

Review of Rates of Mortality Improvement

Demography Committee

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Prepared by:

John Armstrong (Chairman)

Tracy Gilbert

Colm Guiry

Mary Hall

Tony Jeffery

Aisling Kennedy

Yvonne Lynch

Padraic O'Malley

1. Introduction

The following document has been prepared by the Demography Committee of the Society of Actuaries in Ireland. Its purpose is to recommend mortality rates and assumed future rates of mortality improvement to be incorporated in the Society's Actuarial Standards of Practice (ASPs). In particular, the Committee has considered the post-retirement mortality assumptions to be used in ASP-PEN-2 (Retirement Benefit Schemes Transfer Values). Other practice areas of actuarial work have not been addressed in any great detail.

The Committee recognises that it is a matter for each Practice Committee to draft Actuarial Standards of Practice for the relevant practice areas for approval by the appropriate authorities, who include, at the present time, the Actuarial Matters Committee, Council and, for Pensions ASPs, the Minister for Social and Family Affairs. It is, however, desirable that the assumptions incorporated into ASPs should be consistent across practice areas and should take account of the latest mortality research and the assumptions used by other relevant bodies.

In arriving at our recommendations we have considered the following:

- The rates of improvement experienced in Ireland in recent years;
- Comparative experience for other countries; and
- The projected rates of mortality improvement proposed by various expert groups and agencies both within and outside of Ireland.

As far as possible, we have relied upon quantitative evidence in arriving at our recommendations. However, a recommendation in relation to assumed future rates of mortality improvements necessarily requires an element of judgement. In exercising its judgement, the Committee has carefully considered past mortality trends, the recent assumptions made by other relevant bodies, in Ireland and elsewhere, and scientific evidence relating to the scope for future mortality improvements.

2. Key issues

In arriving at its recommendations, the Committee had to consider a number of key issues. The results of our discussions on these key issues are summarised as follows:

Minimum rates of improvement

It was agreed that the Committee would propose standard rates of mortality improvement, on a “best estimate” basis, for use both in transfer value calculations and life assurance policy illustrations. We noted that the transfer value basis specified in ASP PEN-2 is technically a minimum basis, but is in practice a standard basis, as few if any pension schemes offer transfer values on a more generous basis. It is therefore our view that the assumed rates of mortality improvement should reflect a “best estimate” of future mortality experience for the pensioner population.

Age-gender differentials

The rates of mortality improvement experienced by men and women, and in different age groups, have been significantly different in past years. The Committee decided that it was appropriate to recommend different assumed rates of improvement for men and women, and at different ages.

Cohort effect

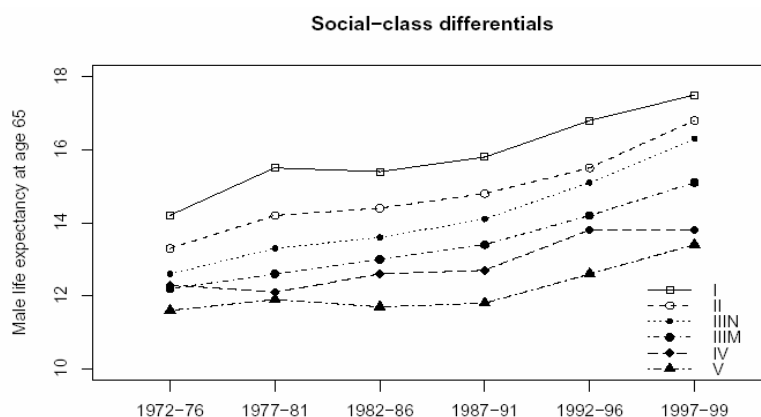
Previous analysis [1,2] has determined that there is some evidence of a cohort effect in Irish population mortality. The influence of the cohort effect seems to be similar to that of England and Wales based on analysis of male and female mortality data. The CSO in their projections [6,7] implicitly allow for cohort-based rates of mortality improvement. The Committee therefore decided that no further allowance was needed for the cohort effect.

Changes in improvements rates over time

The Committee decided that the recommended rates of improvement should not be constant over all future periods. Rather, the rates of improvement assumed should in the short term reflect recent relevant experience, and over the long term should decline to a minimum level of improvement, consistent with actual long term experience in Ireland and elsewhere. In this regard, the Committee notes the Central Statistics Office (CSO) adoption of a long term minimum rate of improvement from 2031 onwards, with higher assumed improvement rates in the intervening period.

Mortality improvements by social class

There is no reliable data for Irish mortality trends by social class. However, UK data reported to the Society [2] suggests that mortality improvements have been higher for the higher social classes i.e. the gap in life expectancy for higher and lower social classes is continuing to widen (see the graph overleaf). This suggests that it may be appropriate to assume higher rates of mortality improvement for Irish pensioners than for the Irish population generally. However, given the lack of reliable Irish data by social class, and having regard to the purpose for which our recommended rates of mortality improvement are to be used, the Committee does not consider it appropriate to assume higher rates of improvement than those that are appropriate for the Irish population generally.



