



PACIFIC LIFE RE

Re:think Mortality Improvements Return of volatility?

EUROPE | UNITED KINGDOM

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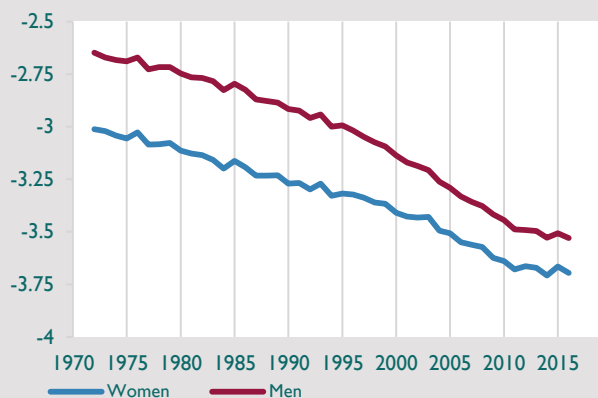
Recent commentary on UK mortality improvements has focused on the slowdown observed since 2010 compared with the preceding decade. While this evidence is suggestive, most analysis has smoothed and averaged raw data in order to detect a “signal”. This can lead to greater confidence being placed on the results than the data warrants, especially at times of high and changing volatility.

In this re:think we explore the possibility that what we have observed since 2010 is a return to more normal levels of volatility in mortality improvements after a decade in which they were unusually regular and predictable. Significant variation in the volatility of improvements has important consequences for anyone managing longevity risk and anyone using models which base short-term and medium-term improvements on recent average improvement rates.

Observed Improvements

Figure 1 may appear familiar; it shows the logarithm of standardised mortality rates from 1972 to 2016 and has been used extensively in recent articles and presentations on mortality improvements. The graph is often used to show a slowdown in improvements post 2010 and the uptick in 2015, sometimes only showing data since 2000 or with trendlines to draw attention to this.

Figure 1: Standardised mortality ratio



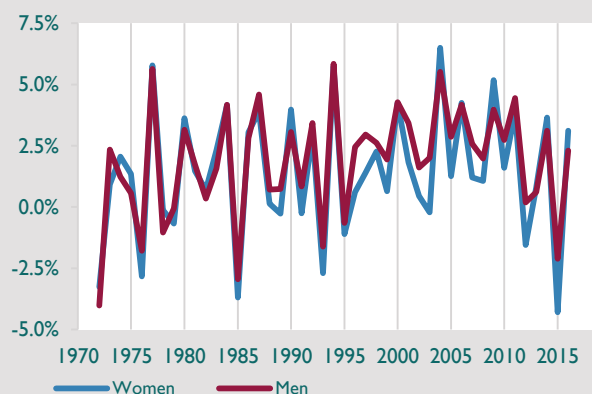
However, what is of more interest to practitioners forecasting mortality are the standardised improvement rates, which are plotted in Figure 2. When we look at the same data from the perspective of annual rates of change the story becomes more ambiguous.

In particular, the experience since 2010 does not look very different to what was observed in the 1970s, 1980s and early 1990s. Events such as the significant worsening of mortality

The standardised population used is England and Wales in 2010 (ages 60 to 89)

(negative improvements) in 2015 are unusual, but not unprecedented, being similar to 1972, 1976, 1985 and 1993.

Figure 2: Annual change in standardised mortality



The unusual period in this graph, if anything, is the decade and a half from 1995 to 2010, including two of the highest years of improvement over the entire period for women (2004 and 2009) and only one year of negative improvements for either sex (a worsening of mortality of 0.02% for women in 2003).

“Has the period between 1995 and 2010 biased our preconception of normal?”

However, this is the period in which many researchers become interested in mortality improvements. Therefore, the experience of low and stable improvements may have set the baseline that is used to define our preconception of “normal”, which could have important consequences for our analysis of later data. Has the period between 1995 and 2010 biased our preconception of normal?

Distribution of Improvements

The graph above highlights just how volatile mortality improvements are. Table 1 below shows summary statistics for the observed distributions of improvements.

