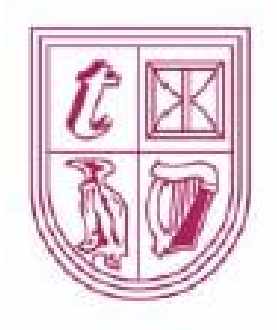

Mortality Trends in Ireland

13th June 2007

Demographic Sub-Committee:

John Armstrong (Chairperson)

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Aisling Kennedy

Liam Sloyan

Shane Whelan

** 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 mortlity 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

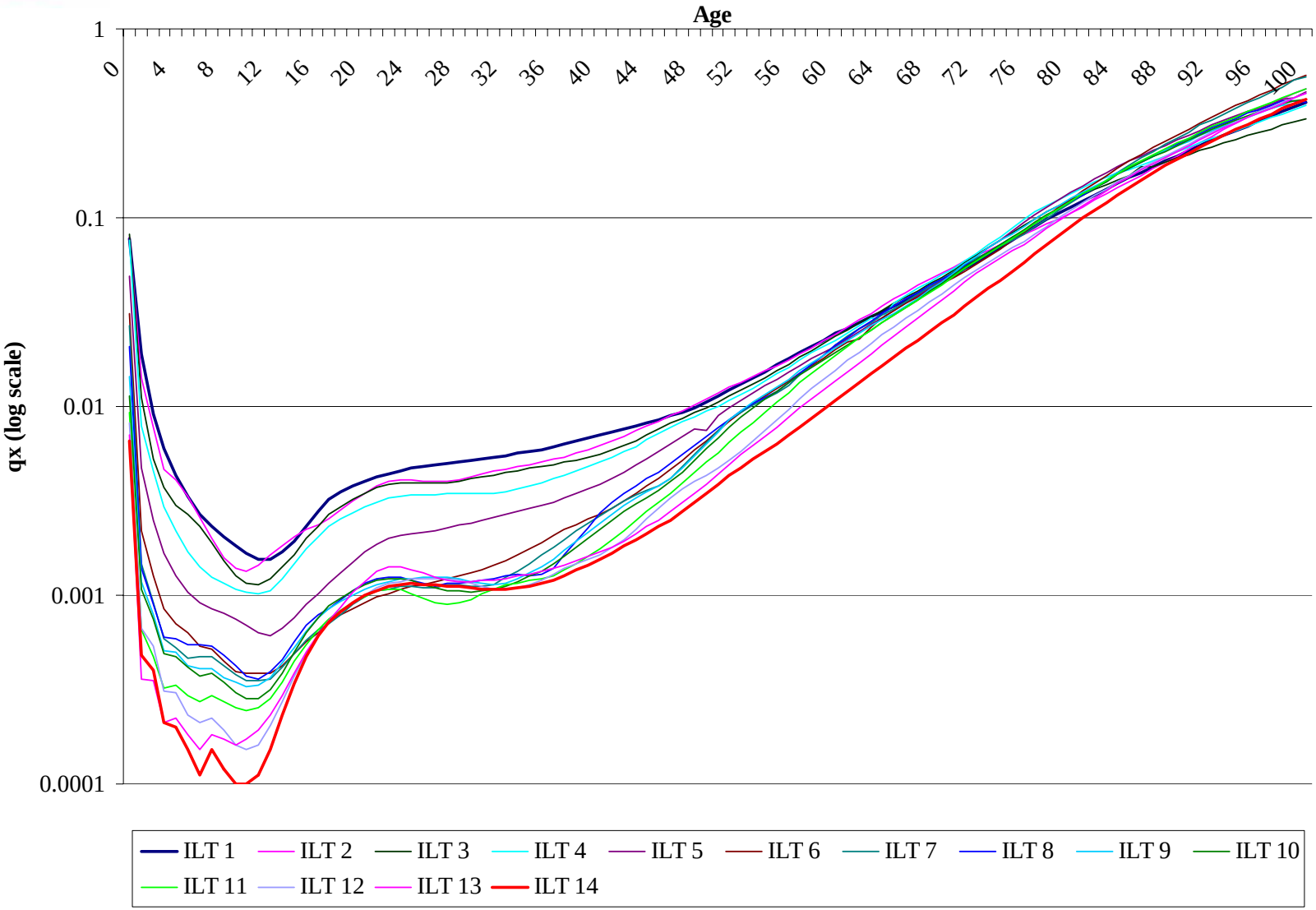
Data: Irish Population Statistics

- 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_xs.
  - 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.

Data: Irish Population Statistics

- 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.”
  - Kannisto, V. (1994) *Development of oldest-old mortality, 1950-1990: Evidence from 28 Developed Countries.* Odense Press.
  - 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 from. [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

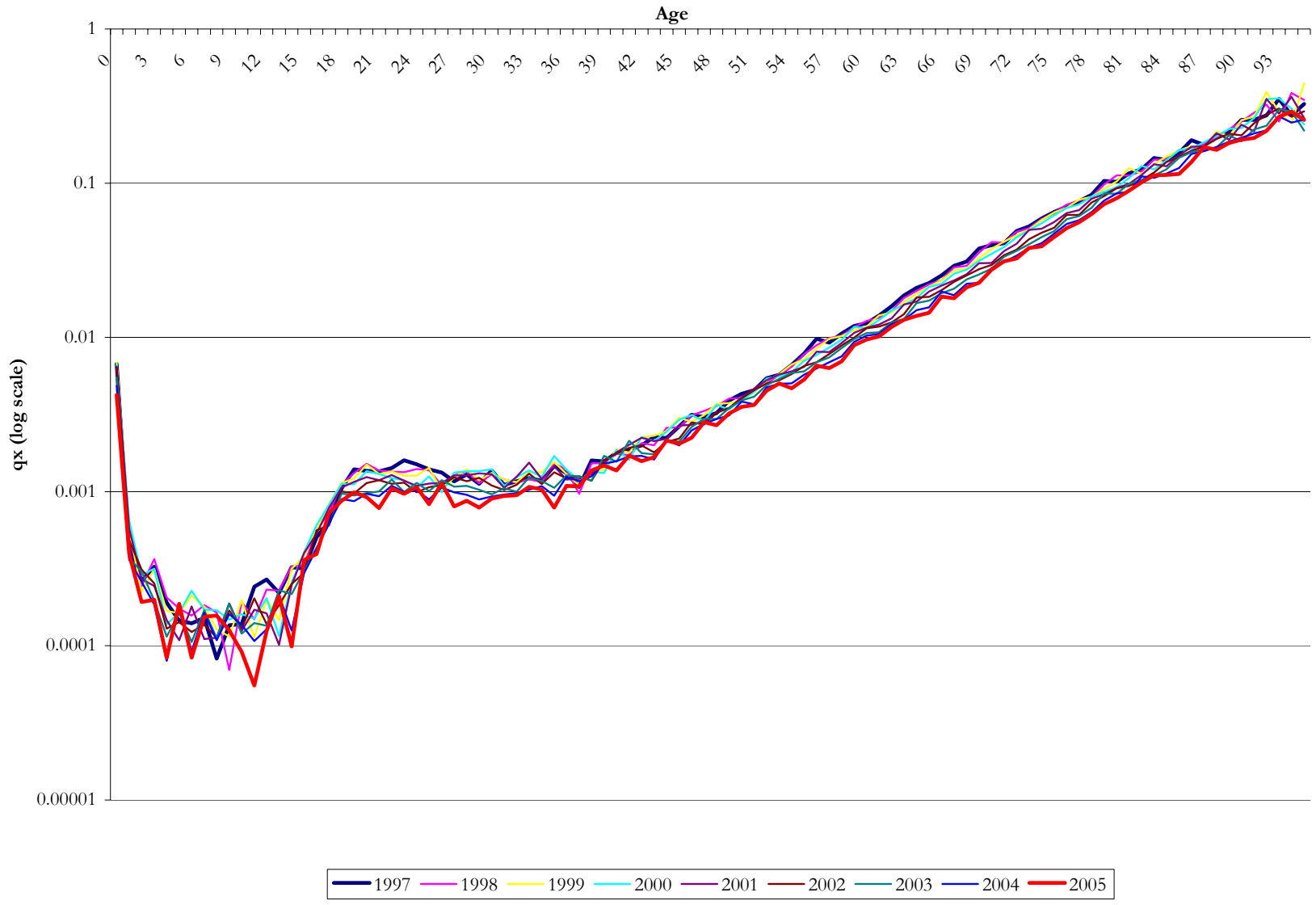


Percentage Fall (p.a.) in Irish Male Mortality Rate to 2002

	10 Years	20 Years	30 Years	50 Years	70 Years	CSO Factor
0	2.13	2.65	3.75	3.95	3.47	2.20
10	3.14	4.63	3.96	3.61	3.65	5.35
20	-0.17	0.52	0.41	1.00	1.84	2.93
30	0.14	-0.18	0.29	1.64	2.09	-0.35
40	0.42	1.73	1.79	1.80	2.03	0.81
50	1.81	2.75	2.23	1.65	1.53	2.43
60	3.30	2.71	2.08	1.25	1.10	3.42
70	3.02	2.15	1.53	0.92	0.68	2.84
80	1.68	1.42	0.93	0.78	0.26	1.94
90	0.95	0.70	0.53	0.41	0.03	1.17

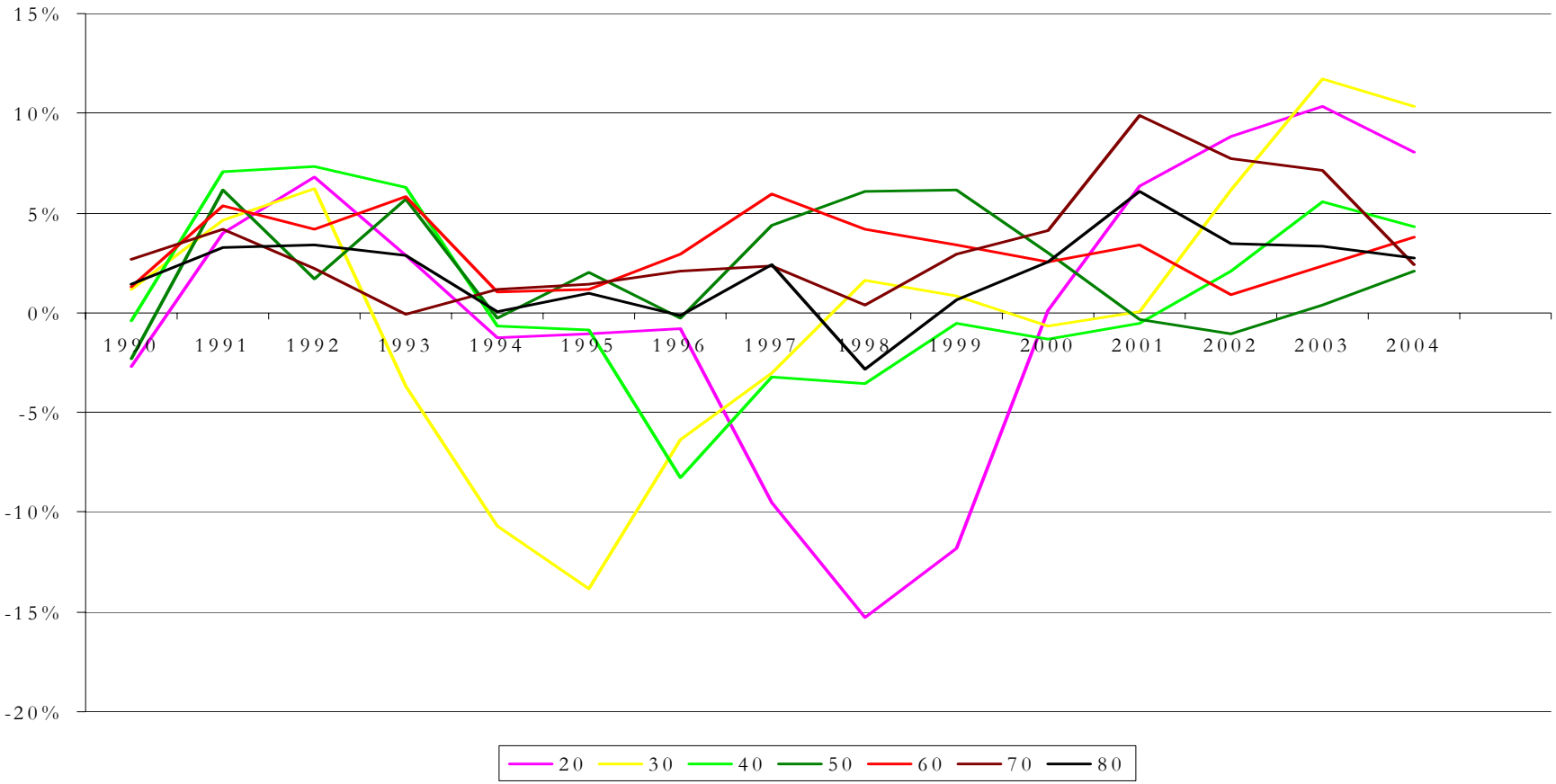
Irish Male Mortality, 1997-2005

[Deaths averaged over 3 years, but 2005 over 1 year]



