ABSTRACT OF THE DISCUSSION

Mr S. D. Baxter, F.I.A. (introducing the paper)**:** I shall introduce the question of whether or not mortality improvements should be subject to a minimum value. To be very clear about this, by 'mortality improvements' I mean how the probability of dying during the year of age x, that is the q_x value, changes from year to year for a fixed age x. The improvement is defined as the decrease in that q_x value from one year to the next. So, the improvement for a specific age x at a certain point in time t is given by formula (1) in ¶2.1.3.

Over the course of this introduction, I hope to convince you that, in order for our mortality projections to look credible, this value should be subject to some minimum value. I will provide a value for each of men and women which, based on historic trends, could be used at all older ages.

I should stress that I am a consulting pensions actuary, and come at this from the point of view of a practitioner. This means that I will be taking a deliberately pragmatic approach to the topic. In particular, my focus is primarily on the post-retirement mortality assumptions used for valuing pension scheme liabilities.

When thinking about this assumption, I typically split the problem into two parts: the level of mortality which a scheme is experiencing currently; and the projection of these mortality rates into the future. I expect that I am fairly typical in currently using the '92' series projections for this purpose, albeit with an allowance for the accelerated improvements seen among recent retirees via the use of the interim cohort projections.

In doing this, I am reliant on the basic '92' series projections to provide for any underlying level of long-term improvements achievable, for instance from medical advances, lifestyle changes and improvements in healthcare. In recent months I have found myself questioning whether the level of improvements assumed in these projections is adequate, or whether I should be subjecting the improvements to some minimum level.

With this background in mind, I have based my paper on the improvements published as part of the '92' series of tables. Despite this, I believe that everything which I say is equally valid when analysing the output of different projection models.

A summary of the basic '92' series projections assumed for mortality improvements is given in Appendix A, illustrated by Figure A.1. This figure shows that there was an assumed improvement of just over 3% between the years 1999 and 2000, at age 60. We can immediately see that, whilst improvements are relatively high now, they tail away fairly quickly, both with time and with age. This is a result of the targeted nature of the '92' series projections. They assumed that there is a natural limit, both to mortality rates and to life expectancy.

Although the '92' series improvements are age and time dependent, they assumed that mortality rates cannot fall below a certain lower limit. This lower limit was defined in terms of a percentage of the rates seen in 1992, and, in particular, a percentage of the rates in the base 1992 table. Critically, at older ages, this limit was taken to be quite high. For example, mortality rates at age 80 were assumed only ever to be able to fall to around about half of the level at which they were in 1992. At older ages still, at age 90, say, mortality rates were assumed to be able to fall by only a third. The speed of convergence to these limits also varies by age. A significant proportion of the convergence happens before 2012, i.e. only a few years hence. This means that, by using the '92' series projections, actuarial valuations are implicitly assuming a lower level of long-term improvements in successive valuations.

In reality, many valuations will also be making an allowance for the accelerated improvements observed among those retiring during the 1990s. This is known as the cohort effect. It effectively introduces a ridge of more rapid improvements, as shown in Figure A.2.

Turning to the question of projecting mortality, in terms of using the '92' series and interim cohort projections, I consider this as being in two parts:

— What allowance should be made for general improvements achievable via ongoing medical advances and improvements in healthcare and lifestyle, i.e. should a minimum level of improvement be applied to the '92' series improvements?

— For how long will the cohort generation continue to exhibit more rapid improvements in mortality rates, i.e. which of the short, medium and long cohort projections should be used (or should a hybrid be used)?

The focus of this paper is on the first question, in particular asking what allowance should be made for general improvements, and does this imply that an underpin should be applied to the level of improvements commonly adopted?

The Projections Working Party of the CMI Mortality Committee has been investigating a number of new techniques and new methods for projecting mortality. These essentially project trends in historic data to answer the two questions simultaneously. In many ways, the question of applying a minimum level to improvements can be seen as an interim measure until these new techniques are readily available.

My starting point for considering general improvements is to look at life expectancy rather than at mortality rates. Why have I chosen to do this? The first reason is that of communication. Trustees of pension schemes are required to adopt prudent assumptions for the purposes of funding. Company directors are generally required to use best estimate assumptions for accounting purposes. I would argue that our clients are more likely to have an opinion as to whether or not a particular life expectancy is prudent or a best estimate than individual mortality rates.

Secondly, life expectancy is actually highlighted in the Pensions Regulator's Code of Practice [Paragraph 80, Regulatory Code of Practice 03 — Funding Defined Benefits], which states that: "Particular attention should be paid to assumptions about future mortality. Here the experience is of a sustained trend in one direction, that of longer life expectancy ..."

Thirdly, when assessed from retirement, life expectancy also represents the length of time for which pension schemes will pay benefits. In current times of low net discount rates, it is also a good proxy to the item of ultimate concern — the annuity value.

This means that life expectancy represents the big picture. It enables us to step back from the detail of trends in mortality rates and look at the impact of our projections. That is not to say that trends in mortality rates should be ignored, merely that life expectancy helps us to view our projections through the eyes of our clients. With this in mind, I focus on projecting older age life expectancy. I define this to be life expectancy from age 65, so this represents the life expectancy from a typical retirement age.

In order to get a long history, I have used period life expectancy. For any calendar year, this is calculated using the mortality rates experienced in that year. This is an objective measure, which can be calculated in a mechanistic way. Unlike cohort life expectancy, which is life expectancy by year of birth, it is a quantity which can be calculated right up to the start of the 21st century. This means that it captures the most recent history in improvements in longevity. Period life expectancy also has the merit of capturing the effect of year-on-year improvements in mortality.

Section 4 outlines the general trend in life expectancy from age 65. I have used England & Wales data, as they provide a long history and, in particular, are indicative of general trends in mortality and in longevity improvements. In recent times the trend has been remarkably linear.