Table 1: Distribution of Improvements 1972 - 2016

Moment	Male	Female
Mean	1.9%	1.4%
Median	2.3%	1.4%
Standard Deviation	2.3%	2.6%
Skewness	-0.52	-0.22
Excess Kurtosis	-0.13	-0.47
Probability(Worsening)	17%	26%

The first thing of note is just how high the standard deviation is, which limits any attempts to measure averages over a short time frame, such as over five-year intervals.

The second thing of interest is the high observed probabilities of experiencing a worsening of mortality in a year. By this measure, the odds of observing a decade and a half of consistently improving mortality purely by chance are very low. This highlights just how unusual the period 1995-2010 was in hindsight.

However, the negative skewness, especially for men, is indicative that there are more large, negative improvements than the normal distribution would suggest and the negative excess kurtosis implies that the peak of the distribution is broader and flatter (but the tails less heavy) than the normal distribution would permit.

However, tests of the normality of a distribution are often imprecise with relatively few datapoints (such as the 46 used here) so no analysis is conclusive that the improvements are not normally distributed.

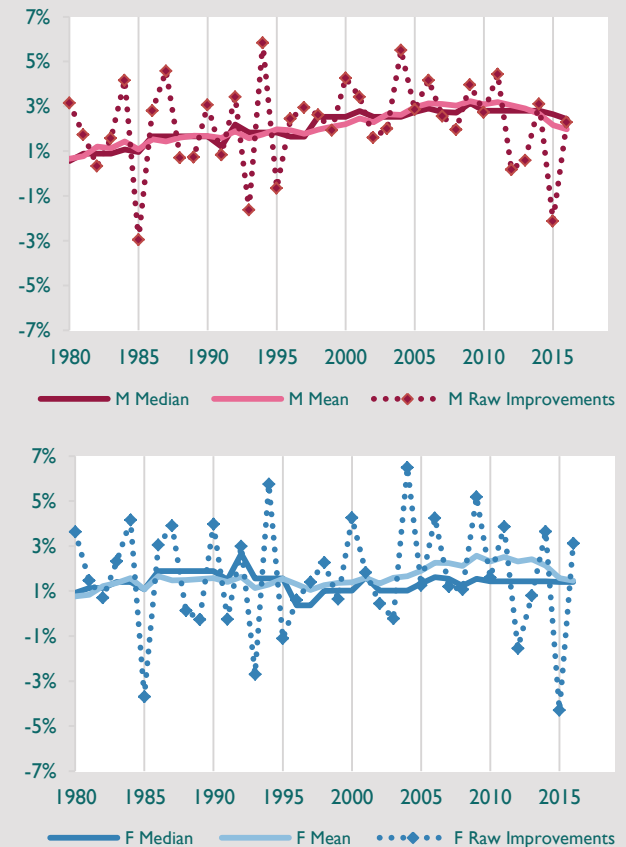
Whilst not conclusive, this again may indicate that there is a lot of uncertainty with mortality improvements. Conventional approaches based on averages and implicit reliance on the normal distribution may not capture the full story of what is going on.

Change of Trend?

Mortality improvements are often averaged over five-year or ten-year periods, in order to reduce their noise and detect any signal of changing mortality improvements.

Unfortunately, the mean can be a poor choice for this, especially over short periods and for improvements which are very volatile or have occasional extreme values. In these

Figure 3: Raw and 10 year average improvements



circumstances, the median provides a more stable and realistic estimate of “typical” improvements.

Figure 3 shows both the mean and median improvements (over the preceding ten-year periods) for men and women together with the raw improvements. The median is clearly more stable and is distorted less by the occasional very high or very low improvement - perhaps giving a more realistic picture of typical improvements over the entire period of the data.

For men, the median improvement increases broadly in-line with the mean up to 2010, but there is now slowdown after this point. For women, the median improvement has barely changed over the entire period since the 1980's and was significantly lower than the mean for most of the period after 2005.

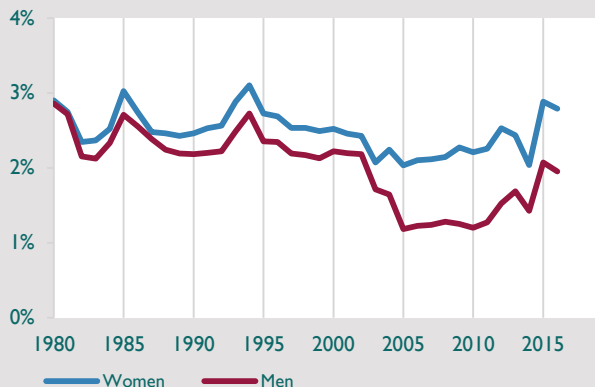
The lack of a slowdown in the median gives rise to some doubt about what has been happening with recent improvements.