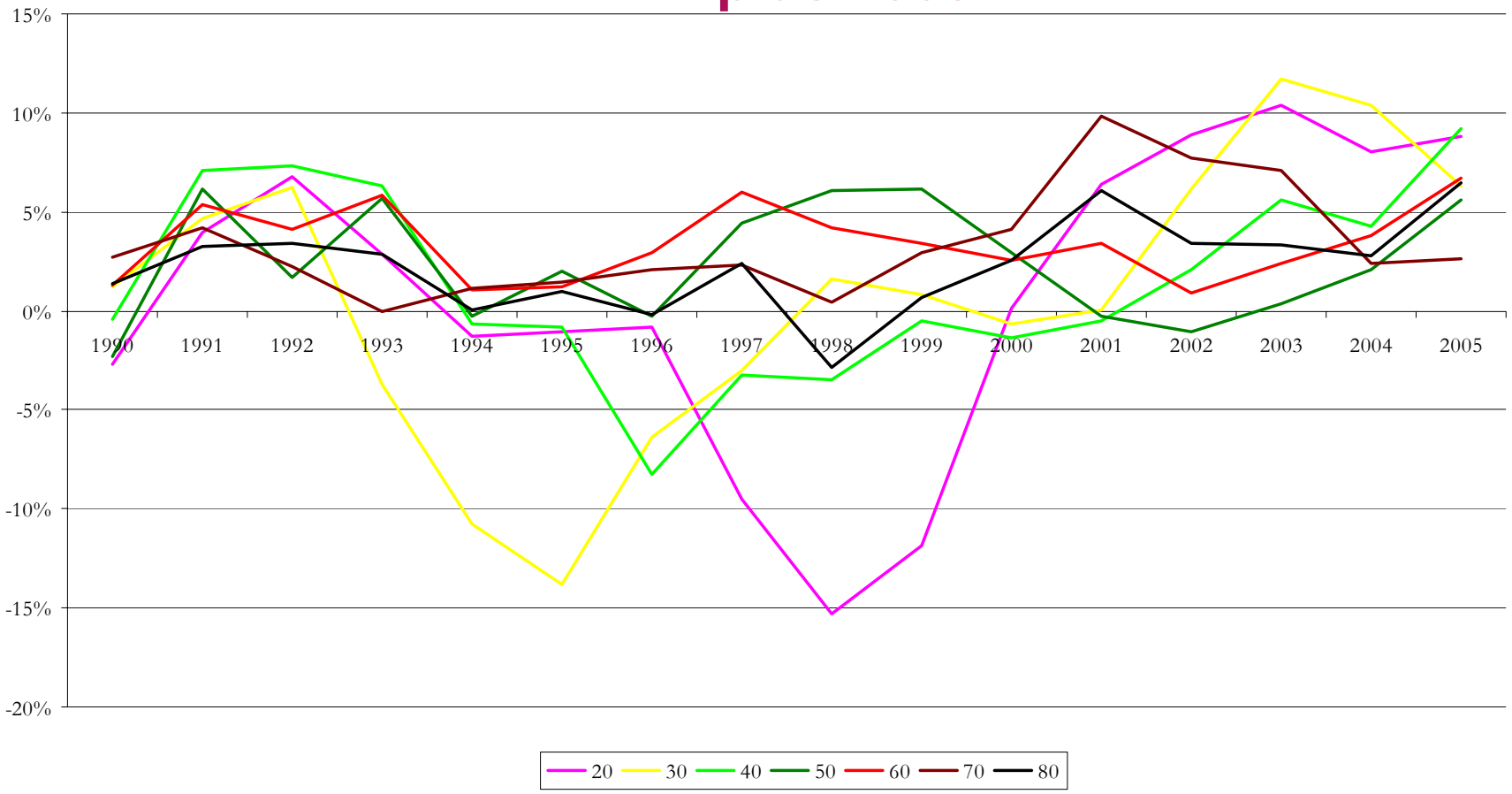
Percentage Fall (p.a.) in Irish Male Mortality Rate

over rolling three year periods ending 1990-2004

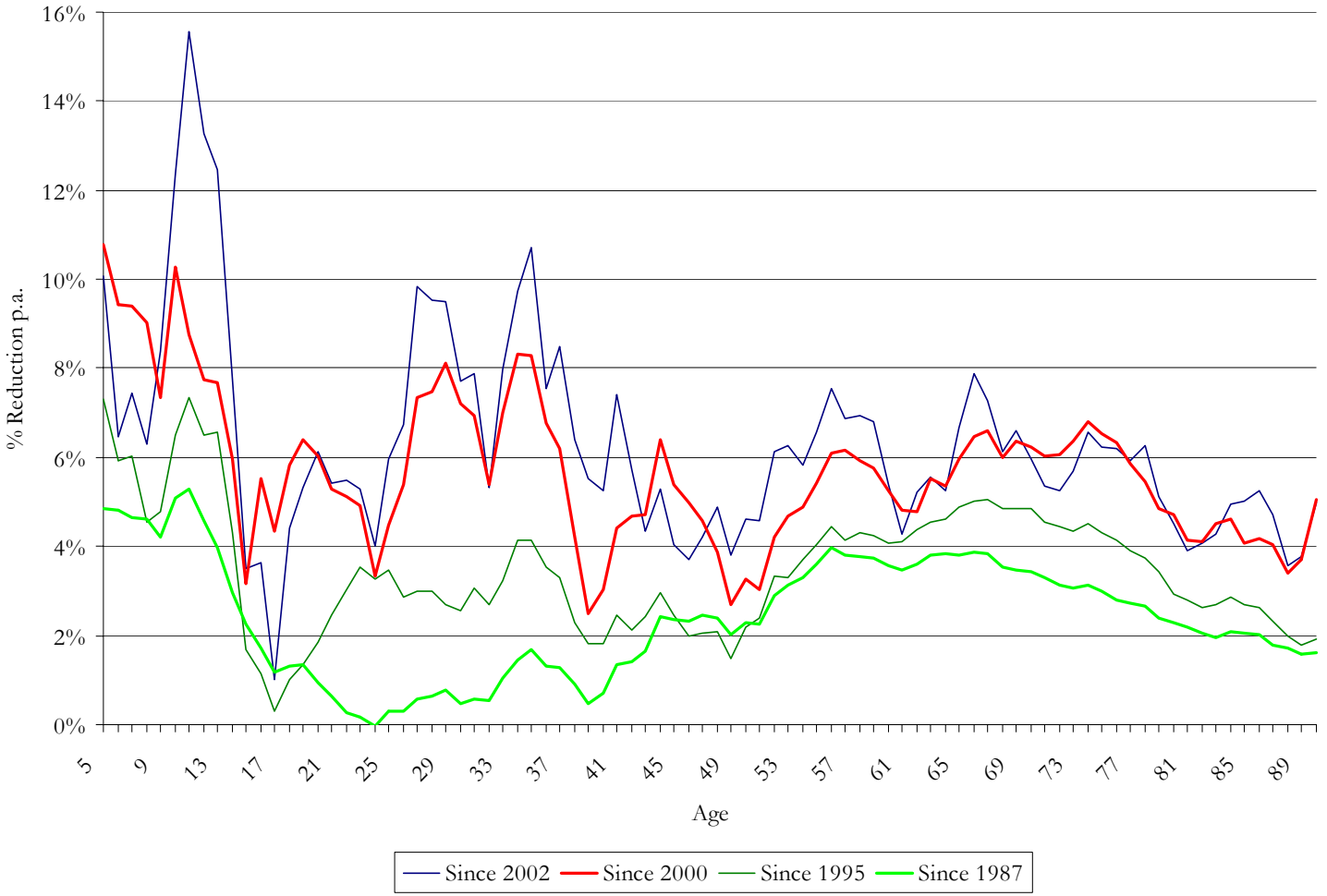


Percentage Fall (p.a.) in Irish Male Mortality Rate

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]

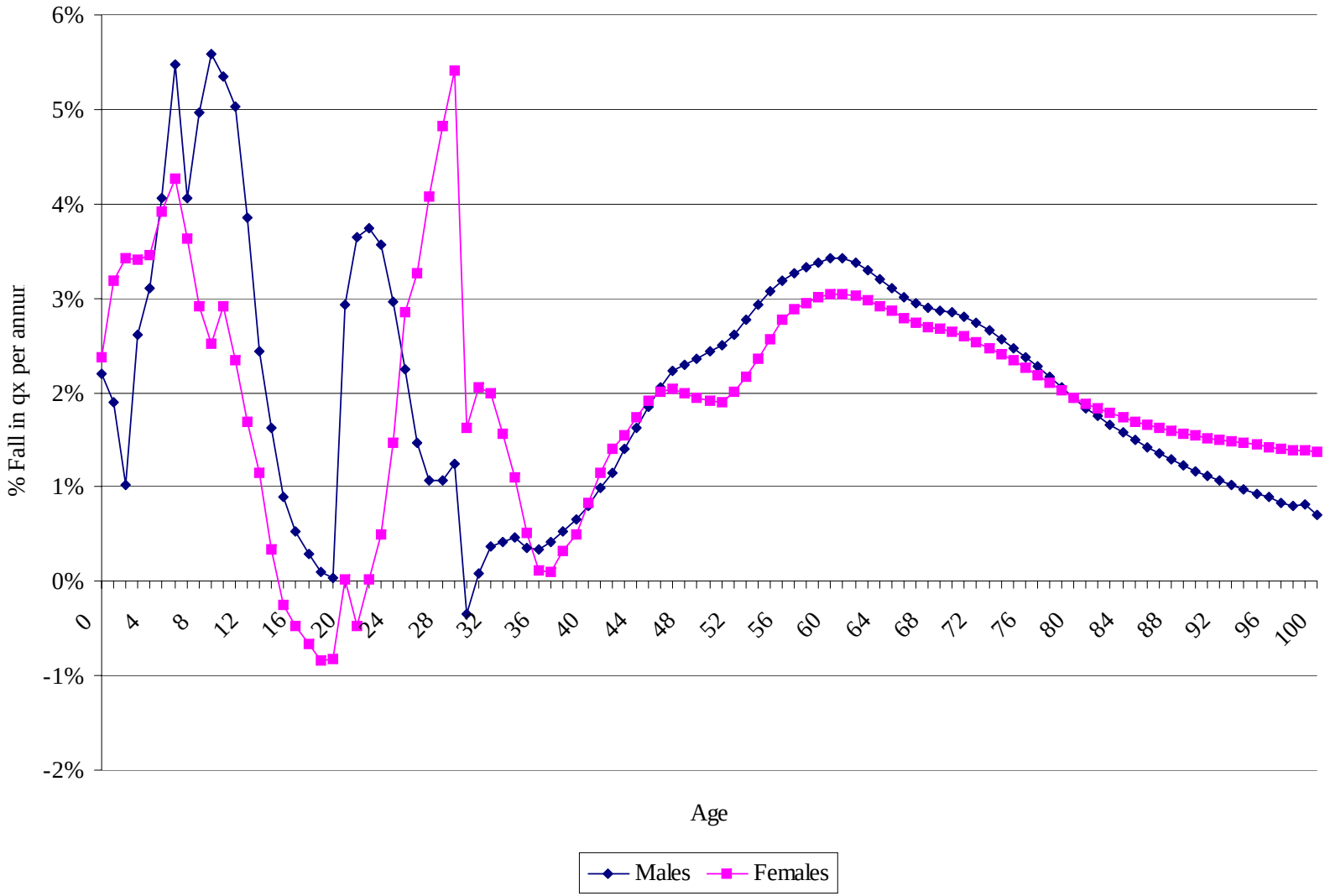


Note: Deaths averaged over 3 years in base year, single year for 2005.