Source: ONS data

3. Recent Mortality Experience in Ireland

Various studies, both by the Society [1,3] and other parties [4,5,6], have identified that the rates of mortality improvement experienced in Ireland have been very significant over the latter part of the 20th century and into the 21st century. There is evidence that rates of mortality improvement have been accelerating over the past ten years. Rates of improvement have been higher for men than for women in recent years due to reductions in mortality from circulatory causes.

The table below sets out the annualised rates of improvement reported in a previous Society of Actuaries in Ireland study.

Table 1: Annualised Reduction in Mortality 1982-2005

Year	Male	Female
1982/84 to 1985/87	0.2%	0.9%
1985/87 to 1988/90	2.5%	1.9%
1988/90 to 1991/93	1.5%	1.7%
1991/93 to 1994/96	1.1%	1.0%
1994/96 to 1997/99	1.6%	1.2%
1997-99 to 2000-02	3.6%	3.0%
2000-02 to 2003-05	4.4%	3.4%

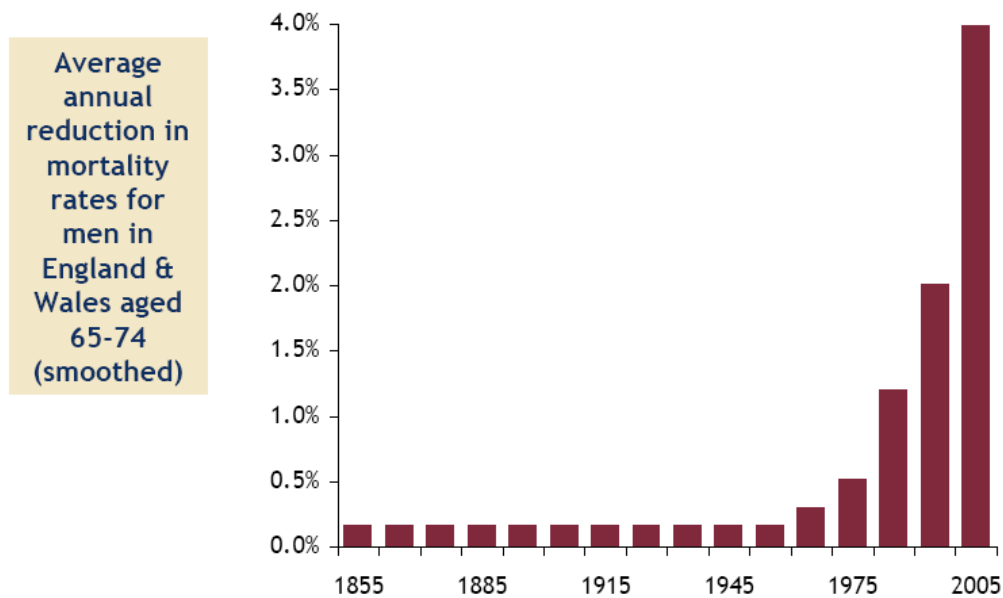
More recently, the Central Statistics Office, in its Population and Labour Force Projections 2011 – 2041 [7], published during 2008, found that the rate of decline of mortality since 2000 for males averaged around 5 per cent per annum across most ages, with surprisingly little variation, while for females, the rate of decline oscillated with age around an average rate of 3.5 per cent per annum. The higher numbers compared to the reported numbers in the Table 1 above are attributable to the additional years of 2006 and 2007.

Similarly, the Society’s Pensioner Mortality Working Party [8], in its report published in May 2008, stated that its investigation suggested rates of improvement of close to 5% per annum, although it was noted that it was difficult to be exact given the wide

spread of years covered in both the most recent and the previous investigation of pensioner mortality.

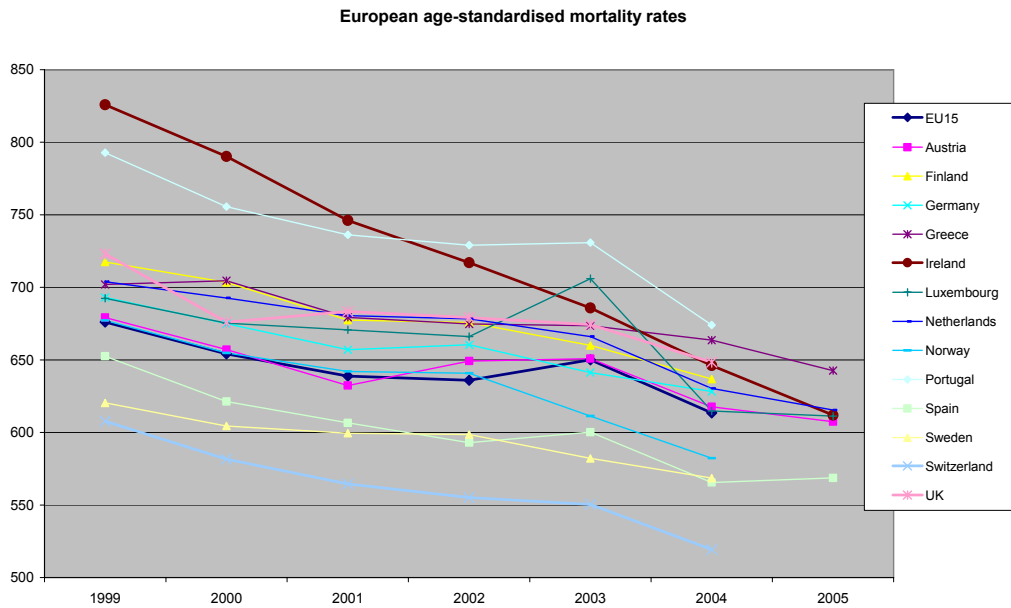
These patterns of improvement are broadly consistent with trends in other European countries. By way of example, the rates of improvement in population mortality in England and Wales are shown in Chart 1 below, extracted from Willets [9].

