our DCF.

Exhibit 28 - Valuation of longevity releases mortality assumption changes (£m)

<table>
<thead>
<tr>
<th>DCF Valuation of Mortality Releases by Financial Year</th>
<th>2019F</th>
<th>2020F</th>
<th>2021F</th>
<th>2022F</th>
<th>2023F</th>
<th>Total</th>
<th>Value / Total</th>
<th>P/E 2019F</th>
<th>P/E CMI 2018</th>
</tr>
</thead>
<tbody>
<tr>
<td>Aviva</td>
<td>1,140</td>
<td>356</td>
<td>191</td>
<td>85</td>
<td>30</td>
<td>1,802</td>
<td>0.83</td>
<td>2.82</td>
<td>1.41</td>
</tr>
<tr>
<td>L&amp;G</td>
<td>396</td>
<td>699</td>
<td>218</td>
<td>117</td>
<td>52</td>
<td>1,483</td>
<td>0.78</td>
<td>3.34</td>
<td>1.69</td>
</tr>
<tr>
<td>Prudential</td>
<td>404</td>
<td>745</td>
<td>233</td>
<td>125</td>
<td>56</td>
<td>1,562</td>
<td>0.78</td>
<td>3.45</td>
<td>1.67</td>
</tr>
<tr>
<td>Total</td>
<td>1,940</td>
<td>1,800</td>
<td>642</td>
<td>327</td>
<td>138</td>
<td>4,847</td>
<td>0.80</td>
<td>3.16</td>
<td>2.23</td>
</tr>
</tbody>
</table>

| Period                                               | 1.00  | 2.00  | 3.00  | 4.00  | 5.00  |
| Cost of Equity                                       | 12.00 |

Source: Jefferies

Discounting these earnings at a 12.0% Cost of Equity to reflect the degree of uncertainty, our DCF suggests a valuation of approximately 3x P/E (based on 2019F mortality earnings). This equates to a P/E on the CMI_2018 related earnings, both the mortality assumption change and the change to Sk of just under 1.6x.

In our view this is not an especially high valuation given that this is increasingly likely to be a trend than a one-off. Intuitively, this seems to us to be the right level, it values the fact that previously written business created more value than was originally presumed, while at the same time not overstating it - after all, changing model assumptions ought to be more of a nudge on the tiller than a radical overhaul.

Exhibit 29 - Longevity releases by company (£m)

<table>
<thead>
<tr>
<th>Year</th>
<th>Aviva</th>
<th>L&amp;G</th>
<th>Prudential</th>
</tr>
</thead>
<tbody>
<tr>
<td>2016</td>
<td>200</td>
<td>400</td>
<td>600</td>
</tr>
<tr>
<td>2017</td>
<td>300</td>
<td>500</td>
<td>700</td>
</tr>
<tr>
<td>2018</td>
<td>400</td>
<td>600</td>
<td>800</td>
</tr>
<tr>
<td>2019F</td>
<td>500</td>
<td>700</td>
<td>900</td>
</tr>
<tr>
<td>2020F</td>
<td>600</td>
<td>800</td>
<td>1,000</td>
</tr>
<tr>
<td>2021F</td>
<td>700</td>
<td>900</td>
<td>1,100</td>
</tr>
</tbody>
</table>

Source: Jefferies

Exhibit 30 - Value of longevity releases relative to market cap

<table>
<thead>
<tr>
<th>Year</th>
<th>Aviva</th>
<th>L&amp;G</th>
<th>Prudential</th>
</tr>
</thead>
<tbody>
<tr>
<td>2016</td>
<td>0.0%</td>
<td></td>
<td></td>
</tr>
<tr>
<td>2017</td>
<td>2.0%</td>
<td></td>
<td></td>
</tr>
<tr>
<td>2018</td>
<td>4.0%</td>
<td></td>
<td></td>
</tr>
<tr>
<td>2019F</td>
<td>6.0%</td>
<td></td>
<td></td>
</tr>
<tr>
<td>2020F</td>
<td>8.0%</td>
<td></td>
<td></td>
</tr>
<tr>
<td>2021F</td>
<td>10.0%</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

Source: Jefferies, Factset
Corporate Optionality

Retaining the benefits
Given that the potential value of these changes to mortality assumptions could be worth up to 4% of Prudential’s market capitalisation, 9% of Legal & General and 11% of Aviva, one of the most critical strategic decisions will be how insurers use the financial benefit. Already there have been calls for the insurers to repatriate the benefit to shareholders via special dividends and stock buybacks, calls which we expect will amplify from here, as the extent of the benefit is recognised by the wider market.

However, we would urge the industry to be more cautious. Though it may prove to be an unpopular view, we believe that the industry has been presented with an opportunity to lock in considerably stronger balance sheets and protect their businesses from the numerous macro uncertainties that financial markets face. At a time when Brexit still presents a considerable business risk, financial markets appear increasingly volatile and the economic boom appears long in the tooth, this improvement in balance sheet strength could not come at a better time.

In our view, UK Life Insurers should be cautious when releasing reserves

Limiting recognition
Inevitably the magnitude of the potential assumption change will mean that insurers must recognise a substantial gain in IFRS earnings, or face the ire of their auditors. However, as we have already noted, IFRS gives insurers considerable freedom to build in reserve buffers through conservative assumptions. It is our view that management should seek to use this to its fullest effect and minimise the booked earnings benefit, for four reasons:

• **Market recognition.** Firstly, as previously noted, we believe the market will be unwilling to place a high valuation on these earnings and, even in our valuation, the P/E on CMI_2018 movements is less than 1.75x. Given the low value attached to the earnings, this is little value creation from recognising a higher benefit.