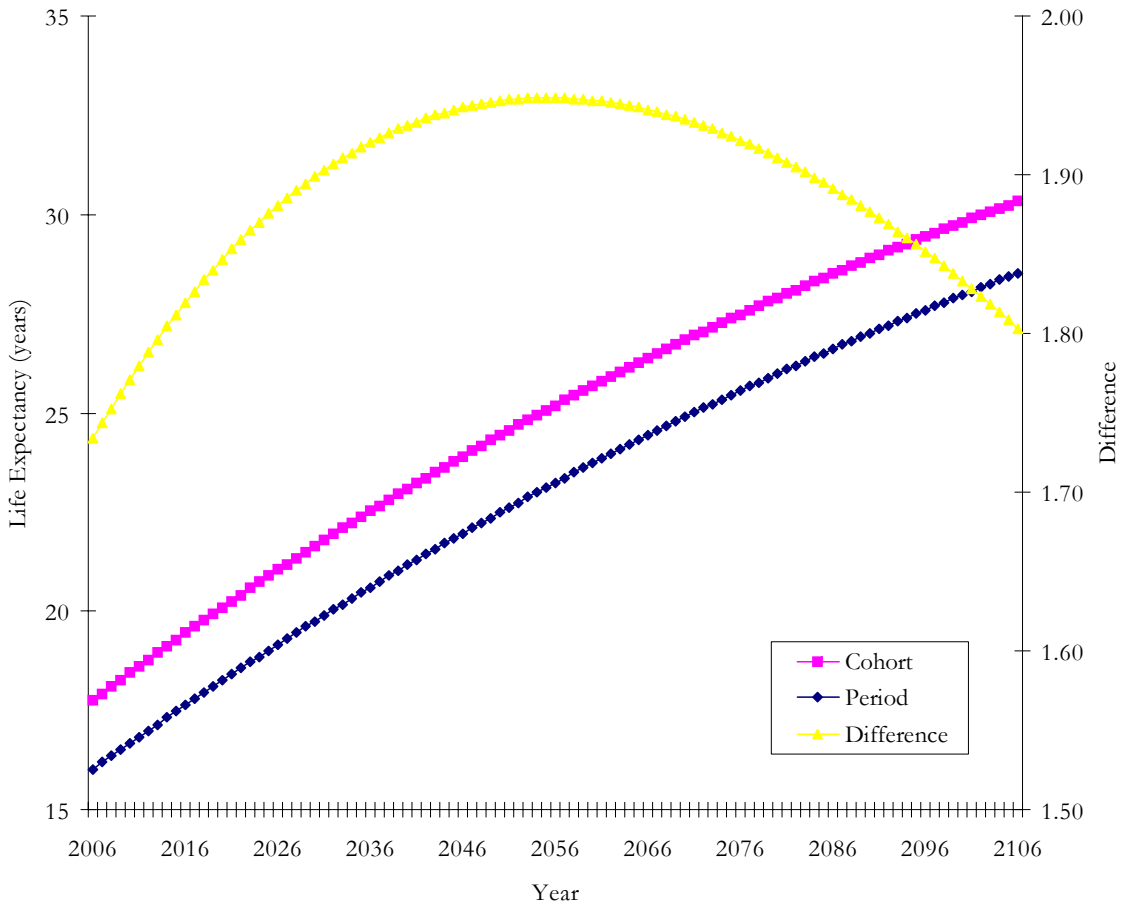
CSO Method of Mortality Projection (2004)

- 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.

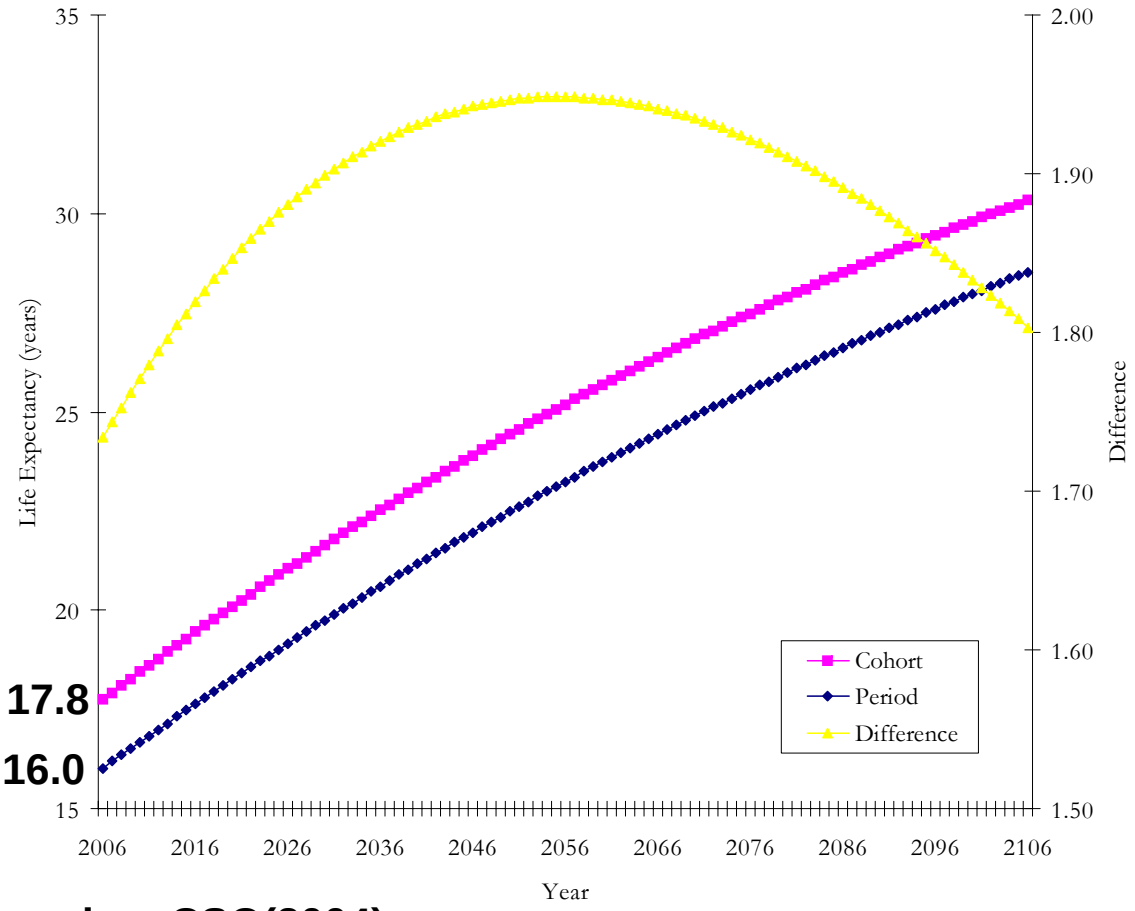
CSO: Forecast fall in q_x p.a. in projections



Period & Cohort Life Expectancies, CSO (2004) Projections, Males, age 65



Period & Cohort Life Expectancies, CSO (2004) Projections, Males, age 65



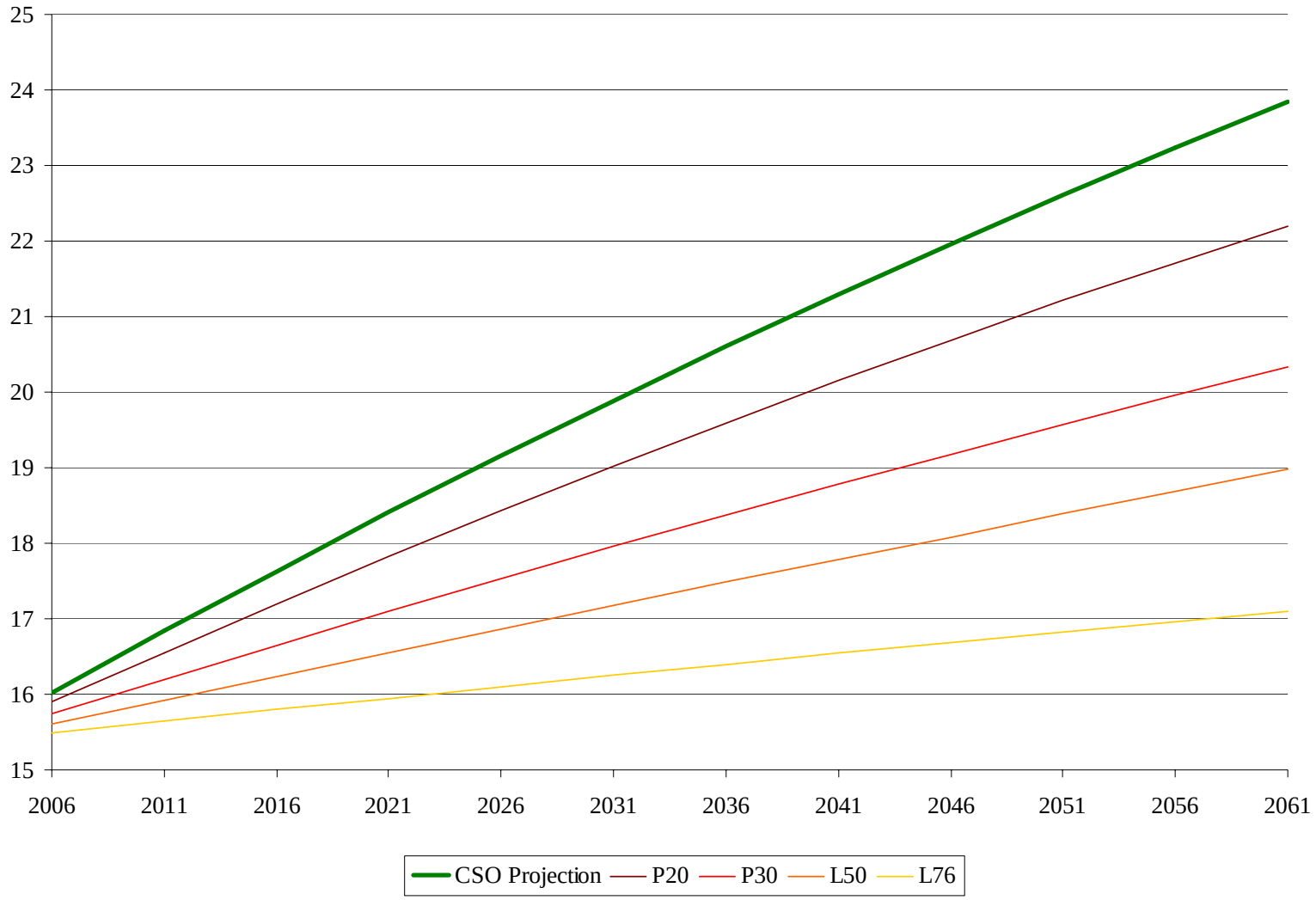
<u>Rules of Thumb based on CSO(2004)</u>:

(1) Cohort life expectancy is 1.75 to 2 years higher than period life expectancy.

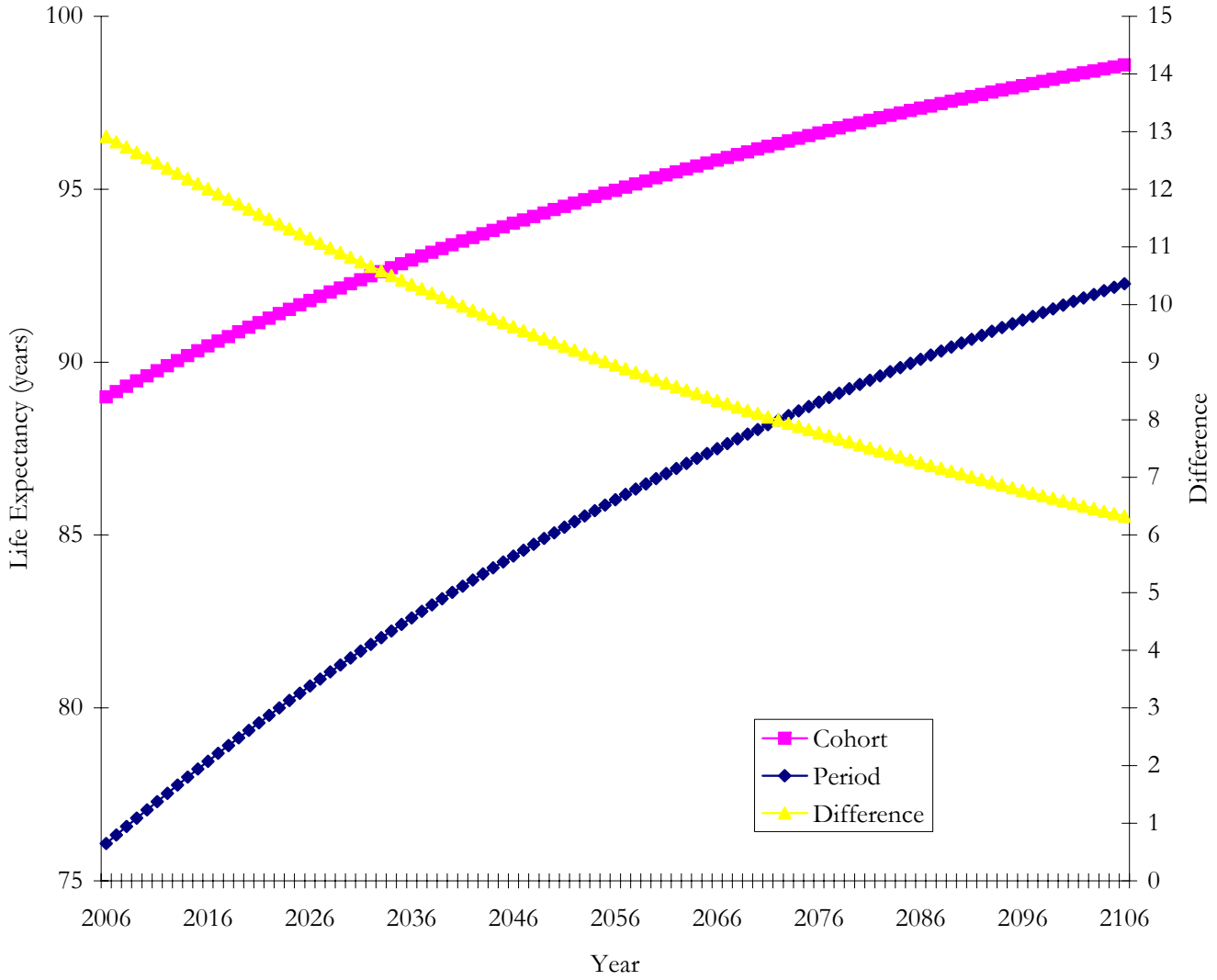
(2) Life expectancy (cohort or period) is increasing by about 0.17 of a year with the passing of each calendar year.