Chart 1: Mortality Reduction in England & Wales



However, over the period 1999 – 2004, overall rates of mortality improvement in Ireland were higher than any other country in Western Europe, as shown in Chart 2 below. The data is taken from numbers reported by Eurostat and the World Health Organisation.[10].

Chart 2: European Age-Standardised Mortality Rates



This shows that until recently Irish mortality rates were high relative to other European countries. However, notwithstanding the improvements over the past 10 years, Irish mortality rates are now only average by Western European standards. Considerable scope therefore remains for further improvement in our mortality experience relative to other Western European countries given our rates of mortality compared to these countries for certain causes of death.

In particular, Ireland still has much higher rates of cancer mortality (especially for men) than other European countries. This suggests that there is scope for continuing high rates of improvement in Irish mortality over the coming years.

In terms of long term rates of improvement, the average rate of improvement in Irish mortality over the 76-year period 1926-2002 was 1.43% per annum for males and 2.1% per annum for females (calculated as a simple average of the rates of improvement at each age from age 0 years to age 100 years over that period). There is a pronounced age structure effect to the improvements, with the rate of improvement generally lowering with increasing age. However, over more recent periods, the age

pattern is less pronounced with later ages now showing large improvements. Also, in more recent decades, males have recorded larger proportionate reductions in mortality rates than females.

4. Future prospects for life expectancy

From an analysis of reported data it can be shown that over the period 1985 – 2006, male period life expectancy at birth has increased by 5.7 years to 76.7 (with 3.7 years of this increase occurring in the last 11 years). During the same period, male period life expectancy at age 70 increased by 3.1 years to 12.8 years (with an increase of 2.2 years over the past 11 years). Over the same period, female period life expectancy at birth increased by 4.8 years to 81.5.

There are diverse opinions amongst demographers as to the level of longevity that might reasonably be expected in the future. In Japan, period life expectancy at birth in 2006 was 79 for men and 85.8 for women. Other countries in Europe, such as Italy, Norway, Sweden and Switzerland, also currently have higher period life expectancy than Ireland for both men and women. This suggests scope for further improvement in Irish life expectancy.

There is also the possibility of significant reductions in the incidence of cancer, heart disease and strokes through changes in lifestyle and the scope for further significant reductions in mortality from these diseases when they do occur, as a result of further medical advances.

The following comments, quoted by Richard Willetts in his presentation to the Society in June 2007, indicate the potential scale of future mortality improvements in heart disease alone:

- *“Premature death from heart disease could be eliminated within 10 years” - Professor Roger Boyle, National Director for Heart Disease & Stroke (2004)*
- *Cardiovascular disease could be reduced by 80%, Professors Wald & Law (2003)*

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- *Relatively modest changes in population cholesterol, blood pressure and smoking levels could reduce heart disease mortality by 50%, Health Development Agency (2004)*
 - *Medical experts tend to suggest 20-year reductions for circulatory disease mortality in the range of 60%-75%*

On the other hand some demographers believe that, despite the possibility of advances in medical practices and of encouraging healthy lifestyles, a law of diminishing returns will apply to death rate reductions at advanced ages, partly because no more than a minority of the population will adopt truly healthy lifestyles. It is also possible that new diseases, or the re-emergence of existing diseases such as tuberculosis, may serve to temper future improvements in mortality.

Our research suggests that most current projections are based on the assumption that current rates of improvement will continue for a time, but will reduce gradually over a number of years, with long term rates of improvement of the order of 1% to 1.5% (see section 5 below).

Essentially, this represents a “trend reversal” scenario, using Willetts’ terminology. He described the likely composition of such a scenario as follows: *“Mortality rates from circulatory disease continue to reduce rapidly but other causes of death prove more difficult to eliminate. The total pace of improvement slows as deaths from heart disease and stroke become less common. Generations born in the post-war years continue to experience less rapid improvement as increasing obesity and alcohol-related illness take their toll.”*

If medical advances continue at the rate experienced in recent years, it is very possible that mortality improvements will continue at their current pace or accelerate, in which case current “trend reversal” projections will significantly overstate future mortality. At the other end of the spectrum, earlier mortality projections, with lower assumed rates of improvement, and no long term underpin, in effect represented an “extreme trend reversal” scenario, which to date has not been borne out in practice.

5. Assumed rates of improvement

CSO, Irish population projections

In their latest population projections [7], published in April 2008, the CSO has adopted a “targeting” methodology, similar to that used in UK population projections, in order to arrive at expected future mortality rates. It has set a long term rate of improvement of 1.5% per annum for Irish mortality, based on experience over the course of the 20th century. Rates of improvement in the immediate future are assumed to reflect recent actual experience, and short term rates of improvement are assumed to decline towards the long term average over a 25-year period.