Since I am looking at the underlying trend in improvements, I wish to avoid any unnecessary distortions from the more rapid improvements owing to the cohort generation. At the national level, the cohort generation started later and relates to those born between 1925 and 1945. So, for the purposes of analysis and of extrapolating this trend, I need to exclude the data points from about 1995 onwards.

I now draw your attention to the most recent data points. These have a propensity to lie above the overall trend line. This suggests that the current trend, even excluding the cohort effect, is faster than historic levels, so that any improvements derived by looking back at the very-long historic trend may be an understatement.

We can extrapolate this trend into the future, and Figure 6 shows how this compares to the '92' series projections. By excluding the cohort data points, we have reduced the problem to comparing the projected trend in life expectancy from age 65 to life expectancy under successive calendar year tables. Overlaying the '92' series calendar year tables, starting with PFA92C2006

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on the left going through to PFA92C2050 on the far right, we can see that, after some initial divergence, the '92' series converges towards the national trend. Once we have reached the 2020s, the '92' series is suggesting a lower rate of year-on-year increase in life expectancy than the sustained trend seen virtually throughout the 20th century.

In terms of the topic of this paper, a simple and pragmatic way of avoiding this potential anomaly is to subject the rate of annual improvement in mortality to a minimum value, also known as an underpin. This simplistic approach has the dual advantage that the resultant tables are easy to calculate and that the approach is very simple to communicate; indeed, to the extent that our clients are unlikely to understand that it is a simplification. Figure 7 shows how, by using a minimum of ¾% p.a., projections of female life expectancy at least keep pace with the extrapolation of the national trend.

Looking at Section 6, it is very apparent that the increases in male life expectancy since 1970 are also especially linear, once we exclude those data points which might have been distorted by the cohort effect. Fitting a simple trend, we see that period life expectancy from age 65 was about 12 years in the 1950s and 1960s, and since then has been increasing at about 41 days per annum. Using a similar approach to that for women, Figure 13 compares the '92' series projections to the extrapolation of the current national trend for men. This gives rise to a rapid convergence of the '92' series with the projected trend, i.e. the '92' series projections fall well short of the 41 days per annum increase in life expectancy being seen at the national level. Figure 14 shows that, when using a minimum improvement of 1¼% p.a., projections of male life expectancy keep pace broadly with the extrapolation of the national trend.

You might wonder what these extrapolated trends are assuming about the relative differences in life expectancy between men and women. For example, am I assuming that, at some point in the future, men will outlive women? The solid line in Figure 17 plots the history of differences in female and male life expectancy from age 65 over time. It can be seen that there is a very discernible hump in this chart. Women outlived men by about nine months back in the 19th century. This reached a peak of four years in the late 1970s and the early 1980s. The dotted line is based on the extrapolated trends for men and women shown earlier in the paper. We can see that, by the time we reach 2050, I am not assuming that men outlive women — far from it. There is still a one-year difference in life expectancy.

We also need to check whether, when we apply different levels of minimum improvements to men and women, we will end up with men outliving women. For this purpose, it makes sense to look at cohort life expectancies, i.e. those based on an individual's year of birth. These allow for the different levels of improvements in mortality for men and women, both up to age 65 and in the years thereafter. Using the improvements of 1¼% and ¾%, suggested in ¶6.4.2 and ¶5.4.4 respectively, gives a fairly comforting picture in Figure 18.

So far, I have considered a pragmatic practitioner's approach to determining an underpin to future mortality improvements. There are a number of reasons why individual actuaries might come to different conclusions. For example, I have focused on life expectancy from age 65. In practice, members of different pension schemes may retire at different ages. Alternatively, you may be most concerned with the retired members of a pension scheme, so would consider older ages. I have also looked at the big picture of life expectancy. Ultimately, this is a simplification of underlying trends in mortality rates. Lastly, I have assumed that the past is a guide to the future, and doing this in isolation can be dangerous.

So, starting with life expectancies at different ages, we can repeat the analysis seen earlier for a number of different ages. Table 3 summarises this.

I have omitted the results for males from age 55, which is because, for age 55, I cannot differentiate between the long-term trend and the cohort effects, as they start at too similar points in time.

We can see immediately that the conclusion as to what level of underpin to use is not particularly sensitive to retirement age. This is hardly surprising, as life expectancy is most sensitive to mortality rates between the ages of 75 and 90. However, looking at older ages, we can see that there may be some kind of underlying age structure, which I have simplified by purely looking at life expectancies. This might lead us to question the simplicity of using a single

underpin. For example, perhaps an age dependent underpin would be more appropriate. To understand more about the trends, we need to look at the last 40 years in more detail. Once we do this, and start looking at the year-on-year improvements in mortality rates, there is considerable variation. To smooth out this variation, we need to focus on key ages and to look at moving averages over time. This is illustrated for men in Figure 25, which shows a clear trend of increasing improvements. If trustees or sponsors are seeking an assumption whereby improvements continue at the most recent levels, then an annual rate of improvement closer to 2% p.a. might be appropriate. However, it also shows that the 1¼% p.a., discussed in ¶6.4.2, may be a broad average over the period in question.

For women, Figure 28 shows that the improvements over the last 40 years have averaged at about 1% p.a., again broadly consistent with the number which I gave earlier. Figure 28 also shows an interesting feature; the ageing of mortality improvements. We can see this by looking at the 80 to 84-year-old age band. At times this has actually been higher than the level of improvements seen among 75 to 79 year olds. This is important. As individuals live longer, so the emphasis shifts to improving mortality and morbidity at the older ages, with the most rapid improvements occurring at gradually older ages. This observation was one of the many features of trends in mortality rates identified by a cross-board Working Party, which presented the paper 'Longevity in the 21st Century' (Willets *et al.*, 2004). That paper, which is considered in Section 10.4, provides a comprehensive analysis of trends in mortality rates, and it includes analysis of the trends by cause of death.