CSO Method: Variations

Projections of Period Life Expectancy from 65 Males

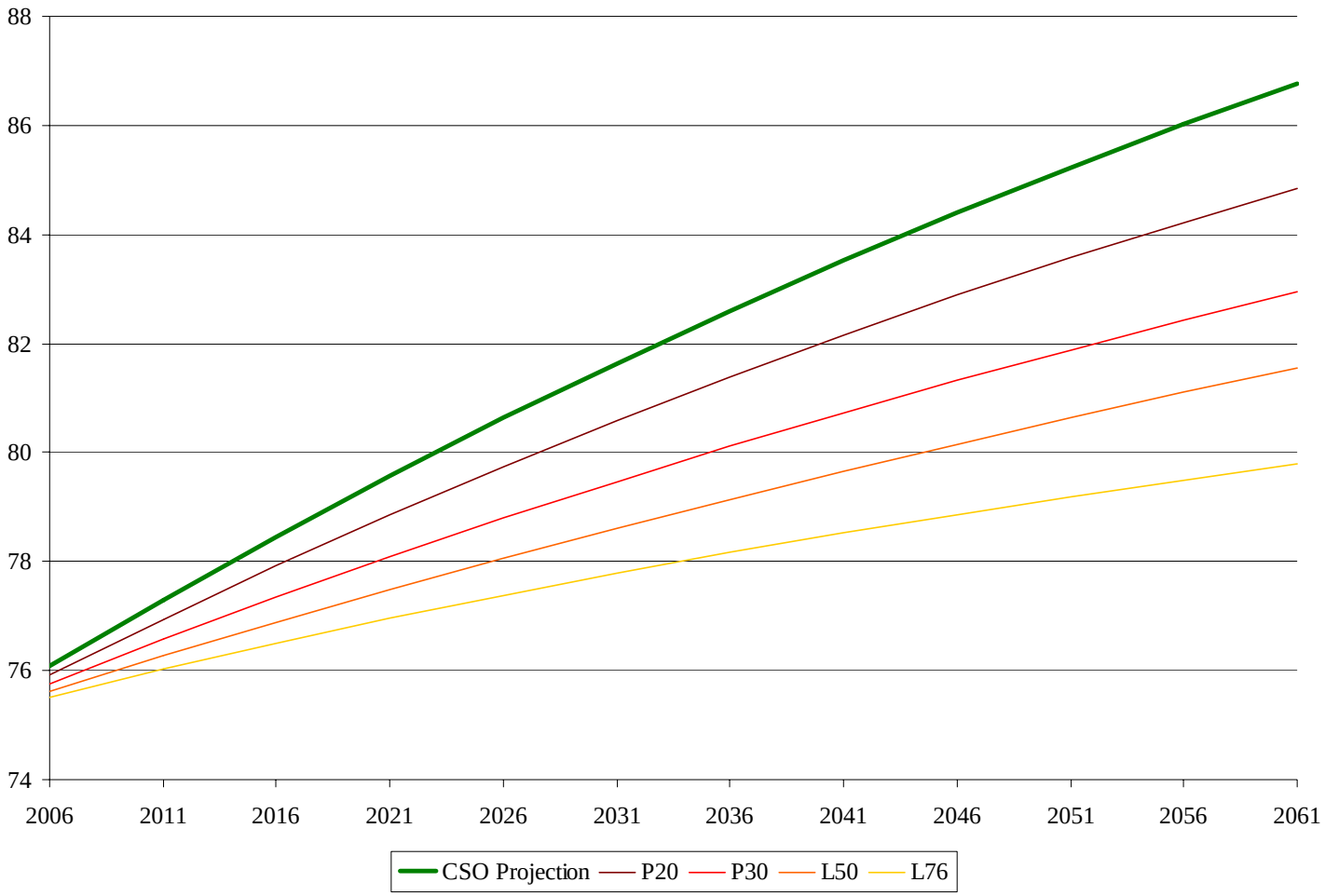


Period & Cohort Life Expectancies, CSO (2004) Projections, Males, age 0



CSO Method: Variations

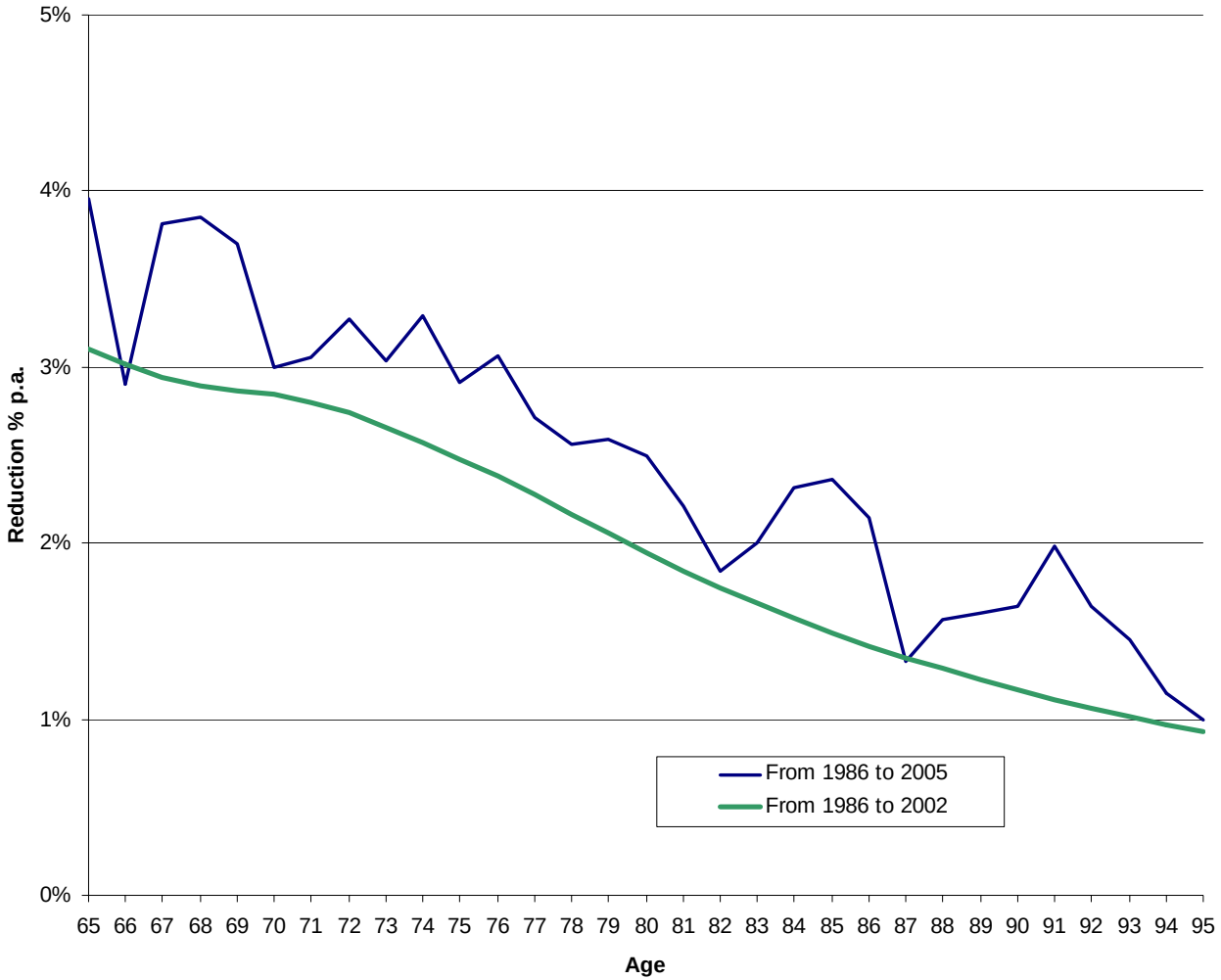
Projections of Period Life Expectancy from 0 Males



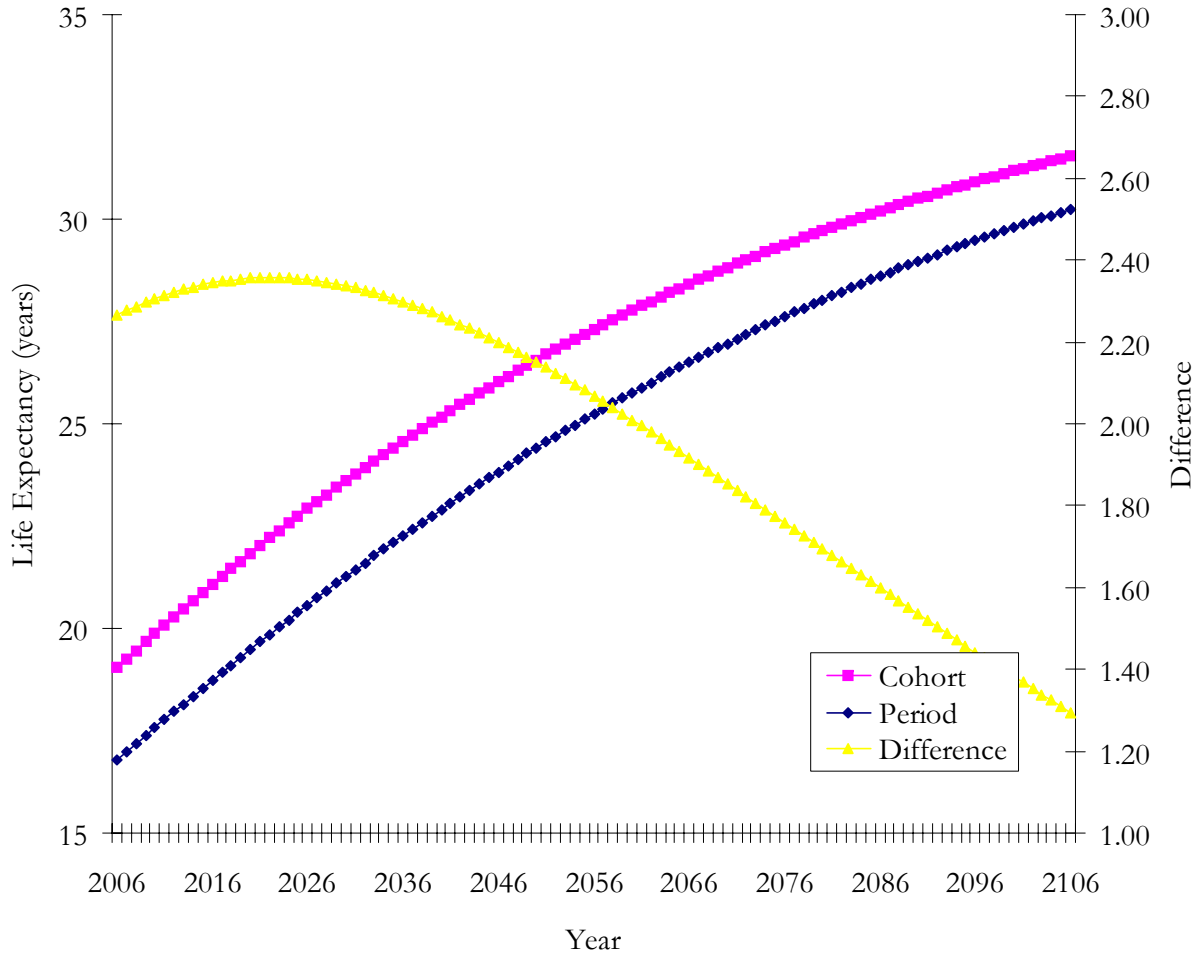
Updating CSO Projection Method

- 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)