- It is assumed that mortality rates will improve by 5% for males and 3.5% for females in 2005 and will continue to improve into the future. Over the period to 2031 the rate of improvement will decline on a uniform basis.
- From 2031, it is assumed that the rate of mortality improvement will be 1.5% per annum for both men and women, up to age 90.
- It is assumed that mortality improvements in 2005 will be 5% for men and 3.5% for women. Rates of mortality improvement between 2005 and 2031 are determined on the basis of simple linear interpolation between the rates assumed for 2005 and 2031.
- A zero per cent improvement (i.e. no improvement) was assumed for ages of 100 years and over for all time periods. For ages 91 years to 99 years, the assumed rate of improvement for 2005 was estimated by linear interpolation between the assumed rate of improvement at age 90 years (5% for males and 3.5% for females) and the zero per cent rate of improvement at age 100 years, with similar linear interpolation in each projected calendar year.

UK Office for National Statistics, 2006-based Population Projections

The most recent UK population projections are based on the following mortality assumptions [11]:

- The rate of improvement for 2031 has been assumed to be 1.0% for most ages (i.e. equivalent to the average rate of improvement over the whole of the 20th century).
- It is assumed that those born during the period 1923–1940 will continue to experience higher rates of improvement than the overall average with the assumed rate of improvement in 2031 rising from 1% a year for those born before 1923 to a peak of 2.5% a year for those born in 1931 and then declining back to 1.0% a year for those born in 1941 and later.
- The transition from current rates of mortality improvement by age and gender, derived from recent trends, which are used in the early years of the projections, to the assumed rates of 1% to 2.5% in 2031, is not assumed to take place linearly, but more rapidly at first for males and less rapidly for females.

UK Pensions Regulator

In February 2008, the Pensions Regulator [12] proposed a new basis for the setting of mortality assumptions and issued a consultation to the industry in this regard. Specifically, its draft statement specified that, in the context of Recovery Plans submitted to the regulator:

- “mortality assumptions that appear to be weaker than the long cohort assumption will attract further scrutiny and dialogue with the trustees where appropriate
- assumptions which assume that the rate of improvement tends towards zero, and do not have some form of underpin, will also attract further scrutiny.”

In effect, the Regulator is proposing the use of the “long cohort” projection basis, with a minimum of 1.5% per annum for men and 1% for women.

However, following consultation, the Pensions Regulator announced in July 2008 [13] that it had decided to delay the introduction of changes to the way longevity is treated in the scheme funding regime. Changes will not now apply until the beginning of the next defined benefit scheme valuation cycle starting in September 2008. This will impact valuations, and follow-up recovery plans that must be submitted to the regulator by schemes in deficit, due from December 2009. Originally, it had been suggested that the changes would apply to valuations due from March 2007.

Canadian Social Security projections

Based upon work undertaken by The Board of Trustees of the Federal Old-Age and Survivors Insurance and Disability Insurance in Canada [14], it was decided that the following should be assumed as a basis for projections:

- Mortality improvements are expected to continue in the future, but at a slower pace than observed in the past, except for ages 90 and above, where improvements are assumed to be higher than in the past.
- Rates of improvement for the period 2005 to 2009, varying by age and sex, are assumed to be those experienced in Canada over the period 1989 to 2004.
- Improvement rates for years 2010 to 2028 are obtained by linear interpolation between the improvement rates of year 2009 and fixed minimum improvement rates in respect of the period 2029 and thereafter as follows:

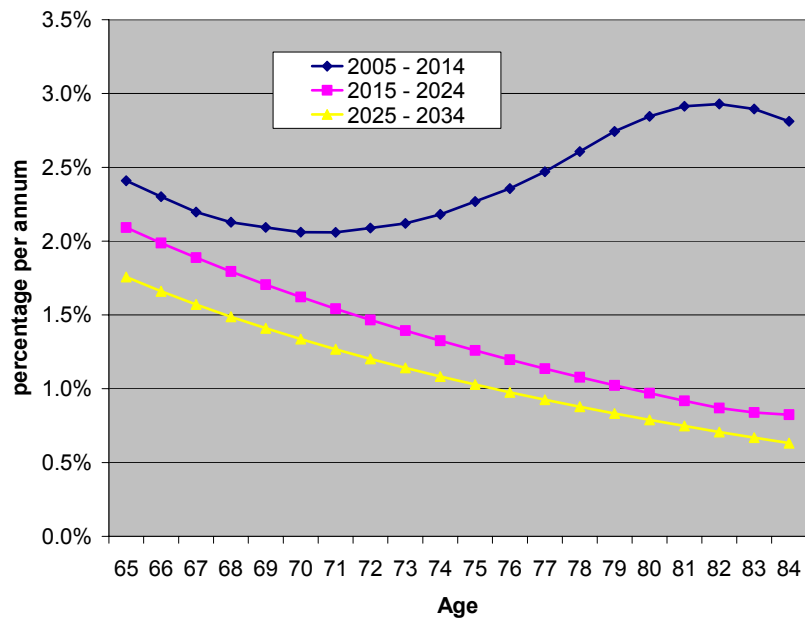
Table 2: Projected Annual Reduction in Mortality Rates in Canada from 2029 onwards

Age group	Male	Female
0-84 years	0.7%	0.7%
85-89 years	0.6%	0.6%
90 years and above	0.4%	0.4%

Recent assumptions compared with the UK Actuarial Profession’s medium cohort projection

Given that the rates of mortality improvement currently assumed in the Society’s ASPs are based on the medium cohort projection, it is appropriate to consider the rates of improvement underlying the UK Actuarial Profession’s medium cohort projection, compared with those actually experienced and assumed by the CSO and others for future years. Chart 3 below shows the rates of improvement included in the medium cohort projection. These are significantly lower than recent actual improvements in Irish population and pensioner mortality.