However, the far more detailed analysis contained in that paper verifies a number of the observations which I have made already. For example, Table 4 is an extract from that paper. This table shows the annual level of mortality improvement between 1960 and 2001 for men and women. Firstly, for males, we see a verification of the age structure with improvements decreasing with age. We can see that the 1¼%, which I suggested in ¶6.4.2, is a broad average of these values. We can certainly see that there is a degree of stability across the age groups for women. However, Table 4 also suggests a higher level of improvements for females than I gave. This is not surprising, given my earlier observation that female life expectancy seems to have been increasing more rapidly over recent years than over the long term.

With this in mind, it is important to consider whether or not the past is truly a guide to the future. Consider the following quotation from Professor J. Olshansky, at the University of Chicago, who said: "Some make blind forecasts by looking in the rear view mirror which is equivalent to making weather forecasts by looking at past trends for a given date in history rather than looking over the horizon to see whether there is a storm approaching. We see a storm approaching — it is obesity and infectious diseases ...".

Professor Olshansky speaks of a storm approaching, and we should be cognisant of this. In particular, if we believe Professor Olshanksy's words, we may wish to modify the level of minimum improvement downwards — for example, if our best estimate is that of a series of medical challenges which will set back mortality improvements. Equally, we may wish to modify our underpin upwards if we can identify a wave of future improvements.

How we have achieved the mortality rates which we now see is dealt with in Section 11, describing the health and the epidemiological transitions. The first relates to improvements in public health, and the second relates to specific causes of death. In particular, the effects of smoking are dealt with in Section 11.4 and of obesity in Section 11.5.

So, what are the implications of applying a minimum level to mortality improvements? To be clear, what I am suggesting as an interim solution is that we continue to use the '92' series improvements, we make some allowance for the cohort effect, but we also make an allowance for the continuation of general improvements in longevity, via a non-zero minimum level to mortality improvements. I see this as an interim step, given the new techniques which are on the horizon. The implications for pension scheme valuations are discussed in Section 12.1 and Appendix F.

I mentioned earlier that the CMI is currently looking at a number of new techniques for identifying the underlying trends in mortality improvements and projecting these into the future. The approach at which I have looked is deliberately simplistic. It is worth considering how it

compares to where we might end up in the future, with the *P*-spline and the Lee-Carter methods, which are discussed in Section 12.2. I think that this is an important point, since our clients have effectively been hit by increases in life expectancy at a number of successive valuations.

However, the improvements which I have suggested so far might turn out to be lower than reality if current trends continue. It is also important to convey the uncertainty in these projections, perhaps by illustrating results on a variety of different minimum levels, or on a variety of projection techniques.

In conclusion, the original '92' series projections give life expectancies at older ages which do not keep pace with historic trends, even after allowing for the 'cohort effect'. One simple pragmatic solution is to subject these mortality improvements to a single minimum value at all ages. Historic trends in life expectancy might suggest a value of ¾% for that minimum for women and 1¼% for men. Ultimately, this does simplify an underlying age structure to mortality improvements. Further, wider considerations, such as the scope for medical improvements or the socio-economic profile of the particular pension scheme at which we are looking, might lead individual actuaries, trustees and sponsors to arrive at different conclusions.

Mr R. A. Humble, F.I.A. (opening the discussion)**:** The comments which I make are my own, and do not necessarily reflect the views of my office, and they are those of a life office actuary rather than from a pension scheme perspective. Looked at from that way, I think that it is important to make a distinction between two very different situations. The first is when considering the appropriateness of a minimum level of improvement in the context of the rest of the improvements being considered to be realistic. The second is where an office, for reasons of public presentation, may state that its basis is a particular cohort assumption, coupled with a floor of improvements, but may regard the underlying cohort assumption as being prudent.

Taking the first situation, where the other levels of improvement assumption are considered to be realistic, I am not aware of any evidence to support the contention that improvements trend to zero as the '92' projections (which ultimately end up being what occurs in the long term under the cohort methodology) imply. Members may well be aware of the work of Jim Oeppen and James Vaupel in this area, in particular their article in *Science Magazine* in 2002, entitled 'Broken Limits to Life Expectancy'. Indeed, Mr Oeppen, in a joint presentation made with the International Longevity Centre, in this Hall in 2003, gave a very impressive account of their work in this area.

They analysed the trend in life expectancy over time for the country in the world which, at that particular time, had the highest life expectancy. They did not find that it levelled out to a constant, as implied by the '92' projections, but they found that it had continued to increase at a constant rate of a quarter of a year per annum over a period of 160 years. Any suggestion of life expectancy levelling out at some point must be questioned extremely seriously.

Notwithstanding these historical data, I agree with the author that there are other factors which may lead to mortality improvements slowing, or even going into reverse. There has been much press publicity about the possibility of virulent strains of influenza. Indeed, in recent years, we have had some quite near misses on the mortality front. We were very lucky that the AIDS virus proved to be so fragile that it was not easily transmitted by touching door handles, or some such thing. In the case of SARS, we were extremely lucky that that infection was symptomatic before it became infectious, in stark contrast to the cold or influenza.

Obesity was also mentioned. This is an important factor. The impact in the United Kingdom may be different from that in the United States of America. I think that the impact on annuities currently in payment is likely to be rather limited. Looking longer term, obesity, undoubtedly, is an important factor.

If one is looking at a realistic basis, it seems clear that you should have a significant floor as part of that basis. However, returning to the second situation which I have described, i.e. where an office chooses to publish, or to present, its results on the basis of some combination of cohort with a floor; it may have its own internal model on which it is basing its assumptions, but does not wish to publish the model. Here there may be no inconsistency; if it considers the particular

cohort assumption being adopted as conservative, it may not consider having a lower floor, or even no floor at all, provided that the resulting reserves are at a level consistent with its base internal assumption.

