Mortality Trends in Ireland

13th June 2007

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** The authors would like to thank the Central Statistics Office for their help in supplying data required to compile this report.
Background

- Continues previous work of the sub-committee
- Includes recent 2005 experience
- Considers issues overall pattern and possibility of cohort effect
- Considers changes in short-term mortality experience in relation to cause of death
- Considers role of social class as factor affecting mortality
- Review of tables used and implications for actuaries
Agenda/Objectives

To identify trends in Irish mortality

To analyse recent changes in mortality experience by cause of death

To compare Irish mortality experience with that of other countries

To identify how mortality is affected by social class

To understand industry practice

To draw conclusions suitable for application
Part 1: Overall patterns in Irish mortality experience
Outline
Irish Population Mortality Projections

Data Sources

Recent trends in population mortality experience (males)

Projection of Trends (males)

Investigation of Cohort Effect for Irish Males

Projection Using Targeting Method (males)

Overall Conclusion
Data: Irish Population Statistics

- ILT Tables since 1926 to 2002
- All graduated by King’s Method (JIA (1909))
  - Census method used for $q_x$ for ages $x=0$ to 6.
  - Population count and deaths grouped in quinquennial age bands: 5-9, 10-14, 15-19,....., 80-84, and 85-89. Simple ratio to estimate $m_x$ (and thereby $q_x$) for central ages 7, 12, 17,....,82 and 87.
  - Osculatory interpolation used to estimate intervening $q_x$s.
  - Projection of $q_x$ for $x>87$ by fitting quadratic curve or Gompertz

“Saorstat Life Table cannot be unreservedly accepted as a reliable index of actual conditions...Messrs Hooper and Geary in particular are to be congratulated on their enterprise to elucidated the obscurities of Irish population statistics.”

- Brown, P.G. (1930), Irish Free State Life Table, JIA.
Age heaping is still a problem at later ages. At ages above 80, the data is described as “conditionally acceptable quality” with “data give probably a roughly correct description of the mortality trend though at a level artificially lowered by age overstatement.”


- Can be overcome using the method of extinct generations and the Kannisto-Thatcher Old Age Database at the Max Planck Institute for Demographic Research…but beyond scope of this presentation.

Prior to 1987, we have deaths by sex, individual ages and calendar years but population only estimated (to nearest 1,000) in age groups <1, 1-4, 5-9,…, 80-84, 85+ outside of census years. This data only goes back to 1950 in electronic form. [With thanks to CSO.]

From 1987 to 2005 we have both deaths and population estimates by individual age and sex. [With thanks to CSO.]
Irish Life Tables 1-14 Males

The diagram shows the age-specific death rates (qx) on a log scale for males across different life tables (ILT 1 to ILT 14). The x-axis represents age from 0 to 100, while the y-axis represents qx values on a logarithmic scale.

Each life table is represented by a different color, allowing for a comparison of mortality rates across various scenarios or assumptions represented by the different life tables.
## Percentage Fall (p.a.) in Irish Male Mortality Rate to 2002

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</table>
Irish Male Mortality, 1997-2005

[Deaths averaged over 3 years, but 2005 over 1 year]
Percentage Fall (p.a.) in Irish Male Mortality Rate
over rolling three year periods ending 1990-2004
Percentage Fall (p.a.) in Irish Male Mortality Rate over rolling three year periods ending 1990-2004 plus 2005
Percentage Fall (p.a.) in Irish Male Mortality Rate to 2005
[5 year average about age shown]

Note: Deaths averaged over 3 years in base year, single year for 2005.

- Assumes average % annualised fall in mortality rate in 16 year period from 1986 to 2002 to continue in each future year.
  - Except between 20-29 for both sexes where used annualised increases over 6 years from 1996 to 2002.
CSO: Forecast fall in $q_x$ p.a. in projections
Period & Cohort Life Expectancies, CSO (2004) Projections, Males, age 65
Rules of Thumb based on CSO(2004):
(1) Cohort life expectancy is 1.75 to 2 years higher than period life expectancy.
(2) Life expectancy (cohort or period) is increasing by about 0.17 of a year with the passing of each calendar year.
CSO Method: Variations
Projections of Period Life Expectancy from 65 Males
Period & Cohort Life Expectancies, CSO (2004) Projections, Males, age 0
CSO Method: Variations
Projections of Period Life Expectancy from 0 Males
Updating CSO Projection Method