Chart 3: UK Actuarial Profession medium cohort projected improvement rates



6. Our recommendations

Following our review, the Committee recommends that the rates of mortality improvements assumed for the purpose of the Society's ASPs should be the same as the rates of improvement assumed by the CSO in its recently published mortality projections.

The principal reasons for this recommendation can be summarised as follows:

- These rates of improvement reflect the expected experience of the population as a whole using the targeting approach. This is based upon an assessment of short term mortality trends and an estimate of likely long-term mortality improvements;
- While it could be argued that mortality experience for both the insured and pensioner population may be different than for the population generally, there is no evidence for this in Ireland. The recent pensioner mortality study found that rates of mortality improvement were broadly similar to the rates of improvement experienced by the population generally over equivalent time periods (i.e. approximately 5% per annum). Moreover, UK data suggests that, if anything, more privileged groups are likely to experience higher rates of mortality improvement.
- Therefore, we believe that the CSO assumptions represent the minimum rates of improvement that can justifiably be used to project future mortality experience for more select subsets of the population, whether occupational pension scheme members or life assurance policyholders.

The Committee believes that two options recommend themselves as being appropriate for the base mortality table to be used for the purpose of transfer value calculations. These are:

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1. 108% of the '00 series, lives' table for both men and women with CSO mortality improvements applied in respect of 2006 onwards, or
 2. 105% of the '00 series amounts' table for both men and women with CSO mortality improvements applied in respect of 2006 onwards.

We do not consider the Irish Life Table ILT14 to be an appropriate basis given that the underlying experience of the population is somewhat different than the '00 series' table.

The above percentage adjustments reflect the findings of the Pensioner Mortality Working Party in respect of 2005 mortality experience for pensioners excluding public servants (for whom transfer values are generally not required). While the Working Party reported separate estimates for men and women for reasons of both credibility and practicality we recommend that the male factor is used.

The Committee's recommendation is for the 'lives' basis to be used rather than 'amounts' version of the '00 series' table as the base mortality table. This reflects the fact that the transfer value basis specified in the ASP is a minimum basis, and is applied to all pensioners, regardless of income or social class.

The Committee recognises that across the totality of pension schemes the appropriate mortality basis to be used for transfer values would be based on the "amounts" table. However, having regard to the fact that different pension schemes have different membership profiles, and that, as noted above, the basis specified in the ASP is used to determine the minimum transfer payment that can be made, we consider it appropriate to specify the "lives" table in the ASP. We note that in cases of schemes where member income levels are higher than average, the flexibility exists within legislation for them to use the "amounts" table rather than the "lives" table.

7. Impact of recommendation for Pension Valuations

The current professional guidance is based upon assuming post retirement mortality using 90% of PMA92 (c=2004) with an increase to the annuity value for each year between 2004 and the year in which the pension becomes due. The increase is 0.225% per annum compound for males and 0.175% per annum (compound) for females.

The Committee compared this basis with its recommended basis, and for comparison purposes, with a number of other bases. The results are summarised in Tables 3-5 for males and Tables 6-8 for females, for both level and increasing pensions. Cohort life expectancies are also shown for the various bases.

We note that the CSO basis gives rise to cohort life expectancy of 21 years for a male currently aged 65, compared to 19.4 years on the current ASP PEN-2 basis. Clearly, it is not appropriate to assume that a member of an occupational pension scheme will have a shorter life expectancy than for the population generally. This demonstrates the extent to which the current basis needs to be revised.

For the purposes of a sensitivity check, we considered the situation under which slightly lower improvements arise than those assumed by the CSO. The results are included in the tables. This scenario also gives a lower life expectancy than the CSO basis and we therefore do not consider it to be an appropriate basis.

For an indexed annuity (index at 2% per annum), the proposed basis gives rise to annuity values which are 8%, 15% and 17% higher than the current basis for males retiring in 2008, 2028 and 2048 respectively. For females, the equivalent increases above the current basis are 3%, 7% and 9% respectively.

8. Proxy for Recommended Basis

The direct application of the proposed basis would be likely to cause considerable practical difficulties for actuaries working in both the life and pension sectors. In this regard, the Committee has attempted to derive a proxy method that gives results which are close to our recommended basis.

The current post-retirement mortality proxy basis included in ASP PEN-2 is as follows:

Men:	90% of PMA92 (c = 2004)
Women:	90% of PFA92 (c = 2004)

with an increase to the annuity value of:

- 0.225% per annum for men with no spouse's pension);
- 0.175% per annum for women with no spouse's pension); and
- 0.125% per annum for men or women with spouse's pension.