It is also important to consider these average measures in the context of the raw improvements themselves. This suggests that we are seeing relatively small changes in the average values of highly volatile improvement rates. These changes are not statistically significant, even before allowing for any potential non-normality of the improvements.

“The lack of a slowdown in the median gives rise to some doubt about what has been happening with recent improvements.”

Using inappropriate averages can fool us into believing there is greater certainty than the data warrants – is this a change in the signal or noise?

Figure 4: 10 year average standard deviation



Return of Volatility?

Whilst investigation of averages can be difficult, standard deviations can be even harder, but can be a useful measure of volatility and produces some interesting results.

Figure 4 shows the rolling ten-year standard deviation of improvements for men and women. The volatility was consistently around 2%-3% over the period from 1980 to 2000. However, since 2000, there have been significant deviations from this level.

“... it may be more accurate to characterise the last few years as a return to volatility rather than as a change in trend.”

The volatility of improvements for men dropped substantially from its long-term levels in the first decade of 2010 and is only beginning to rise again after a period of quiescence.

The picture is less clear for women, but since male mortality rates are those that are most often shown, it has been this period of unusually low volatility in mortality improvements that has set expectations amongst those interested in longevity risk.

It may therefore be more accurate to characterise the last few years as a return to volatility rather than a change in trend.

Potential Explanations?

When looking for explanations of what we've observed, many commentators have speculated about a possible link between changes in public spending on health and social care and trends in mortality improvement.

It is certainly true that the period between 1995 and 2010 was generally a period of rapid increases in public spending. However, while this correlation is suggestive, over the longer-term it is likely that the trend in improvements is driven principally by lifestyle and medical factors.

Trends in these factors play out over the level of decades and whilst increased funding for preventative medicine and medical research can help, it takes years for the benefits of additional funding to feed into a healthier and longer-lived populace. This manifests itself in the remarkable stability of the median improvement rates seen over the past 40 years.

However, greater health and social care spending can improve the resilience of the population and so prevent events such as cold winters and influenza epidemics causing excess deaths. It is this that creates the volatility we observe and hence may explain the recent increase shown in Figure 4.

Variations by Socio-economic Group

Explanations are unlikely to be correct for the population as a whole; different socio-economic groups are likely to be experiencing varying levels of mortality improvement. Those in lower socio-economic groups, being more dependent on the provision of social care, may be experiencing greater shocks and may therefore be more exposed to a return of volatility.

Rather than necessarily looking for faster or slower mortality improvements in different socio-economic groups, it may be interesting to ask whether the volatility and skewness of improvements differs between these groups.

Given the limitations of using smaller datasets and controlling for consistency within them, it may be some time before we can answer this question definitively.

Implications

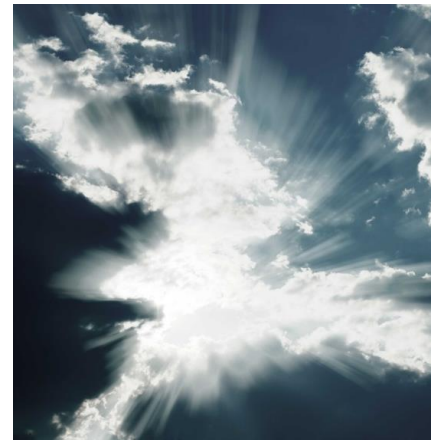
Mortality improvements are very volatile in the short term; this is an unavoidable risk of holding mortality or longevity risk. Averaging or smoothing this volatility can be inappropriate and lead to spurious accuracy or potentially lead to us mistaking noise for useful information.

We also see that the volatility of mortality improvements is different in different time periods and, potentially, for different groups of people. It is this constant flux that means that mortality rates are continually evolving, making the subject endlessly challenging to investigate.



PACIFIC LIFE RE

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