The kind of reason which might lead one to take the view that the particular cohort methodology being published may include elements of conservatism is, as the author has indicated, that there is a significant view that a major contributory factor to some of the cohort improvements is, particularly among males, a consequence of changes in the prevalence of smoking. Notwithstanding statistics relating to the relative proportion of smokers, I think that, if we look at the statistics in more detail, we find that a high percentage of current smokers tend to be young, and that people tend to give up smoking as they get older. The reduction in smoking prevalence among people at older ages has been very marked over the period from 1974 to the current time, which is the period over which the ONS statistics are available. Therefore, changes in the prevalence of smoking may be a considerable contributory factor to the cohort effect, and it may not be realistic to project these improvements forward at that level.

Mr P. J. Tuley, F.I.A.: I am speaking from a life insurance point of view. I also think that the analysis of statistics is extremely important in judging potential future outcomes for this very important topic, which covers both our pension practice area and our life practice area. I fear that the study of statistics on its own will be rather unrewarding eventually, in the sense that it does not bring us to a clear view of the whys and wherefores of the future. We need to spend more time looking at medical science and the drivers of mortality in the future, so that we can better understand what is a plausible future and what the medical science being reported today on the front pages of our newspapers could actually mean for our annuity books.

I suspect that work is going on in various large life offices and pension consultancies, but more needs to be published openly to give credibility to the fact that we, as a Profession, know quite a lot about longevity.

Speaking as a regulator, on behalf of your guest, Mr Tower, we necessarily have a very deep interest in the views of the Profession and the research which the Profession undertakes in this important area. I suppose that we start from the basis that any longevity statistic, which is deeply uncertain on just its best estimate basis, requires a high degree of caution when you come to set prudence or stress, as you do in the life insurance arena, for Pillar I liabilities and for Pillar II capital. So, our view is not to have some type of minimum improvement factor, which looks extremely bullish in the context where you are unsure of the best estimate position. We would be looking for very robust science and reasoning behind anything which looks like a medium cohort, with no improvement factors beyond those already in the table, acknowledging the opener's comment that you could get your margins in a rather different way in any case.

That leads me on to pricing. The bulk annuity market, at the moment, is quite fierce in terms of its pricing. Again, from a regulatory point of view, that is the shareholder's issue or problem. Provided that there is good capital there, customers will be safe. However, bullish or aggressive pricing markets in any branch of insurance do not justify weak reserving standards.

Mr P. M. Greenwood, F.I.A.: I support the author's work. He has drawn attention to an issue about which I have become very concerned over the past nine months. Is medium cohort reserving sufficient, especially for final salary schemes with closed memberships, with a substantial proportion of pensioners from the cohort generations? I have come to the view that it is not. I think that the author's conclusions are very similar. I support his logic for some minimum level of improvement. My own conclusion, based on the data of the past two or three years, is that the rate of improvement for the cohort generations seems to be increasing slightly rather than falling away. So, unfortunately, I suspect that we need to do something in addition.

My concern is that, with schemes shutting, and with the period left before more or less the whole of the cohort generation is in retirement, we have a very short time in which to correct the current underreserving.

Mr B. P. Ridsdale, F.F.A.: It was suggested that we should be looking at the drivers of

mortality, in medical science and in other areas. I would like to draw attention to one or two of these areas in which the Profession is presently working.

First, there is the Actuaries' Panel on Medical Advances, which was set up some years ago. It is running a major project called 'Modelling the Demographic and Financial Effects of Medical Advances'. It takes the approach that, if we can find a way of modelling the impact of a particular medical advance on, for example, coronaries or strokes, and if we can track that through to the resultant improvements in mortality, we should then be able to test a variety of scenarios to find out what might have the best impact on the future population. The work is being sponsored by the Profession and the ESPRC. It is being run in Heriot-Watt University, and it is due to report later in 2007.

There is a multi-disciplinary research project, with start-up funding from the Profession, run by University College, London. It is entitled 'The Contribution of Medical Advancements to Mortality Improvements from 1970 to 2000'. The intention here is to test a variety of models to measure the impacts of factors, such as medical advances, behavioural changes, material changes and socio-political issues, on longevity. One of the most interesting outcomes is expected to be tables of contributions, showing the estimated reduction in population death rates resulting from each of the different developments.

Running at the moment, chaired by the Chairman of the Research Committee, is a six-month 'Scoping Mortality' research project. Taking its lead from a request in the seminal paper Willets *et al.* (2004), it aims to look at improvements in mortality from a multi-disciplinary angle, and at the potential for the future. The project is aiming to take a really wide view on what is happening in other disciplines, and to come up with a scoping study which might include, if possible, a two-dimensional plan, which shows where gerontologists, other medics, epidemiologists, health economists, demographers and a variety of other professions are researching in the field of mortality, how they interrelate, and whether there are any gaps. The idea is to seek out those gaps, and to focus possible future multidisciplinary research on those areas.

These are just three areas which are being worked on by members of the Profession on a multidisciplinary basis, and are funded by the Profession.

As the author stated, looking at the past to understand the future has its limitations. If nothing else, if you could find a way of calibrating your projections, based on the past, with clearer ideas of where mortality might go in the future, you might get a feeling for whether you are going in the right direction.

Mr N. R. Bankhead, F.I.A.: I am with the Board for Actuarial Standards. I start by saying that mortality is not a matter which the Board has considered in depth, to date, but I think that it is true to say that it will undoubtedly fall into our arena at some stage in the future.

Today's question, though, is looking ahead at some of the issues which I think we should ask ourselves when we come to look at the matter. I took the title of the paper: 'Should Mortality Improvements be Subject to a Minimum Value?', and I changed it slightly to see what I could find. I altered the words to: 'Should Mortality Improvements be Subject to an Arbitrary Value?' That, somehow, seemed a lot less attractive.