These increases are applied on a compound basis for each year between 2004 and the year in which normal pension date falls.

This basis is designed to be consistent with the mortality basis for ASP LA-8 – Life Assurance Product Information of:

- Men: 76% of PMA92 (c = 2004)
- Women: 76% of PFA92 (c = 2004)

with the same increases to the annuity values as set out above.

This basis is in turn an approximation to the standard PMA92 table (c=2004) with mortality improvements after 2004 in line with the medium cohort projection of the PMA92 table.¹

¹ The survey of Irish occupational pensioner mortality in November 2005, which found that pensioner mortality over the period 1998 – 2003 was approximately 115% - 120% of the standard PMA92 table for the relevant years (90% = 76% x 118.4%).

Based upon our analysis the Committee proposes a proxy which for the purposes of ASP PEN-2 is as follows:

Men: 62% of PNML00
Women: 70% of PNFL00

with an increase to the annuity value of:

- 0.50% (men with no spouse's pension)
- 0.38% (women with no spouse's pension)
- 0.39% (men or women with spouse's pension)

per annum compound for each year between 2008 and the year in which normal pension date falls.

Our suggested proxy does not provide as close a match to the underlying basis as does the current proxy to the current underlying basis. However, we consider that it provides a sufficiently reasonable fit. Details of the fit as measured by the differences between the two are reported in the Appendices.

Table 3: Flat pension – annuity values, assuming a 4.5% per annum discount rate - Males

<i>Male age 65 in.....</i>	2008	2028	2048	2008	2028	2048
	Annuity value			% increase over current basis		
115% PMA92C2004 medium cohort from 2004	11.86	12.46	12.80			
90% PMA92C2004 with annuity increasing at 0.225% (current proxy method)	11.88	12.43	13.00	0%	0%	0%
92 series (amounts) C2035	12.51	12.51	12.51	5.3%	0.7%	-3.8%
00 series (amounts) medium cohort	12.26	12.84	13.16	3.2%	3.3%	1.3%
00 series (amounts) medium cohort 1% min	12.35	13.12	13.76	4.0%	5.6%	5.9%
00 series (amounts) long cohort	12.73	13.32	13.64	7.2%	7.2%	5.0%
00 series (amounts) long cohort 1% min	12.79	13.58	14.22	7.7%	9.3%	9.4%
00 series (amounts) CSO improvements	13.23	14.27	14.91	11.4%	14.8%	14.7%
105% 00 series (amounts) CSO improvements	13.08	14.14	14.80	10.0%	13.8%	13.8%
00 series (lives) CSO improvements	12.77	13.93	14.63	7.5%	12.1%	12.6%
108% 00 series (lives) CSO improvements	12.51	13.71	14.44	5.3%	10.4%	11.1%
108% 00 series (lives) CSO improvements modified (4% 2006, 1% long term)**	12.11	13.03	13.59	1.9%	4.9%	4.5%
ILT14 CSO improvements	12.31	13.55	14.29	3.6%	9.0%	9.9%
80% ILT14 CSO improvements	12.57	13.78	14.50	5.8%	10.9%	11.6%
62% of PNML0062% of PNML00 with annuity increasing at 0.5% (proposed proxy)	12.56	13.88	15.33	N/A	N/A	N/A
Irish Life annuity rate - pensionchoice.ie	13.52	N/A	N/A	13.8%	N/A	N/A
Measure of Fit of Proxy						
Difference between 108% 00 series (lives) CSO improvements and proposed proxy	0.4%	1.2%	6.2%	N/A	N/A	N/A

** Included for the purposes of a sensitivity check (see section 7 of Report). Assumes initial improvements in mortality at the rate of 4% from 2006, declining to 1% per annum (CSO: 1.5% per annum) from 2031 for both men and women up to age 90. Lower rates of improvement are assumed at older ages.

Table 4:
Indexed pension – annuity values, assuming a 4.5% per annum discount rate, pension increases of 2% per annum - Males

<i>Male age 65 in:.....</i>	2008	2028	2048	2008	2028	2048
	Annuity Value			% increase		
115% PMA92C2004 medium cohort from 2004	14.46	15.30	15.78			
90% PMA92C2004 with annuity increasing at 0.225% (current proxy method)	14.44	15.10	15.80	0%	0%	0%
92 series (amounts) C2035	15.34	15.34	15.34	6.2%	1.5%	-2.9%
00 series (amounts) medium cohort	15.06	15.87	16.33	4.3%	5.1%	3.4%
00 series (amounts) medium cohort 1% min	15.23	16.39	17.41	5.5%	8.5%	10.2%
00 series (amounts) long cohort	15.85	16.68	17.15	9.7%	10.5%	8.6%
00 series (amounts) long cohort 1% min	15.95	17.16	18.21	10.5%	13.6%	15.3%
00 series (amounts) CSO improvements	16.59	18.14	19.14	14.9%	20.1%	21.2%
105% 00 series (amounts) CSO improvements	16.36	17.94	18.96	13.2%	18.8%	20.0%
00 series (lives) CSO improvements	15.94	17.65	18.74	10.4%	16.9%	18.6%
108% 00 series (lives) CSO improvements	15.55	17.31	18.44	7.7%	14.6%	16.7%
108% 00 series (lives) CSO improvements modified (4% 2006, 1% long term)**	14.93	16.25	17.09	3.4%	7.6%	8.2%
ILT14 CSO improvements	15.25	17.05	18.18	5.6%	12.9%	15.1%
80% ILT14 CSO improvements	15.64	17.42	18.53	8.3%	15.3%	17.3%
62% of PNML0062% of PNML00 with annuity increasing at 0.5% (proposed proxy)	15.55	17.18	18.98	N/A	N/A	N/A
Irish Life annuity rate - pensionchoice.ie	16.51	N/A	N/A	14.3%	N/A	N/A
Measure of Fit of Proxy						
Difference between 108% 00 series (lives) CSO improvements and proposed proxy	0.0%	-0.8%	2.9%	N/A	N/A	N/A