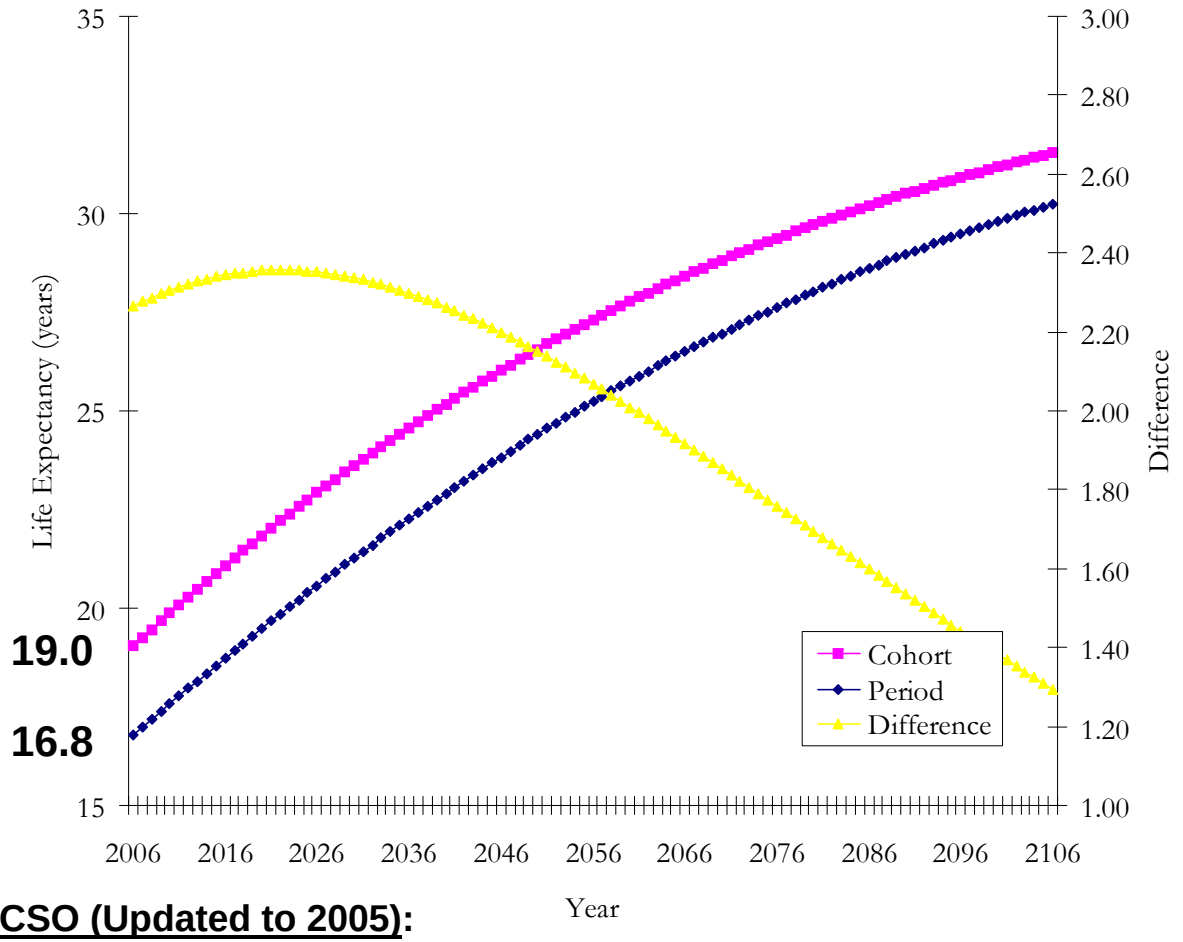
Reduction Factors % p.a. for Male Projections above age 65



Period & Cohort Life Expectancies, Projections, Males, age 65, updated to 2005



Period & Cohort Life Expectancies, Projections, Males, age 65, updated to 2005



<u>Rules of Thumb based on CSO (Updated to 2005)</u>:

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’.

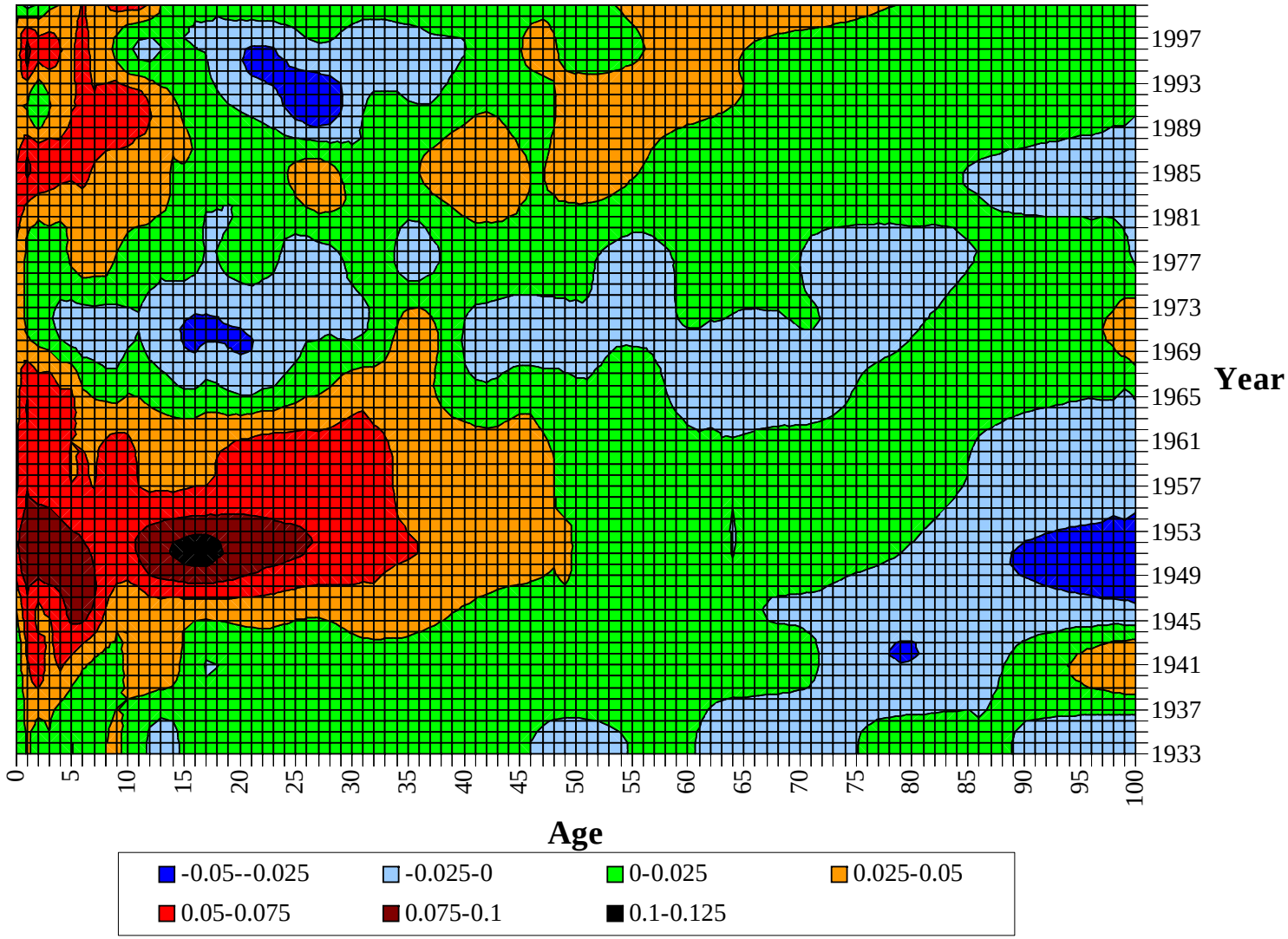
Percentage Fall (p.a.) in Irish Male Mortality Rate over Decade Ending

Age	1941	1951	1961	1971	1981	1991	2001
0	-0.39	4.87	4.47	4.02	5.93	3.16	2.13
10	2.59	4.91	5.72	0.40	2.59	6.10	3.14
20	0.70	6.98	6.01	-2.44	0.20	1.20	-0.17
30	1.24	5.17	5.87	1.34	1.22	-0.51	0.14
40	1.66	3.54	3.63	-0.05	1.91	3.02	0.42
50	0.88	1.53	1.87	-0.31	1.19	3.67	1.81
60	0.32	1.11	0.52	-0.53	0.80	2.11	3.30
70	-0.10	0.28	0.66	-0.66	0.27	1.28	3.02
80	-1.16	-0.96	0.83	0.27	-0.07	1.16	1.68
90	0.56	-2.40	-0.78	1.23	0.18	0.46	0.95

Percentage Fall (p.a.) in Irish Male Mortality Rate over Decade Ending

Age	1941	1951	1961	1971	1981	1991	2001
0	-0.39	4.87	4.47	4.02	5.93	3.16	2.13
10	**2.59**	**4.91**	**5.72**	0.40	2.59	6.10	3.14
20	0.70	**6.98**	**6.01**	-2.44	0.20	1.20	-0.17
30	1.24	5.17	**5.87**	**1.34**	**1.22**	-0.51	0.14
40	1.66	3.54	3.63	-0.05	**1.91**	**3.02**	0.42
50	0.88	1.53	1.87	-0.31	**1.19**	**3.67**	**1.81**
60	0.32	1.11	0.52	-0.53	0.80	**2.11**	**3.30**
70	-0.10	0.28	0.66	-0.66	0.27	1.28	**3.02**
80	-1.16	-0.96	0.83	0.27	-0.07	1.16	1.68
90	0.56	-2.40	-0.78	1.23	0.18	0.46	0.95

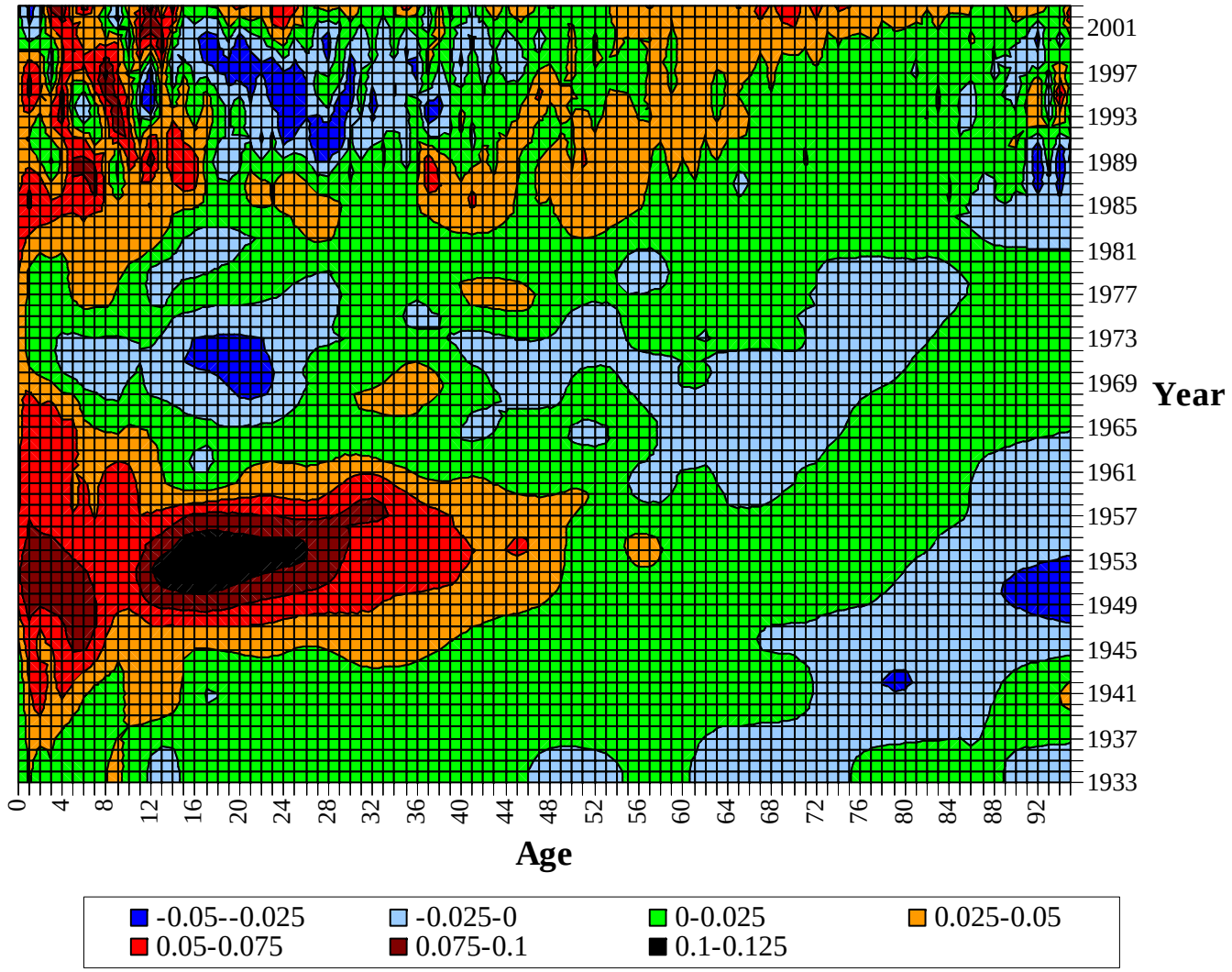
Map of Improvements in Male Mortality (% pa average fall over 5 years centred in calendar year shown) [Based on ILTs]