It led me to consider the question: "Why would it be necessary even to go down that line of thought?" I think that it comes down to this question, which is a key one: "Can longevity itself be forecast reliably?" That seems to me to be the key question. If the answer to that is 'Yes', it is quite simple, we should do so. If the answer to that is 'No', we should probably say so.

The second issue is to look at longevity itself, and ask what it represents. If the future regarding longevity is not certain, it must represent a risk. The questions are: "What sort of risk is it which it represents? Is it a diversifiable risk, or is it non-diversifiable?"

It seems to me that it is probably a non-diversifiable risk. So, whatever your expectation, by holding more of that risk you have concentration. You are not disbursing the risk. If you then asked: "What measures do you have for covering risk?", if it is a non-diversifiable risk you could say: "Let us try to cover that in the measure." However, even that may not be successful. I think that you would come back to the answer that, if you are facing a non-diversifiable risk, the

answer is going to be to hold capital. Outcomes in the future may vary, and that would be the method of providing security.

Mr R. B. Colbran, F.I.A.: I have reached the age when reminders of my personal mortality come with ever-increasing frequency. I remember a lady saying to me some years ago that old age seldom comes alone, and, as one gets older, one appreciates the meaning of this. There was a piece in the *Financial Times Magazine* this weekend attributed to David Blake, where he was saying that our grandchildren might live to age 160. However, it seems to me that the human body begins to deteriorate such that there must be an ultimate limit beyond which it becomes impossible to continue. This is a point which some of these projections seem to be ignoring.

When lay people project trends, as they often do, I tend to tell them that actuaries absorb, with their mother's milk, the dangers of extrapolation. Yet, we have here a paper which seems to depend entirely on extrapolation, and, therefore, I regard the graphs in the paper as highly dangerous. We could well be in the situation of being over-anxious.

One other thing which strikes me, as time passes, is that there are an increasing number of ever more expensive medical treatments to prolong life. At some time, there must be a limit on what the country can afford to spend in this area. Similarly, from presentations in this Hall, we have seen that the full life expectation is increasing faster than the healthy life expectation. I find that very disturbing. It seems to me that more and more state costs are going to be spent on keeping people who need great amounts of care alive. I do not know when it will happen, but, at some time, governments will have to address these issues and to deal with the costs. The changes which they then make could have some effect on life expectation.

Mr R. J. Houghton, F.I.A.: When I saw the graphs extrapolating the baseline improvements, I thought that we had a trend in the past which was flat, then we had a step change, it moved to increasing, and then that increasing trend was extrapolated. Why would there not be another step change in the future? It could have happened already in the past, but we do not have enough evidence to see that step change. It almost seems a little arbitrary to use the past trends to say what the level should be in the future.

Another comment which I have relates to the medium cohort, where we have a ridge of more rapid mortality improvements. It is the younger ages, below the cohort, which do not have rapid enough improvements. Whether your floor minimum value is the correct level to use for them, who knows? I think that it is far too subjective just to apply to an interim improvement table (MC), which may be deficient at younger and older ages, a floor into the future where there could be big step changes which we have not yet identified.

I would prefer to see more use of some of the *P*-spline methods, which are more statistically valid, until we can actually pull together with the medical profession and get their comments on this very interesting subject.

Mr R. J. Hall, F.I.A.: I plead guilty to being another life insurance actuary, albeit one who occasionally treads into the area of pension schemes.

It is worth noting that the use of minimum improvement factors by insurers is, to some extent, in the public domain. As at 31 December 2005, the majority of the larger annuity providers were using minimum improvement factors of between about 0.6% and 2% per annum for males, and 0.6% and 1.5% for females. This is in the public domain (within the annual returns to the FSA), but only for the bases which are used by life insurers for their mathematical reserves, which are intended to be prudent assumptions. However, from experience, this does tend to feed through into pricing calculations, by reason of the need for insurers to reflect the cost of regulatory capital, and, hence, affects the prices offered for bulk buyouts. In turn, this is relevant, in a pension scheme environment, to the quantification of Section 75 debts, and, increasingly, to matters such as IAS 19 disclosures, and, indeed, to funding disclosures more generally. Also, perhaps, it may be of relevance to Technical Memorandum No 1, governing the annuity rates used in statutory money purchase illustrations.

The author mentioned that he was a practitioner, looking at matters from a practitioner's

viewpoint. I wonder whether this may be viewed by pension scheme practitioners as some further evidence to support the use of minimum improvement factors.

Mr D. C. E. Wilson, F.I.A.: I shall pick up on the question which was asked earlier about whether longevity can be forecast. Most of us would agree that the Actuarial Profession has answered that question by saying: "No, it cannot", and hence the CMI Bureau has said that it is no longer appropriate to publish any standard improvement factors for use, and, therefore, actuaries will have to come up with their own assessments.

So, we recognise that there can been no accurate forecasts. Nevertheless, we all have to come up with some basis for assessing reserves, assessing prices, and other such factors, hence the sort of statistical results at which we have been looking in this paper. Clearly, there are limits. If we start to look towards medical improvements, that is one thing, but, as another speaker effectively indicated, there comes a point where it is no longer about medical advances, it is a political decision about how long people will live, because of the amount of money which it would take to prolong life.

There then comes a question whether that political decision is, itself, affected by the sorts of things which actuaries do. For example, I think that the more of this risk which is picked up by the private sector, where the Government can, perhaps, think that it is a risk which can be ignored from their perspective, then it could have a knock-on effect on what the outcomes will be.

Thus, this is a very difficult question.

Mr J. L. C. Lu, F.I.A.: One question which I keep asking myself is: "How reasonable are these projections?" It does not matter what projection we use: MC; MC with a floor; and so on.

There have been several developments in the demography arena, where they look at the age structure of mortality. One example is the use of Gompertz's law. We already know about age structures, such as that given by Gompertz's law, as well as convergence at older ages. There are also questions for asymptotic levels of mortality rates. Is there a minimum level at these ages? It is said that the only two certainties in life are death and taxes. Are we going to predict such a low level of death rates that they will become unreasonable?