** Included for the purposes of a sensitivity check (see section 7 of Report). Assumes initial improvements in mortality at the rate of 4% from 2006, declining to 1% per annum (CSO: 1.5% per annum) from 2031 for both men and women up to age 90. Lower rates of improvement are assumed at older ages.

Table 5: Life expectancy - Males

<i>Male age 65 in.....:</i>	2008	2028	2048	2008	2028	2048
	Life Expectancy			Absolute increase		
115% PMA92C2004 medium cohort from 2004	19.5	20.8	21.5			
90% PMA92C2004 with annuity increasing at 0.225% (current proxy method)	19.4	20.2	21.1	0%	0%	0%
92 series (amounts) C2035	20.8	20.8	20.8	1.4	0.5	-0.4
00 series (amounts) medium cohort	20.5	21.8	22.5	1.1	1.5	1.4
00 series (amounts) medium cohort 1% min	20.8	22.9	24.8	1.5	2.6	3.6
00 series (amounts) long cohort	22.0	23.3	24.1	2.6	3.1	3.0
00 series (amounts) long cohort 1% min	22.2	24.4	26.4	2.9	4.1	5.2
00 series (amounts) CSO improvements	23.2	25.9	27.7	3.9	5.6	6.5
105% 00 series (amounts) CSO improvements	22.8	25.5	27.3	3.4	5.3	6.2
00 series (lives) CSO improvements	22.2	25.1	27.0	2.8	4.8	5.9
108% 00 series (lives) CSO improvements	21.5	24.4	26.4	2.2	4.2	5.3
108% 00 series (lives) CSO improvements modified (4% 2006, 1% long term)**	20.4	22.6	24.0	1.1	2.3	2.9
ILT14 CSO improvements	21.0	24.0	25.9	1.7	3.7	4.8
80% ILT14 CSO improvements	21.7	24.7	26.6	2.4	4.4	5.5

** Included for the purposes of a sensitivity check (see section 7 of Report). Assumes initial improvements in mortality at the rate of 4% from 2006, declining to 1% per annum (CSO: 1.5% per annum) from 2031 for both men and women up to age 90. Lower rates of improvement are assumed at older ages.

Table 6: Flat pension – annuity values, assuming a 4.5% per annum discount rate – Females

	2008	2028	2048	2008	2028	2048
	Annuity value			% increase		
115% PMA92C2004 medium cohort from 2004	12.99	13.51	13.81			
90% PMA92C2004 with annuity increasing at 0.175% (current proxy method)	13.01	13.47	13.95	0.0%	0.0%	0.0%
92 series (amounts) C2035	13.55	13.55	13.55	4.2%	0.6%	-2.8%
85% 92 series (amounts) C2030	13.90	13.90	13.90	6.9%	3.2%	-0.3%
00 series (amounts) medium cohort	13.25	13.72	13.98	1.9%	1.9%	0.2%
00 series (amounts) medium cohort 1% min	13.37	14.05	14.62	2.8%	4.3%	4.8%
00 series (amounts) long cohort	13.73	14.20	14.46	5.6%	5.4%	3.6%
00 series (amounts) long cohort 1% min	13.80	14.48	15.04	6.1%	7.5%	7.8%
00 series (amounts) CSO improvements	13.77	14.59	15.17	5.8%	8.3%	8.8%
118% 00 series (amounts) CSO improvements	13.30	14.19	14.82	2.2%	5.3%	6.2%
00 series (lives) CSO improvements	13.48	14.36	14.98	3.7%	6.6%	7.4%
115% 00 series (lives) CSO improvements	13.07	14.01	14.67	0.5%	4.0%	5.2%
108% 00 series (lives) CSO improvements	13.26	14.17	14.81	1.9%	5.2%	6.2%
108% 00 series (lives) CSO improvements -modified (4% 2006, 1% long term)**	13.07	14.01	14.67	0.5%	4.0%	5.2%
ILT14 CSO improvements	13.18	14.11	14.76	1.3%	4.7%	5.8%
80% ILT14 CSO improvements	13.83	14.43	15.05	6.3%	7.1%	7.9%
70% 00 series (lives) with annuity increasing at 0.38% (proposed proxy method)	13.29	14.34	15.47	N/A	N/A	N/A
Irish Life annuity rate - pensionchoice.ie	13.52	N/A	N/A	3.9%	N/A	N/A
Measure of Fit of Proxy						
Difference between 108% 00 series (lives) CSO improvements and proposed proxy	0.2%	1.2%	5.5%	N/A	N/A	N/A

** Included for the purposes of a sensitivity check (see section 7 of Report). Assumes initial improvements in mortality at the rate of 4% from 2006, declining to 1% per annum (CSO: 1.5% per annum) from 2031 for both men and women up to age 90. Lower rates of improvement are assumed at older ages.