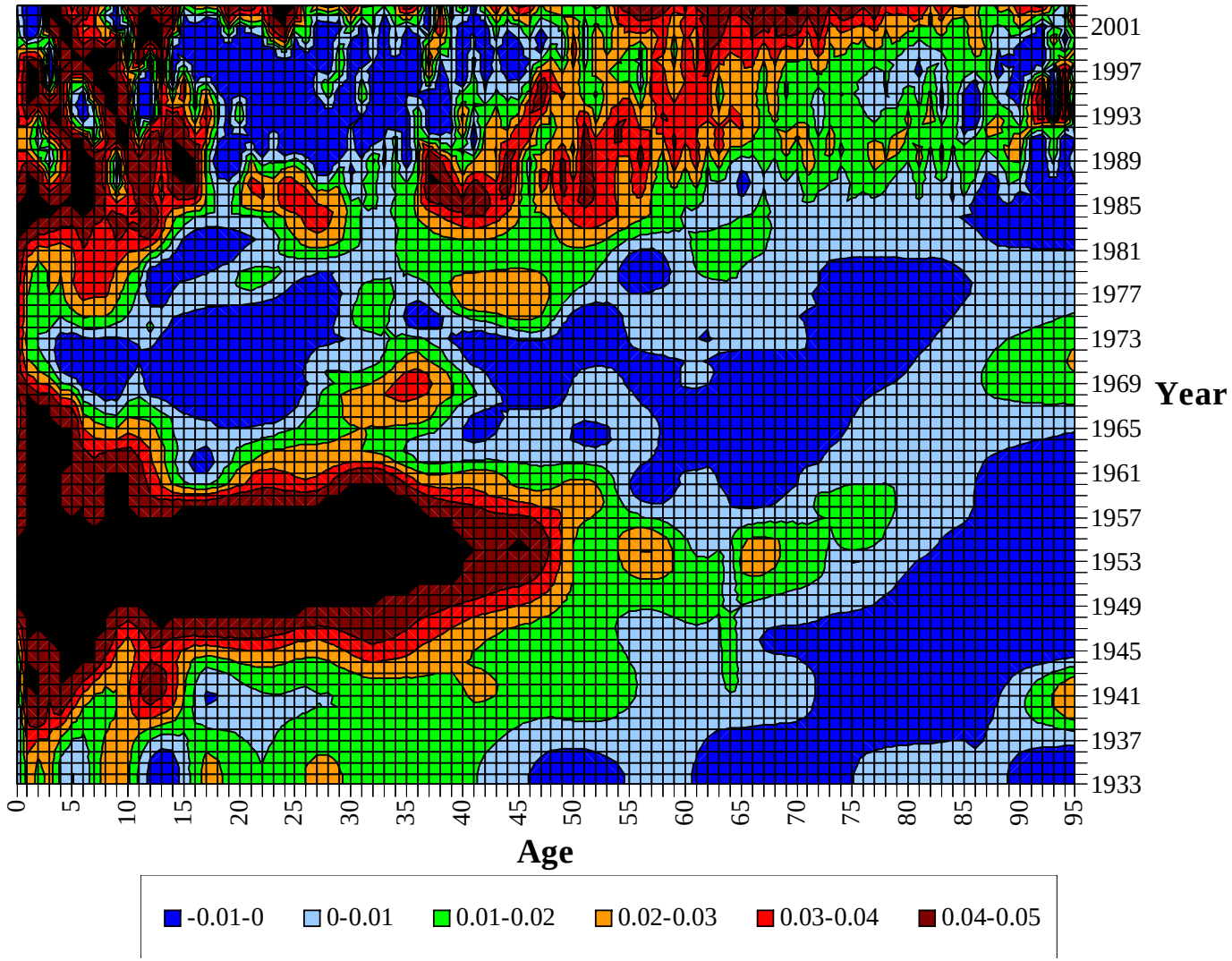
Aim

- 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

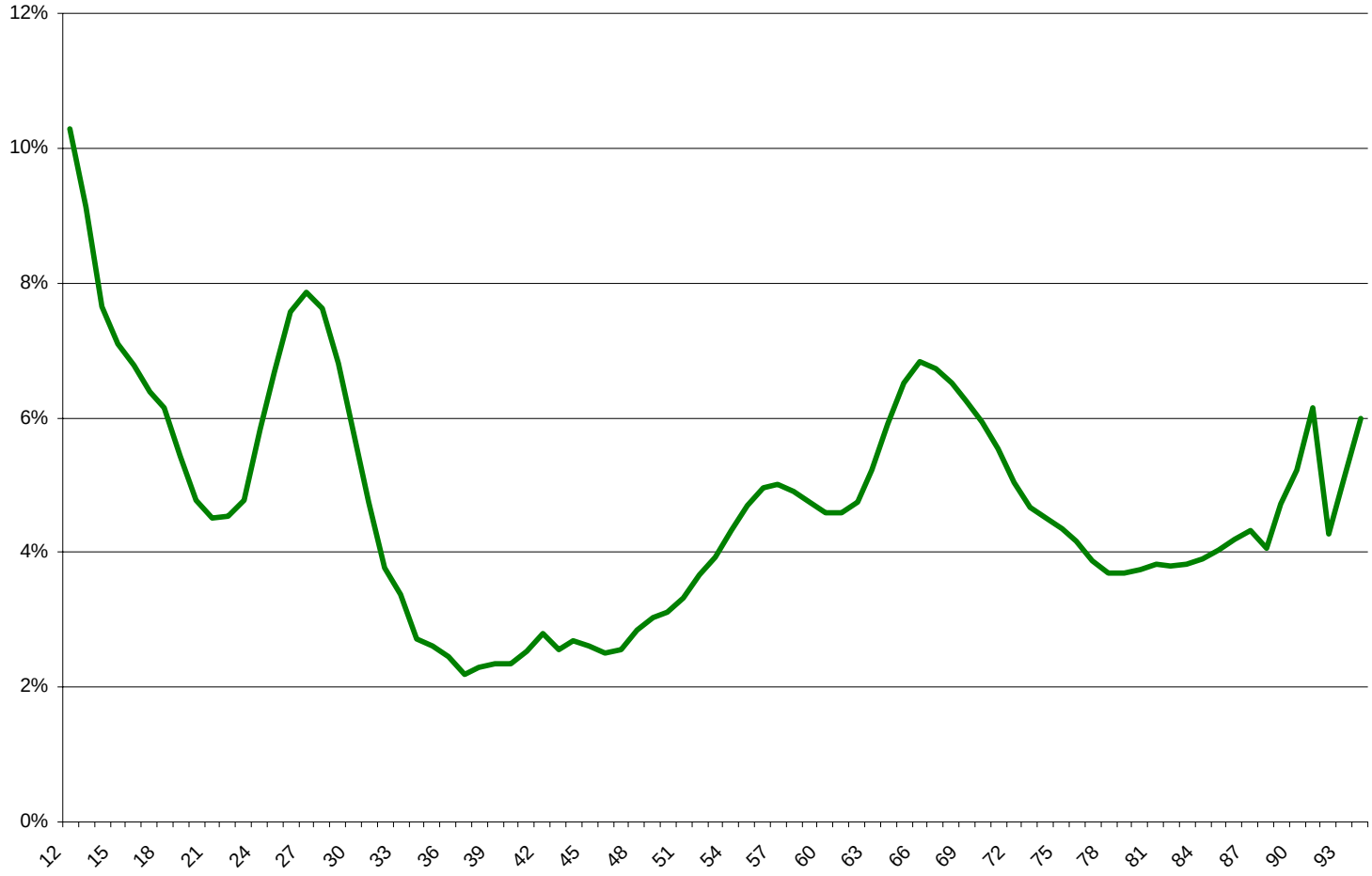
Methods of Mortality Projection

- 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)

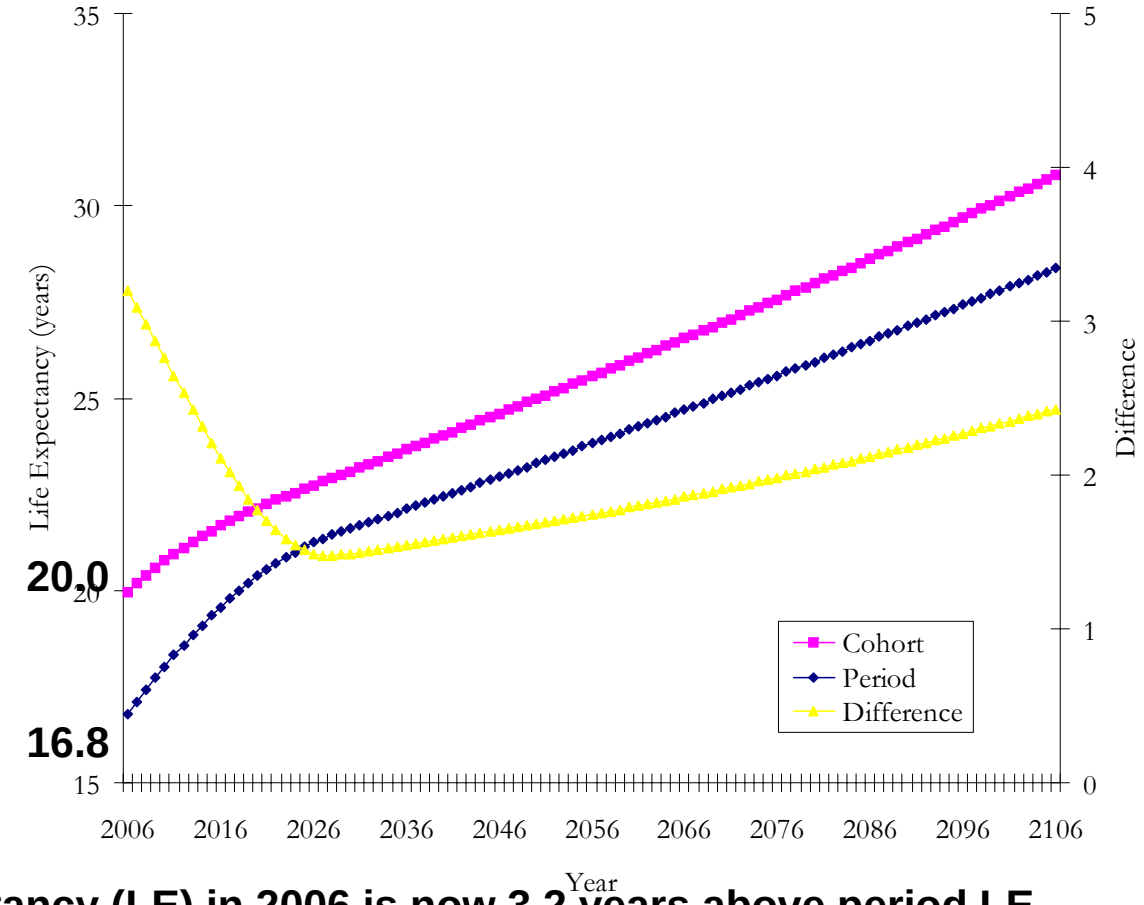
- UK Method (GAD)
  - *National Population Projections: Review of Methodology for Projecting Mortality* (2001) 117pp. [Adrian Gallop]
  - Impressive study of logarithmic, logit, Lee-Carter, modified Lee-Carter, stochastic Lee-Carter, etc. and how they performed in past but ability to incorporate the 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)



Life Expectancy, Irish Male at age 65, using targeting method

[current rate of improvement falls to steady state of 1% p.a. over 25 years]



<u>Rules of Thumb</u>:

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:

Method	Period LE at 65	Cohort LE at 65
CSO (Updated)	17.6 (years)	19.9 (years)
GAD (1%)	17.6	20.9
GAD (2%)	17.6	21.8