- Acceleration in pace of mortality decline...all ages and, remarkably, also at the higher ages
- Projection results depend on period in past used...the longer the past period the lower the mortality improvements forecast
- Illustration...basing it on, say, 19 years observed reduction rate at each age to end 2005 (1986 to 2005)
Reduction Factors % p.a. for Male Projections above age 65
Period & Cohort Life Expectancies, Projections, Males, age 65, updated to 2005

![Graph showing life expectancy and difference over time for period and cohort projections for males age 65, updated to 2005.]
Rules of Thumb based on CSO (Updated to 2005):
Cohort life expectancy (LE) in 2006 increased by 1.2 years (period LE increased by 0.8 years) over previous forecast. Cohort LE now 2.25 years above period LE.
Life expectancy (cohort or period) is increasing by about 0.2 of a year with the passing of each calendar year.
Investigation of Cohort Effect for Irish Males
Aim

• To estimate timing and size of cohort effect in Ireland, sufficiently accurate to make reasonable projections.

• Based on interpolations between official ILTs, cohort born 1923-1943 seem to exhibit a ‘step down’ in mortality….the so called ‘cohort effect’.
**Percentage Fall (p.a.) in Irish Male Mortality Rate over Decade Ending**

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Map of Improvements in Male Mortality (% pa average fall over 5 years centred in calendar year shown) [Based on ILTs]
Aim

- Must refine analysis
  - Graduating mortality experience back as far as data allows.
    - Average deaths over 3 calendar years for numerator (as by official ILTs)
    - Apply King’s method to get mortality rates for ages 12 to 72 from 1950 in each calendar year
- This gives a higher resolution in heat-map …
Map of Improvements in Male Mortality (% pa average fall over 5 years centred in calendar year shown) [fine Data]
Map of Improvements in Male Mortality (% pa average fall over 5 years centred in calendar year shown) [fine Data]
Tentative Conclusion:

Cohort Effect is Weak for Irish Males
Methods of Mortality Projection

- Aggregate trend or pattern extrapolation
  - Ireland, The Netherlands, France, Belgium
  - Italy also use cohort as well as age-specific mortality rate projections
  - Many EU countries (like the UN and World Bank) forecast life expectancy
- Targeting methods
  - Germany, Austria, Sweden, UK
  - US Census Bureau.
- By parametric methods – fitting a mathematical curve and projecting trends in the best fitting parameters over time.
  - Heligman & Pollard formula, Australia 1998
- By separate projections by underlying cause of death (e.g., 10 Main ICD Classes)
  - US Social Security Administration projections, Japan
GAD Targeting Method
(with Cohort Effect)

• UK Method (GAD)
  – Impressive study of logarithmic, logit, Lee-Carter, modified Lee-Carter, stochastic Lee-Carter, etc. and how they performed in past but ability to incorporate the cohort effect found to be key
    - “…the clear conclusion was that there were no grounds for believing that an alternative methodology would be likely to outperform the present method.” p. 109.
    - Method is to blend current trends mortality rates by age and gender, with allowance for cohort effect, to assumed ultimate steady state in 25 years’ time.
    - The steady state is 1.0% p.a. fall in mortality at each age and for each sex from 2029. This is close to the average rate of improvement over 20th century.
    - Steady state in 2002 projections was 1% p.a. fall from 2027 but halving every 25 years thereafter.

• Apply Method to Irish Males…based on a graduation of 2004 experience (King’s Method) and following immediate improvement factors…
Current Rate of Improvement in Irish Male Mortality p.a. (2004 graduated experience over 2002, annualised)
Rules of Thumb:

Cohort life expectancy (LE) in 2006 is now 3.2 years above period LE.
Life expectancy (cohort or period) is increasing rapidly in near future by about 0.2 and 0.3 (respectively) with the passing of each calendar year.
Irish Pensioners

• Suppose Irish Male Pensioners have mortality rates 90% of Irish Male Population
• Assume same rate of reduction in mortality, i.e. mortality differentials remain constant with time.
• Then previous analyses give mortality projections for male pensioners reaching at 65 in 2006 as:

<table>
<thead>
<tr>
<th>Method</th>
<th>Period LE at 65</th>
<th>Cohort LE at 65</th>
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<tr>
<td>CSO (Updated)</td>
<td>17.6 (years)</td>
<td>19.9 (years)</td>
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<td>GAD (1%)</td>
<td>17.6</td>
<td>20.9</td>
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<td>GAD (2%)</td>
<td>17.6</td>
<td>21.8</td>
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In Summary

- Recent dramatic reductions in mortality rates AT ALL AGES
  - pattern of improvement shows acceleration
- Cohort effect is present but not very pronounced in Irish Males
- Cohort life expectancies for male aged 65 in 2006 is
  - 19.0 years (CSO Method, updated), increasing at 0.2 years per calendar year
  - 20.0 years (GAD, 1%), increasing at 0.2 years per calendar year
  - 20.7 years (GAD, 2%), increasing at 0.27 per calendar year
- If male pensioners have mortality rates 90% of population males through time then cohort life expectancies for 65 year old male pensioner in 2006 are about one year higher under each method
- Need better assessment of mortality at older ages in Ireland (Kannisto-Thatcher database must be used)
Part 2: Mortality experience by cause of death
Summary of previous findings

- Considerable improvements in mortality rates for principal causes of death since 1980 on age-standardised basis for both males & females
- Nearly 80% of deaths were caused by three main causes:
  - Circulatory diseases – Ischaemic heart disease, Cerebrovascular
  - Cancers
  - Respiratory diseases – Pneumonia, Influenza, Chronic lower respiratory diseases
- Rates of improvements most pronounced for circulatory diseases
- Rates of improvement ignoring cohort effect better for younger ages
Comments on the cause of death analysis

- Useful for understanding underlying causes of mortality
- However, poor method for forecasting
  - Empirically has shown has under-estimated improvements
  - Measurement error
  - Causes of death are not independent
- Given size of country, volume of data becomes quite small once segment by age and gender and therefore credibility issues arise
How has recent experience changed?

- Considered experience in 2005 compared to other years as underlying mortality improvement seemed more significant in 2005
- Possible explanations:
  - 2004 experience particularly high
  - Special factors in 2005
- Method:
  - Banded years and considered change in mortality patterns for 3-year periods from 1980 for principal causes of deaths
- Results suggests that mortality has continued to improve in 2003-2005 period
- Rate of improvement faster than before
## Rates of Improvement

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<td>0.2%</td>
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<td>Change from 1985-1987 to 1988-1990</td>
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<td>Change from 1997-1999 to 2000-2002</td>
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<tr>
<td>Change from 2000-2002 to 2003-2005</td>
<td>3.4%</td>
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</table>
Female Mortality for Circulatory conditions

Rates per 100,000 Population

- 40-44 years
- 45-49 years
- 50-54 years
- 55-59 years
- 60-64 years
- 54-69 years
- 70-74 years
- 75-79 years
- 80-84 years
- 85 years and over

Year

Male Mortality for Neoplasms

Year

Rates per 100,000 Population

- 40-44 years
- 45-49 years
- 50-54 years
- 55-59 years
- 60-64 years
- 65-69 years
- 70-74 years
- 75-79 years
- 80-84 years
- 85 years and over
Part 3: International Comparisons
European age-standardised death rates – all causes

Reduction in mortality % p.a.:
2000-2004: EU-15: 1.5%; Ireland: 4.8%
2002-2004: EU-15: 1.6%; Ireland: 5.0%
European age-standardised death rates – circulatory diseases

Austria
Finland
Germany
Greece
Ireland
Luxembourg
Netherlands
Portugal
Spain
United Kingdom
EU-15
European age-standardised death rates – cancer
European age-standardised death rates – cancer - men

The graph shows the age-standardised death rates per 100,000 population for men in various European countries from 1996 to 2005. The y-axis represents the standardised death rate per 100,000 population, while the x-axis represents the years from 1996 to 2005. Each country is represented by a distinct line and marker, allowing for a comparison of trends over time.
European age-standardised death rates – cancer - women
European age-standardised death rates – external causes
Part 4: Mortality and Social Class
Social Classification