Table 7:
Indexed pension – annuity values, assuming a 4.5% per annum discount rate, pension increases of 2% per annum -
Females

	2008	2028	2048	2008	2028	2048
	Annuity value			% increase		
115% PMA92C2004 medium cohort from 2004	16.18	16.94	17.36			
90% PMA92C2004 with annuity increasing at 0.175% (current proxy method)	16.17	16.75	17.34	0.0%	0.0%	0.0%
85% 92 series (amounts) C2030	17.54	17.54	17.54	8.5%	4.8%	1.2%
92 series (amounts) C2035	16.97	16.97	16.97	4.9%	1.3%	-2.1%
00 series (amounts) medium cohort	16.53	17.21	17.59	2.2%	2.7%	1.4%
00 series (amounts) medium cohort 1% min	16.75	17.81	18.76	3.6%	6.4%	8.2%
00 series (amounts) long cohort	17.35	18.03	18.42	7.3%	7.7%	6.2%
00 series (amounts) long cohort 1% min	17.48	18.56	19.52	8.1%	10.8%	12.5%
00 series (amounts) CSO improvements	17.37	18.63	19.56	7.4%	11.2%	12.7%
118% 00 series (amounts) CSO improvements	16.64	17.98	18.97	2.9%	7.4%	9.4%
00 series (lives) CSO improvements	16.94	18.28	19.26	4.8%	9.1%	11.0%
115% 00 series (lives) CSO improvements	16.31	17.71	18.74	0.8%	5.7%	8.1%
108% 00 series (lives) CSO improvements	16.59	17.97	18.98	2.6%	7.3%	9.4%
108% 00 series (lives) CSO improvements -modified (4% 2006, 1% long term)**	16.31	17.71	18.74	0.8%	5.7%	8.1%
ILT14 CSO improvements	16.48	17.87	18.89	1.9%	6.7%	8.9%
80% ILT14 CSO improvements	17.49	18.40	19.39	8.2%	9.9%	11.8%
70% 00 series (lives) with annuity increasing at 0.38% (proposed proxy method)	16.61	17.91	19.33	N/A	N/A	N/A
Irish Life annuity rate - pensionchoice.ie	16.51	N/A	N/A	2.1%	N/A	N/A
Measure of Fit of Proxy						
Difference between 108% 00 series (lives) CSO improvements and proposed	0.1%	-0.3%	1.8%	N/A	N/A	N/A

** Included for the purposes of a sensitivity check (see section 7 of Report). Assumes initial improvements in mortality at the rate of 4% from 2006, declining to 1% per annum (CSO: 1.5% per annum) from 2031 for both men and women up to age 90. Lower rates of improvement are assumed at older ages.

Table 8: Life expectancy - Females

	2008	2028	2048	2008	2028	2048
	<i>Life expectancy</i>			<i>Increase</i>		
115% PMA92C2004 medium cohort from 2004	22.4	23.7	24.4			
90% PMA92C2004 with annuity increasing at 0.175% (current proxy method)	22.4	23.2	24.0	0.0	0.0	0.0
85% 92 series (amounts) C2030	24.8	24.8	24.8	2.4	1.6	0.8
92 series (amounts) C2035	23.7	23.7	23.7	1.3	0.5	-0.3
00 series (amounts) medium cohort	22.9	24.0	24.7	0.5	0.9	0.7
00 series (amounts) medium cohort 1% min	23.4	25.4	27.2	1.0	2.2	3.2
00 series (amounts) long cohort	24.6	25.7	26.4	2.2	2.5	2.4
00 series (amounts) long cohort 1% min	24.9	26.9	28.8	2.5	3.7	4.8
00 series (amounts) CSO improvements	24.5	26.7	28.4	2.1	3.5	4.4
00 series (lives) CSO improvements	23.8	26.1	27.9	1.4	2.9	3.9
118% 00 series (amounts) CSO improvements	23.2	25.5	27.3	0.8	2.3	3.3
115% 00 series (lives) CSO improvements	22.7	25.0	26.9	0.3	1.9	2.9
108% 00 series (lives) CSO improvements	23.2	25.5	27.3	0.8	2.3	3.3
108% 00 series (lives) CSO improvements -modified (4% 2006, 1% long term)**	22.7	25.0	26.9	0.3	1.9	2.9
ILT14 CSO improvements	23.0	25.3	27.2	0.6	2.2	3.2
80% ILT14 CSO improvements	24.8	26.4	28.1	2.4	3.2	4.2

** Included for the purposes of a sensitivity check (see section 7 of Report). Assumes initial improvements in mortality at the rate of 4% from 2006, declining to 1% per annum (CSO: 1.5% per annum) from 2031 for both men and women up to age 90. Lower rates of improvement are assumed at older ages.

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