Also, what kind of scenarios are we projecting? Can we articulate them? Can we describe them to other people in other professions? Can we say things like: "This will mean that $x\%$ of heart attacks can be cured"; "Cancer can be cured"; or "We can postpone death by two months every year"?

We need some tools to help us to visualise these future scenarios.

Mr J. Goford, F.I.A.: I would seriously recommend that those of you who can do so come to meetings of the International Longevity Centre (ILC), which are held in this Hall every couple of months or so. People attend who are much closer to the drivers of mortality than we are. Wholly unscientifically, I would say that the impression which I have gained from attending these meetings is that, in their view, longevity is increasing at a far greater rate than the numbers which we have in the paper are showing.

There is a huge divergence, it seems to me, between those of us who are looking at trends and those who are looking at the drivers. That, in itself, should be reflected in the individual capital assessment's (ICA) capital and, indeed, the cost of that capital in pricing.

One of the characters at the ILC U.K. meetings is Aubrey de Grey, who runs the Methuselah Foundation. He is of the view that, until recently, medical science has concentrated on two things. One is keeping people alive who are already sick, and the other is trying to do things to prevent people getting sick in the first place. It is his view that there is a third way, in the middle, which he calls 'repairing'. There, you allow people to get sick, but you repair that sickness and rejuvenate them by so doing. He draws the parallel of having a loose tile on your roof. There are those who patch up the wallpaper on the inside, but the rain is still coming in. There are those who are growing trees around the outside to prevent the next tile coming off. He is a repairer of tiles.

In his view, there are only seven damages to be repaired, and there have been no more than seven discovered in the past 20 years. It is also his view that a repair mechanism for all of these seven will be available in 20 years. He, therefore, comes to the conclusion that the person who will live to age 1,000 is already alive, because that person will die only by accident. That is his view. It is extreme one, but sincerely held.

There is a whole breadth of other views at the ILC meetings.

I think that both the level of this risk, and its uncertainty, should be increasingly worrying to trustees and to sponsors. They should be dumping these uncertain risks as fast as they possibly can, and getting on with making widgets, which is what their shareholders gave them capital to make.

Mr D. B. Martin, F.F.A.: We have been discussing mortality improvements generally, without specifying at which area we are looking. Pensions and life offices have been mentioned. Most final salary pension schemes, perhaps sadly, have a closed membership, so that we are looking at a group of people who are probably over a certain age, maybe mid-30s at the youngest. Average age is increasing very fast. These people are those who are connected with the cohort effect about which we have been talking.

We have also heard about the effects of childhood obesity, and other negative lifestyle factors. My view is that they are likely to affect a different set of generations. If we are looking at a different problem, which may be, for example, projections of mortality for the population as a whole, we might have different considerations. If we look at other countries — we have heard a little about the U.S.A. — there are many in the world where trends are very different. We heard about how our anxieties about AIDS, thankfully, have not come to fruition in the U.K. However, if we look at countries in the south of Africa, the situation is very different.

I read the other day that, in Russia, because of changes in economic conditions, life expectancy is reducing. So, the economic situation also affects mortality.

To summarise, my point is, depending on where we are looking, which group we are looking at, and what problem are we are trying to solve, the appropriate projection may be very different.

Mr N. D. V. Bodie, F.I.A.: I have considerable sympathy for the author's views regarding the application of a minimum rate of mortality improvement, and I point out that my recent move from a leading benefit consultancy to a leading audit firm has not coloured my view whatsoever.

A fairly broad brush approach to allowing for improving longevity has advantages. I find the suggestion that we can project year-on-year rates of mortality improvement to several decimal places somewhat implausible. However, the clear continuation of the cohort effect means that a broad brush approach across all ages is inappropriate.

Nevertheless, I will make a somewhat esoteric point regarding rates of mortality improvement at extreme ages. Is it appropriate to apply the same minimum rate of improvement to people at ages 90 or 100 as it is to people who are aged 65? It is making a very strong statement about how fast we expect the limit to life, if, indeed, there is such a thing, to be pushed out. It probably does not have a significant effect on normal retirement age annuity values, because of discounting. However, with expectations of life, which are clearly not discounted, we may find that this disclosable item will be significantly affected by the extent to which we are projecting higher age longevity improvements.

Also, although it does not affect current annuity values very much, a minimum rate of mortality improvement will affect the liabilities for younger active members of occupational pension schemes. There are a few such in the private sector, but it will have a more significant impact on the cost of public sector benefits.

Mr M. A. Pomery, F.I.A.: I share with you one anecdote, one observation and one request. The anecdote is this. During the course of my Presidency I was giving a talk at a conference, and I found myself sitting at the top table, before the conference started, next to an elderly gentleman who introduced himself as a Member of the House of Lords.

I asked him what his background was. He said that he was an economist. He asked me what my background was and I told him that I was an actuary. He said: "Oh, yes, you are the people who got mortality all wrong!"

I started talking to him about some of the issues here, very briefly. He said: "It is very simple, really. You just take the current trends and project them forwards." I had in my mind one of the figures in the paper, which illustrated that life expectancy had not only been increasing for a long time, but the rate of increase had been speeding up. I said: "The difficulty with that is that, if you do that, then we all become immortal." Then I heard about Aubrey de Gray, and I am wondering whether he might have been right and I was wrong. However, it seems to me that the rate of increase in life expectancy has to slow down at some time. The problem is that we do not know when, and we do not know by how much.

My observation is about the drivers of change. It seems to me that, when you look back over the last 50 years, you can identify, quite easily, things which must have led to an improvement in life expectancy: fewer people smoking; improvements in the medical profession; better lifestyles; and better understanding about things like diet, and so forth. Trying to quantify these is quite difficult, because you do not have a control group. It is quite difficult to get a control group to say: "If we had not had those improvements in diet, this is what the life expectancy would have been, so now we can measure how much it has improved." That creates problems when we are looking forward.