- I Professional
- II Managerial & Technical
- IIIN Skilled Non-manual
- IIIM Skilled Manual
- IV Partly Skilled
- V Unskilled
Examples of Correlations between Social Class and Factors Influencing Mortality

- Highest proportion of smokers in IIIIM (32%)
  Proportion in I & II is 19%
  (Source: Office of Tobacco Control)

- Prevalence of Obesity rises from 10% in I&II to 17% in IV & V
  (Source: National Taskforce on Obesity)

- Prevalence of serious disability rises from 2.5% for class I to 7.5% for class V
  Prevalence of moderate disability rises from 8% for class I to 23% for class V
  (Source: Health Survey for England, 2001 – UK Department of Health)
UK ONS Longitudinal Study

- Office of National Statistics in the UK
- Study involving c. 1% of the population in England and Wales – chosen by DOB
- Study commenced in 1972 and is continuing
- Latest available data is for 2001
- If unclassified – spouse’s / parent’s classification is used
- Social class at date of entry to the study is maintained throughout
Male Life Expectancy at Birth by Social Class (England & Wales)

Source - Office of National Statistics Longitudinal Study
Male Life Expectancy at Age 65 by Social Class (England and Wales)

Source - Office of National Statistics Longitudinal Study
Difference in Male LE at 65 between Social Classes (Eng & Wales)
Changes in Irish Social Demographic (1991 to 2002)
Effect of change in Social Demographic on Irish LE

- Assume Social Demographic distribution for 65 year-olds is the same as for 45 + (assumption validated for 2002 data)
- Apply LE social class differentials from ONS study for England & Wales
- Impact on LE of change in demographic between 1991 and 2002 estimated at 0.2 yrs for men aged 65 and 0.1 yrs for women aged 65
Part 5: Industry mortality projections
Methods and rates of improvement used

- Examined projections used by life offices and pension schemes.
- Life office assumptions are based on returns to the Financial Regulator at 31 December 2005.
- Pension scheme assumptions are based on ASP Pen-2 and discussions with scheme actuaries.
- Also included CSO data from ‘Population and labour force projections’ of 2004.
Methods and rates of improvement used

- Produced comparison of 6 sets of projections:
  - CSO
  - PMA/PFA 92c2006 with future mortality rates improving at fixed 2% p.a.
  - PMA/PFA 92c2006 with future mortality rates in line with medium cohort subject to a minimum improvement of 1% p.a.
  - ASP Pen-2 (90% PMA/PFA92c2004 with fixed annuity increase factors 0.225%/0.175% p.a.)
  - PMA/PFA 92c2010
  - PMA/PFA 92c2025
Period vs. Cohort approach

- Pension scheme mortality projections currently tend to use period approach, e.g.
  - q65c2007
  - q66c2007
  - q67c2007 etc.

- Life office annuitant mortality projections tend to use cohort approach, e.g.
  - q65c2007
  - q66c2008
  - q67c2009 etc.
Period method - projected Male $e(65)$
Period method - projected Female e(65)
Effect of introducing cohort method - projected Male $e(65)$
Effect of introducing cohort method - projected Female e(65)

- **PFA92c06 (2% p.a.)**
- **PFA92c06 (MC/1%)**
- **PFA92c06 (2% p.a.) (Period)**
- **PFA92c06 (MC/1%) (Period)**

- 2006 2011 2016 2021 2026 2031 2036
Part 6: Recommendations and Next Steps
Conclusions

• Recent dramatic reductions in mortality rates AT ALL AGES
  – pattern of improvement shows acceleration

• Cohort effect is present but not very pronounced in Irish Males

• Cohort life expectancies for male aged 65 in 2006 have been estimated as:
  – 19.0 years (CSO Method, updated), increasing at 0.2 years per calendar year
  – 20.0 years (GAD, 1%), increasing at 0.2 years per calendar year
  – 20.7 years (GAD, 2%), increasing at 0.27 years per calendar year

• Irish mortality improvements have been dramatic by international standards and Irish mortality is now approaching EU-15 average

• Recent changes in the mix of the population by social class are considered to have had a limited impact on life expectancy

• Changing mortality patterns will have profound effects for policy-makers & actuaries including projection method