• **Long term uncertainty.** Secondly, the long duration of annuity liabilities creates an asymmetric risk and reward profile, where a one-off reward for releasing the financial benefits will be more than offset by the higher risk to reserve strength that will endure for the next 20 years or more. We do not believe shareholders should want cash today at the expense of a higher risk premium for two decades or more.

• **Life Insurers already have a high risk premium.** Thirdly, it seems to us that UK life insurers are already valued with a high risk premium, reflecting market concerns about UK based asset risk. Releasing reserve prudence would compound the risk premium, while retaining the prudence would be an offsetting factor if asset risk premiums rise.

• **Low interest rates make imprudence tempting.** Finally, the low asset yield (ROA) environment means that if reserves are released through earnings, then insurers will be tempted to pay this to shareholders, as the ROA is a diminishing share of the ROE. Thus recognising the benefit could tempt life insurers to weaken their balance sheets, while avoiding recognition will do the inverse.

Sacrificing special dividends today de-risks future dividends
Thus, should UK life insurers opt to retain a large proportion of the financial benefits from the mortality slowdown, this leaves management the option to smooth future volatility. If current mortality trends were to reverse, or asset values were to come under pressure, then management’s prudence when estimating annuity liabilities could be used to offset the earnings cost. This offset should not be understated, as it de-risks dividend flows, allowing the group to pay dividends even if the balance sheet came under stress.
Company Valuation/Risks

Aviva Plc
Our 12-month price target is driven by a multi-stage residual income model cross checked by our dividend discount model (DDM). Downside risks include a non-life underwriting downturn, Brexit impacts on UK property valuations, stalling of momentum at AIMS, falling UK equity markets and a credit cycle.

Legal & General
Our 12-month share price target of 273p is driven by a multi stage residual income model cross checked by our DDM, and values the group on 2019F 6.4% yield and 12.2X SII operating earnings. Upside risks include higher than expected bulks, Downside risks are a credit cycle, falling equity markets and declining infrastructure values post Brexit.

Prudential Plc
We model the group using a Multi-Stage Residual Income model, cross-checked by a DDM. Upside risks include faster Asian growth and further UK back book sales. Downside risks include unfavourable FX movements and a US equity market sell-off.

Analyst Certification:
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I, Mark Cathcart, certify that all of the views expressed in this research report accurately reflect my personal views about the subject security(ies) and subject company(ies). I also certify that no part of my compensation was, is, or will be, directly or indirectly, related to the specific recommendations or views expressed in this research report.

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Investment Recommendation Record
(Article 3(1)e and Article 7 of MAR)
Recommendation Published April 26, 2019, 12:05 ET.
Recommendation Distributed April 29, 2019, 00:00 ET.

Company Specific Disclosures
Mark Cathcart holds a long equity position in AVIVA PLC.
Jefferies Group LLC makes a market in the securities or ADRs of Aviva Plc.
Jefferies Group LLC makes a market in the securities or ADRs of Legal & General.
Jefferies Group LLC makes a market in the securities or ADRs of Prudential Plc.

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Underperform - Describes securities that we expect to provide a total return (price appreciation plus yield) of minus 10% or less within a 12-month period.

Please see important disclosure information on pages 18 - 24 of this report.
The expected total return (price appreciation plus yield) for Buy rated securities with an average security price consistently below $10 is 20% or more within a 12-month period as these companies are typically more volatile than the overall stock market. For Hold rated securities with an average security price consistently below $10, the expected total return (price appreciation plus yield) is plus or minus 20% within a 12-month period. For Underperform rated securities with an average security price consistently below $10, the expected total return (price appreciation plus yield) is minus 20% or less within a 12-month period.

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Other Companies Mentioned in This Report
- Aviva Plc (AV/ LN: p418.80, BUY)
- Legal & General (LGEN LN: p275.20, HOLD)
- Prudential Plc (PRU LN: p1,744.00, HOLD)
Rating and Price Target History for: Aviva Plc (AV/ LN) as of 04-25-2019

Mark Cathcart holds a long equity position in AVIVA PLC.

Rating and Price Target History for: Legal & General (LGEN LN) as of 04-25-2019

Rating and Price Target History for: Prudential Plc (PRU LN) as of 04-25-2019

Notes: Each box in the Rating and Price Target History chart above represents actions over the past three years in which an analyst initiated on a company, made a change to a rating or price target of a company or discontinued coverage of a company.

Legend:
I: Initiating Coverage
D: Dropped Coverage
B: Buy
H: Hold
UP: Underperform

Please see important disclosure information on pages 18 - 24 of this report.
### Distribution of Ratings

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<tr>
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<th>IB Serv./Past12 Mos.</th>
<th>JIL Mkt Serv./Past12 Mos.</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Count</td>
<td>Percent</td>
</tr>
<tr>
<td>BUY</td>
<td>1152</td>
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</tr>
<tr>
<td>HOLD</td>
<td>821</td>
<td>38.74%</td>
</tr>
<tr>
<td>UNDERPERFORM</td>
<td>146</td>
<td>6.89%</td>
</tr>
</tbody>
</table>

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