My request, or my plea, is around the question of uncertainty and communicating uncertainty. The graphs and the projections in the paper are all very nice. We look at them, and they all look very plausible. As actuaries, we must not be taken in by them, and, when we present our results to clients, we must not forget to keep reminding them about how uncertain all this is.

However beguiling the projections and extrapolations of the trends and the applications of minimum values seem to us as actuaries, we must remember to keep stressing the uncertainty of our work.

Mr D. A. Shaffer, F.I.A.: I thought that the title of the paper was rather cleverly ambiguous. It might mean: "When you do a technical valuation, or pricing exercise, should you use a minimum number like a 1% floor going forwards?" On the other hand, it might mean: "Should some sort of regulatory body be imposing a minimum on the profession, because individual actuaries who are making projections are not doing that in a sensible or plausible way?"

I think that most of the discussion has been around the first interpretation, whether or not it is plausible that an individual actuary ought to use a minimum. I would be interested in the views of others on whether the regulators ought to be imposing a minimum, given that there is a very wide dispersion of views, particularly in the pensions world. There seem to be many pension funds using no floors in their future improvements, which seems to be moving away from what a lot of people here seem to think. I would be asking some of the regulators whether they would be considering putting a minimum floor across all actuarial projections.

Mr D. Norgrove (a visitor; The Pensions Regulator)**:** The short answer to that is 'No', but I suppose that I should say a little more than that.

I am very grateful to have been invited here to hear a very interesting discussion, as we all grapple with an extremely difficult and imponderable subject. I suppose that my overwhelming feeling about it is that, even if projections are impossible to do with any degree of certainty, and are statistically not valid if you are looking at it as a professional statistician, they have to be done.

Then the question is: "Is it better to be underestimating or overestimating longevity?" That is a question on which different people are going to have different views. Of course, as a Regulator, we come down on one side rather than on the other. As professionals, the question would be: "On which side, from the point of view of the Profession, is it better?" I suspect that the criticism is more likely to be from the point of view of under-reserving or under-providing than of over-reserving or over-providing.

The other thing about which we clearly need to think, and I know that the Board for

Actuarial Standards and the Institute are thinking about it, is who owns this question? The question is: "How long are people going to live?" I am not myself convinced that who owns that question is yet clear, but I do believe that it needs to be owned, not necessarily by one institution alone. Together we have to work out a way of coming, not to a consensus which leads to one, single answer necessarily, but to a set of views which then can be taken forward, however uncertain they are.

Mr L. Churchill (a visitor; Pension Protection Fund)**:** I should like to add my perspective, both to the remarks of Mr Bankhead and also to those of Mr Norgrove. It seems to me that, where you cannot predict something exactly, then you should treat it as a risk factor. The questions then are: "What spread of risk are you going to consider?" "What stress test are you going to apply?" "What difference does it make as to what answer you obtain?" The key issue might be how well capitalised occupational pension schemes are.

As my life coach used to say to me whenever I was in a spot of bother with my personal life: "How would money solve this problem?" I think that it has a contribution to make, but that leads us into the Solvency II area, and so on, and some very difficult, practical issues for the U.K., given the heritage from which we are coming.

Mr A. G. Sharp, F.F.A.: I have a few comments from the perspective of the Profession's Pensions Board. Certainly we do not want to take over anything which the Regulator might want to do in this area, but we are conscious, particularly, of the need to make the whole subject of mortality, and the all the new research, much more accessible to all pensions actuaries of firms of whatever size. There are various initiatives under way in this area to provide more tools on projection methodologies.

What we have not talked about in this discussion is base mortality. This is something, again on the pensions side, on which we have focused less than we might.

The Self-Administered Pension Schemes (SAPS) Investigation has already put out three working papers. This is something which is obviously very new in the pensions arena. As with everything to do with mortality, it will take time before any trends emerge. I am sure that we will come back to this in more detail in the future.

Mr R. C. Willets, F.F.A. (closing the discussion)**:** First, I should like to thank the author for his excellent paper. He has attempted, to use his own words, to come up with a simple and pragmatic solution to counter what seems to be one of the key flaws of the '92' series and interim cohort projections. He has done this in a very clear, original and accessible manner.

As someone who spends almost all of his working hours delving into the minutiae of mortality statistics, I found the author's more high level approach quite refreshing. Sometimes it makes sense to look at the bigger picture, and to focus on the life expectancy statistic helps to do this very well.

The author's approach works well, because it focuses on the long-term trends, rather than just on the most recent changes, in mortality. It has also provided us with a practical way of stripping out the impact of the cohort effect on the general pattern of mortality improvement. Most fundamentally, it highlights and addresses one of the major faults of the '92' series projections, that is the very low rates of improvement projected into the future for certain ages and calendar years.

Almost inevitably, given the approach, it is deliberately simplistic. There are a number of features of the methodology, which some speakers have mentioned already, which are worth discussing more. One point is that the calibration by the author of the floor assumes that the absolute difference between the population life expectancy at age 65 and the life expectancy of pensioners remains broadly constant. It is not particularly clear that this is a reasonable assumption, especially given that, in practice, the life expectancy gap has actually increased substantially in recent years. For example, in the early 1980s the difference between the England & Wales population expectancy and the pensioner life expectancy, as given by the '80' series mortality tables, was only around 1.7 years, which is far less than the current difference.

Secondly, as the author has already acknowledged, in order to strip out the impact of the cohort effect, what he has done is to ignore experience data from the last ten years or so. When you look closely at U.K. trend data from the most recent past, as a number of speakers, such as Mr Greenwood, have mentioned, what you see is that the pace of improvement has been accelerating steadily for people in all birth cohorts. Therefore, to ignore the most recent experience tends to understate the projected pace of improvement.

A number of speakers have mentioned international trends, especially the situation in the U.S.A. The pace of improvement which the author has used to project forward the life expectancy is 26 days per annum for females and 41 days per annum for males. That equates to an increase in life expectancy at age 65 of 0.7 of a year per decade for females and 1.1 years per decade for males.

I think that it is quite useful to compare these rates of change per decade with the pace of change seen in other developed countries, similar to the U.K., which have not experienced the same kind of cohort effects which we have in the U.K. What you see, over the last ten years, in other developed countries is: in Germany increases of 1.8 years; Italy, 1.6 years; Japan, 1.6 years; Canada, 1.5 years; France, 1.2 years; and, even in the U.S.A., 1.2 years. All are higher than the 1.1 years assumed in the author's projection. This would tend to suggest that the projected pace of improvement may be understated.

The author acknowledges that his particular method does not specifically address the issue of an allowance for the cohort effect and the pace to which that effect may drop away over time. The opener mentioned the fact that there is a theory that part of the cohort effect is due to changes in smoking prevalence, and that, therefore, because smoking prevalence has stabilised, the cohort effect may begin to fade away and some of the cohort projections may be conservative. A possible problem with that is that smoking prevalence stabilised in the 1990s after very sharp falls in the 1970s and 1980s. During the 1990s, and especially over the past five years or so, the cohort effect has not faded away at all. In fact, the pace of improvement has actually been accelerating constantly. Even though it is an appealing idea in theory, it just does not seem to be happening in practice.

The problem with the medium cohort projection is that, if you take males born in the mid-1930s who were at the epicentre of the cohort effect in terms of the general population, the suggested floor of 1.25% would actually begin to bite in just six years' time, in 2013, despite the fact that the current pace of improvement in the population of England & Wales for that birth cohort is actually about 4% p.a. So, there is a very rapid tail off assumed in the medium cohort basis.

To me, it is clear that, in most circumstances, as a couple of speakers have mentioned, the medium cohort projection, without any floor, it is no longer a suitable best estimate for pension scheme valuations. However, if I were to use the same adjusted medium cohort currency as that of the author, I would place the floor somewhat higher, perhaps somewhere in the range 1.5% to 2% as a best estimate for males, and 1% to 1½% as a best estimate for females. I stress that these are best estimates rather than prudent numbers.

As several speakers, including Mr Goford, have mentioned, life expectancy improvements may actually be far more dramatic than those implied by these bases. In recent decades we have seen the pace of mortality improvement accelerating steadily. If the pace of acceleration were to continue into the future, perhaps fuelled by increasingly rapid advances in medicine, then the life expectancy projections which we have made to date would prove to be inadequate.

I would estimate that a scenario of continued acceleration in the pace of improvement, in line with the trend over the past couple of decades, would actually add something in the region of £175 billion to pension scheme liabilities versus the bases which are currently being used for pension scheme valuations.

A number of speakers have mentioned the need to understand the drivers of mortality improvements. Mr Ridsdale mentioned a number of research projects which have started to look into these factors. This is something which the Profession should very much support and encourage. I think that the views of the medical profession are ones which we should be increasingly factoring into our forecasts, which we have acknowledged can never be precise. We

should always stress the uncertainty of forecasts, but bring in the views of the medical profession, demographers, epidemiologists, and so on, which have to be extremely beneficial for us.

I agree with Mr Lu about needing tools to visualise what improvements mean in terms of the future medical scenarios which would bring them about. Mr Sharp mentioned making research more accessible to users. This is a particularly important point in relation to pension scheme valuations. It is very important for trustees to understand the issues with which we are dealing in terms of mortality improvement. This is one particular aspect that the author has dealt with very well. His paper is excellent, and should be extremely useful to a variety of different audiences.

Mr Baxter (replying)**:** First, I agree with almost all the comments which speakers have made, and thank you for these. I should like to pick up on a couple of them.

The first is with regard to the danger of extrapolating trends. I agree that the method which I have presented in the paper is a simplistic extrapolation, and, as such, is potentially dangerous. However, as the closer said, it is also an easy way of communicating what we are doing with our clients. Whilst I acknowledge the danger of extrapolation, we can look elsewhere in the world and observe, as the closer has pointed out, that these extrapolations are well within the achievable limits of life expectancy, i.e. there is a degree of sanity check on the extrapolations.

A number of speakers have also referred to the uncertainty around mortality, and the need both to be aware of it and, potentially, to reserve for it. I would like to give a brief insight from my personal experience. When discussing these issues with clients, particularly sponsors of pension schemes, a number of them are now bearing the uncertainty very much in mind. Whilst they may be funding to a certain level, some are also holding back a degree of reserves in case mortality and longevity are better than already assumed, i.e. longer life expectancy. I believe that this shows a real desire in the marketplace to understand the uncertainty around longevity.

The President (Mr N. J. Dumbreck, F.I.A.): We have had a very interesting discussion. I guess that this is an area to which the Profession has been devoting an increasing amount of attention in recent years, but it is fairly clear that we still have a great deal to learn. There has been a large amount of capital made available to take on longevity risk by the new bulk annuity providers. It is reasonable to assume that they think that they have a reasonable understanding of the risks involved in this area. I am sure that there is a great deal of work going on behind the scenes as well as that which has been made public.

For the Profession's part, Mr Ridsdale has referred to the various research projects, and Mr Sharp has alluded to the work of the Mortality Projections Task Force of the CMI, which, in due course, will be publishing a library of projection approaches, including *P*-splines, Lee-Carter, cohorts, and so on, with some notes on how to use them. There are also plans to increase the amount of training and educational material and seminars which are available to help people to select the most appropriate projection methods for their particular situations. We recognise that this is a very important area for the Profession. We are doing all that we can to make sure that actuaries are up to speed and have the necessary tools to tackle it.

It remains for me to express my own thanks, and, I am sure, the thanks of all those present, to Mr Baxter, to Mr Willets, and to all those who have participated in the discussion.