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

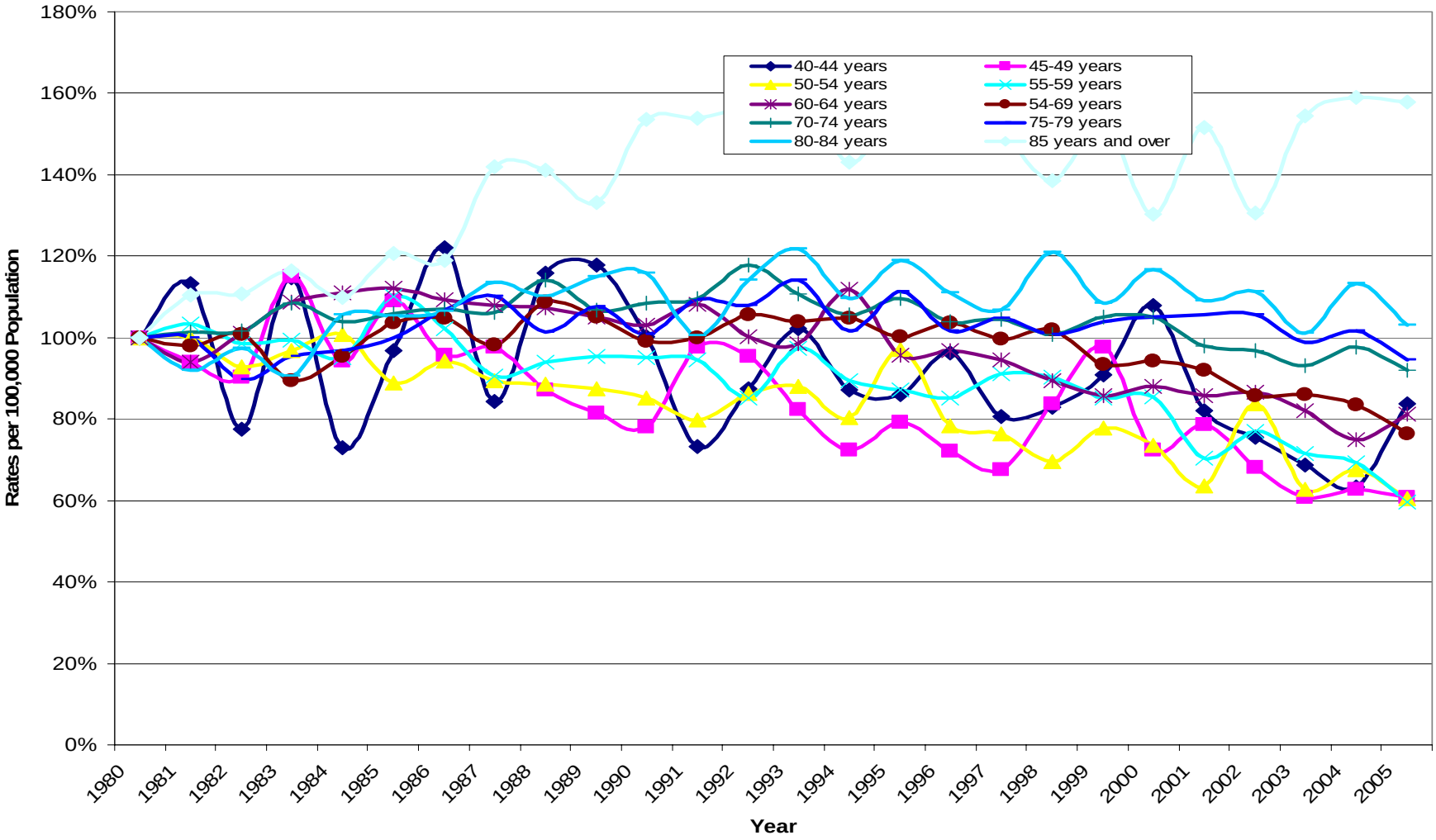
How has recent experience changed?

- 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

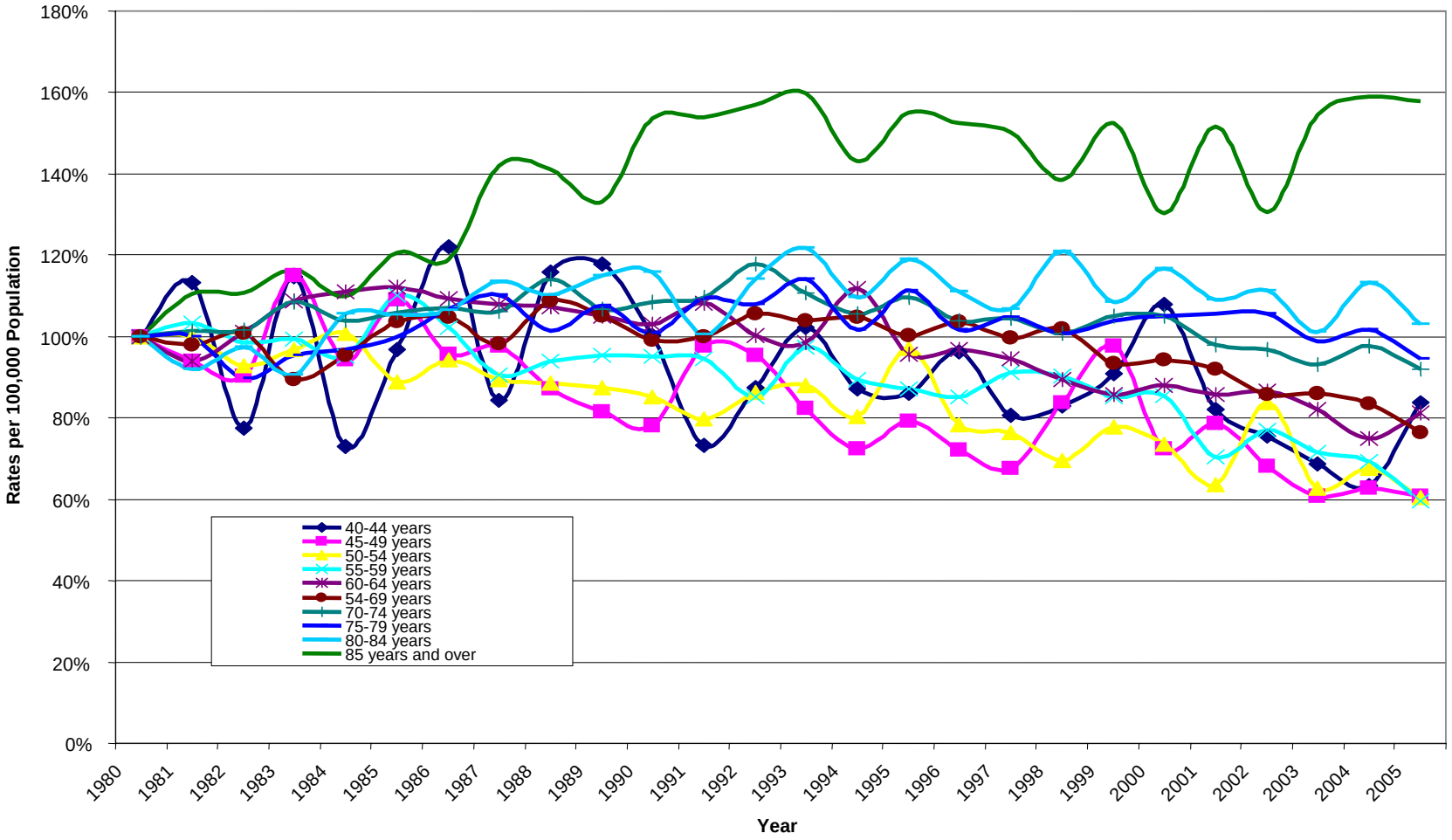
Rates of Improvement

Period	*Females*	*Males*
Change from 1982-1984 to 1985-1987	0.9%	0.2%
Change from 1985-1987 to 1988-1990	1.9%	2.5%
Change from 1988-1990 to 1991-1993	1.7%	1.5%
Change from 1991-1993 to 1994-1996	1.0%	1.1%
Change from 1994-1996 to 1997-1999	1.2%	1.6%
Change from 1997-1999 to 2000-2002	3.0%	3.6%
Change from 2000-2002 to 2003-2005	3.4%	4.4%

Female Mortality for Circulatory conditions

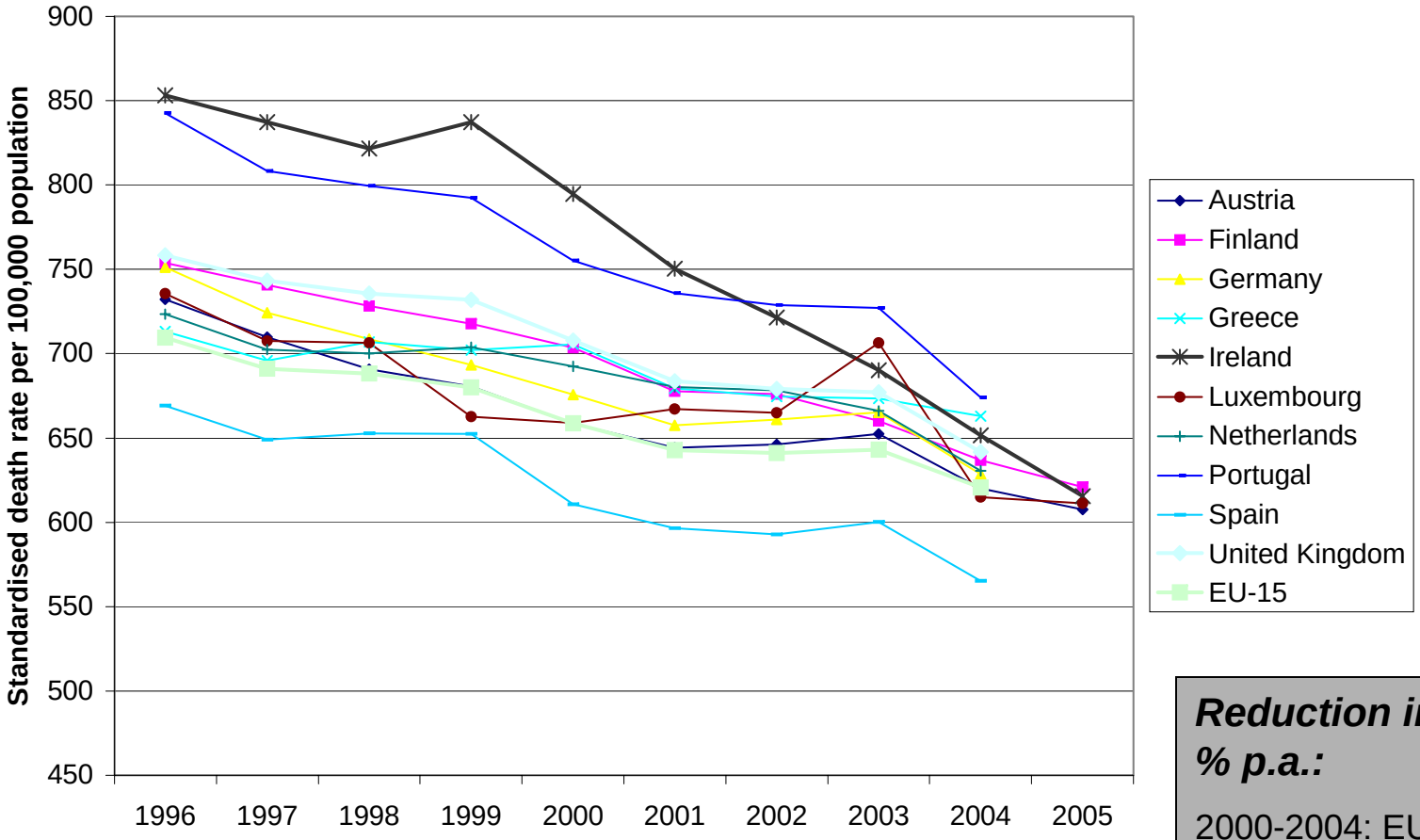


Male Mortality for Neoplasms



Part 3: International Comparisons

European age-standardised death rates – all causes

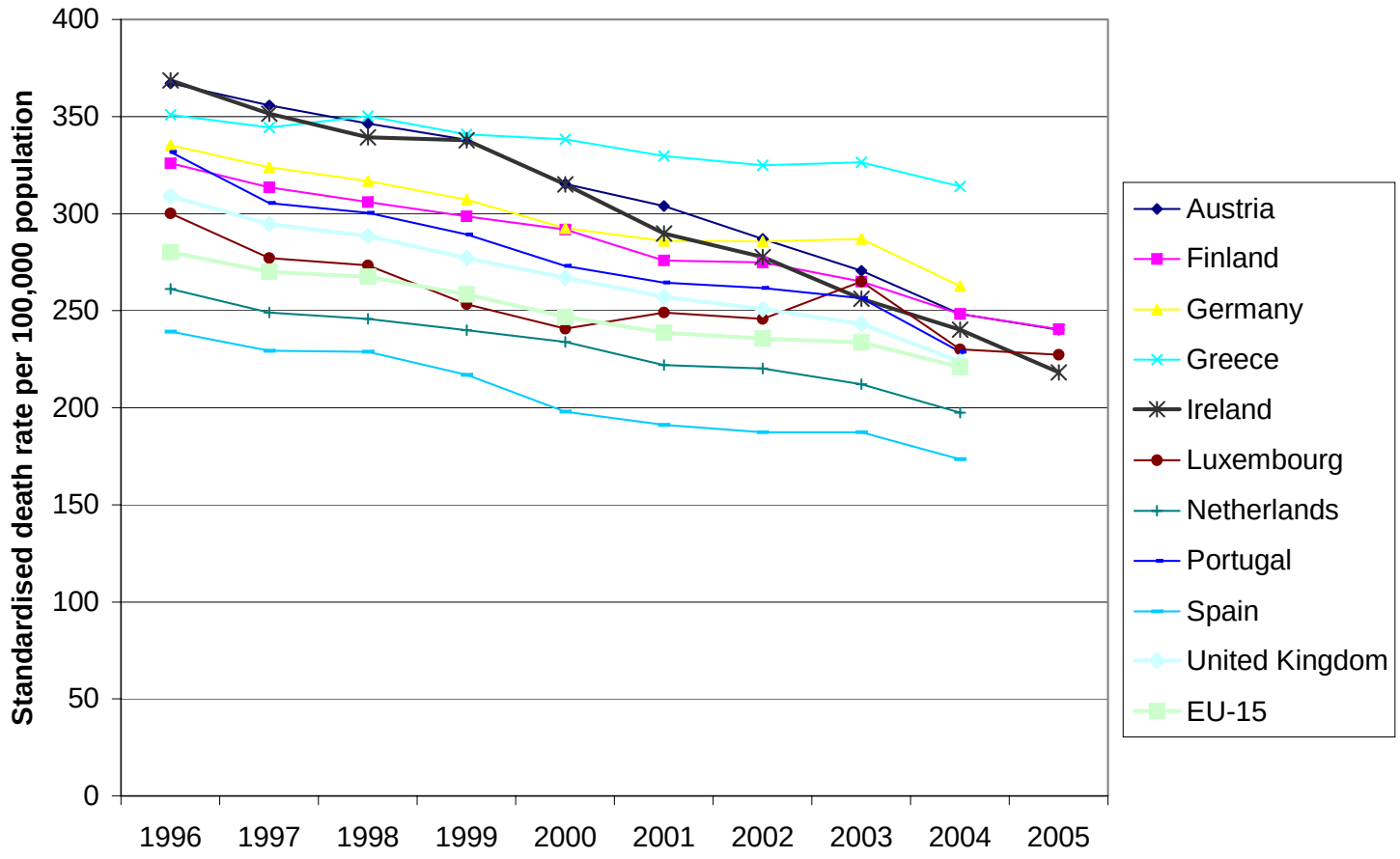


Reduction in mortality % p.a.:

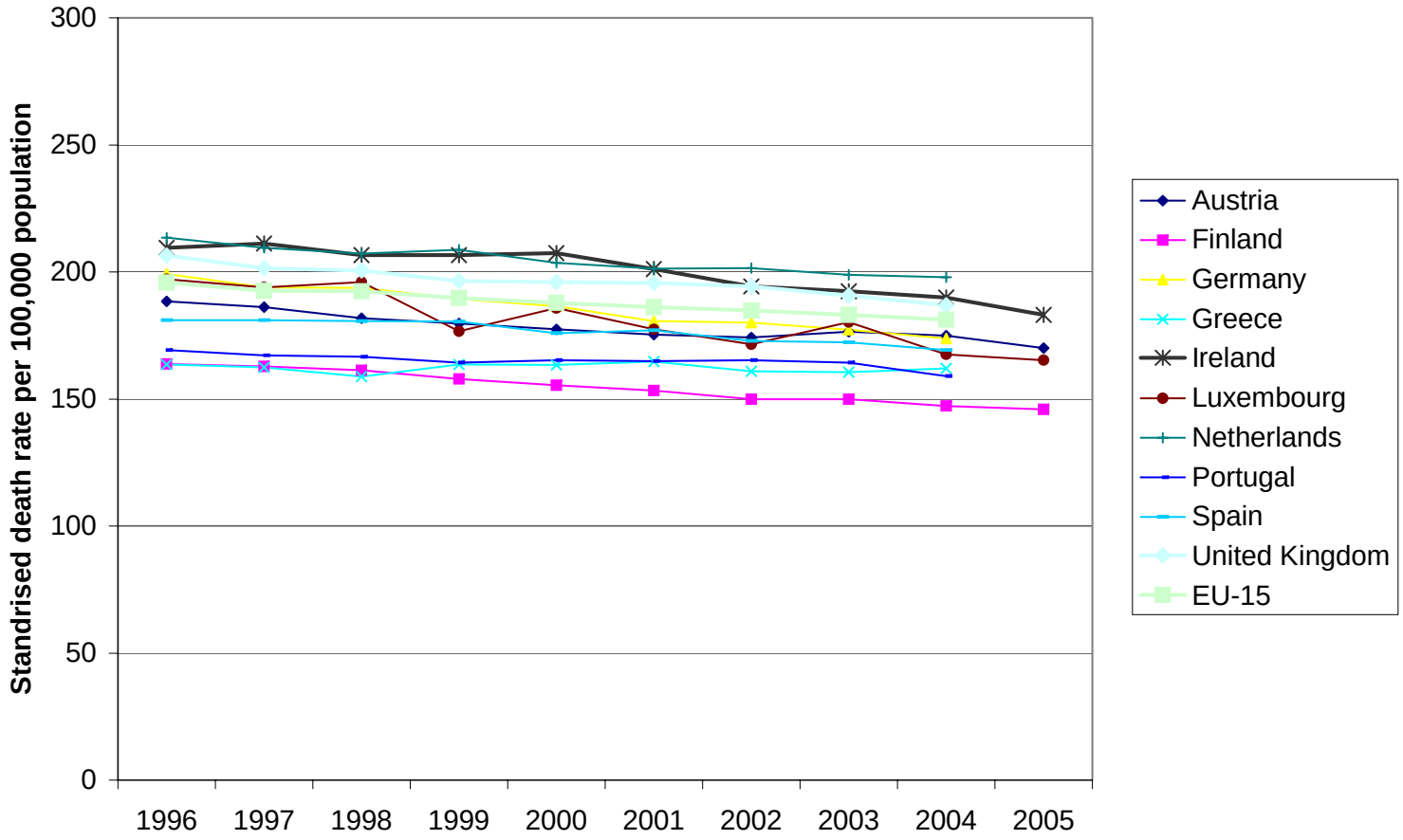
2000-2004: EU-15: 1.5%; Ireland: 4.8%

2002-2004: EU-15: 1.6%; Ireland: 5.0%

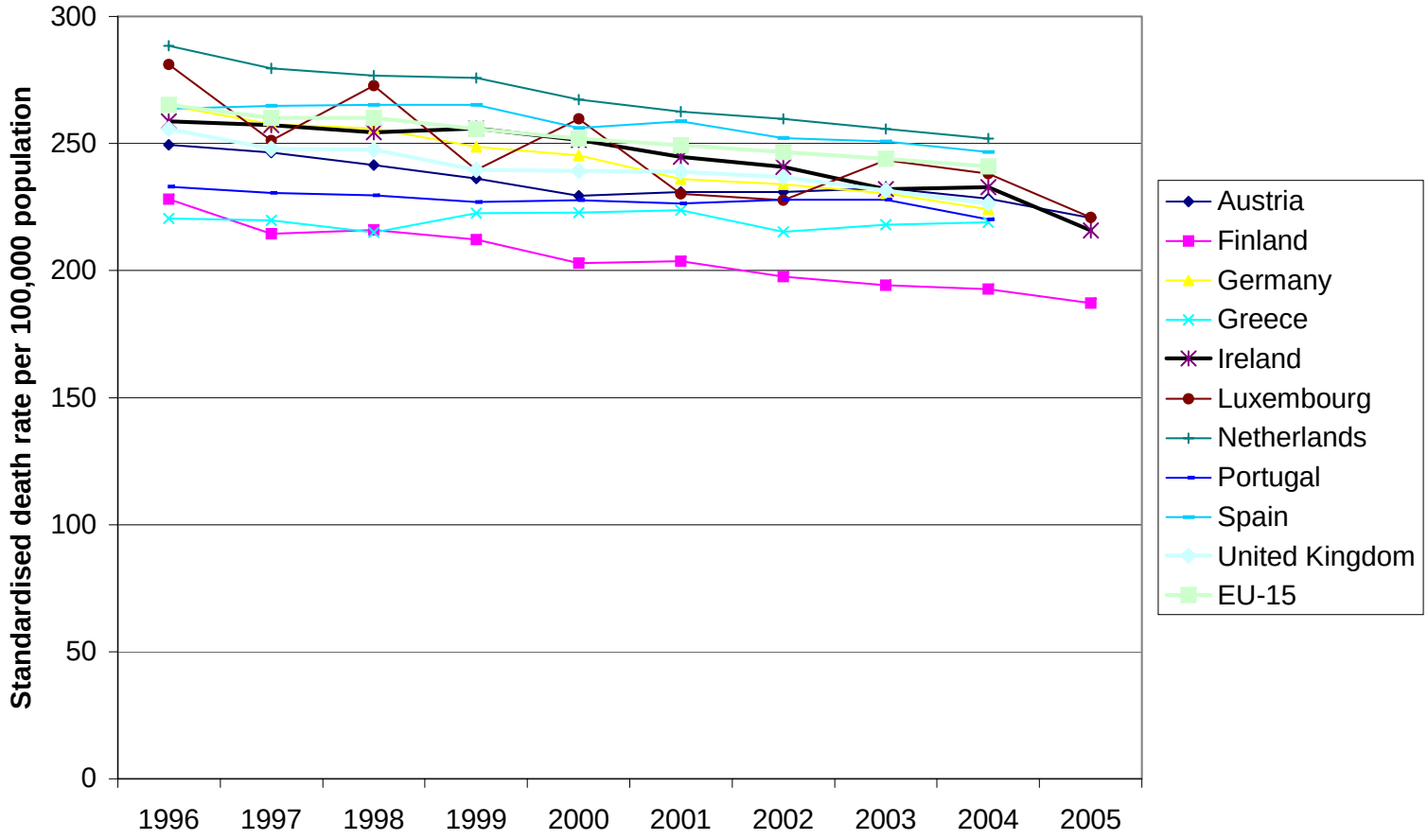
European age-standardised death rates – circulatory diseases



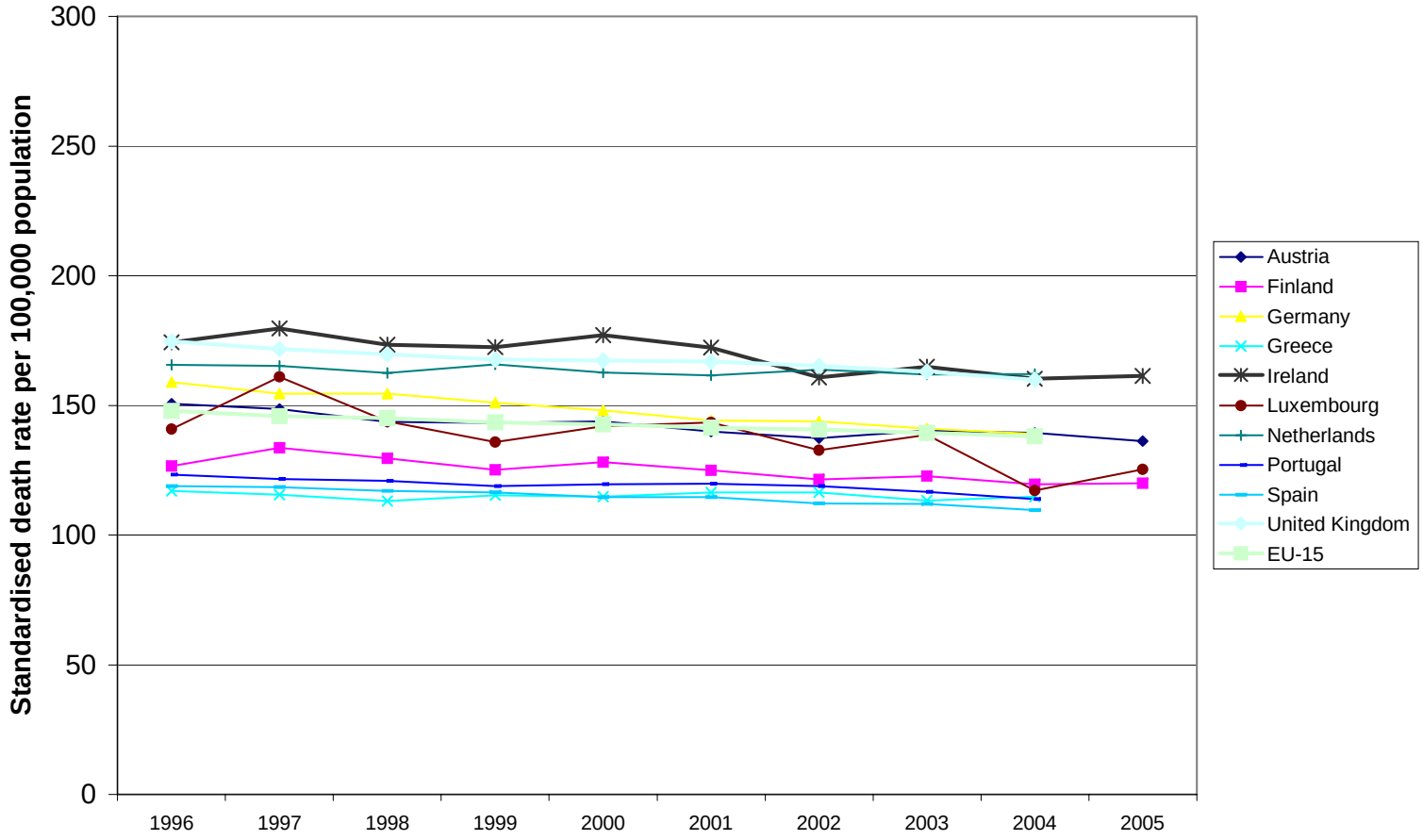
European age-standardised death rates – cancer



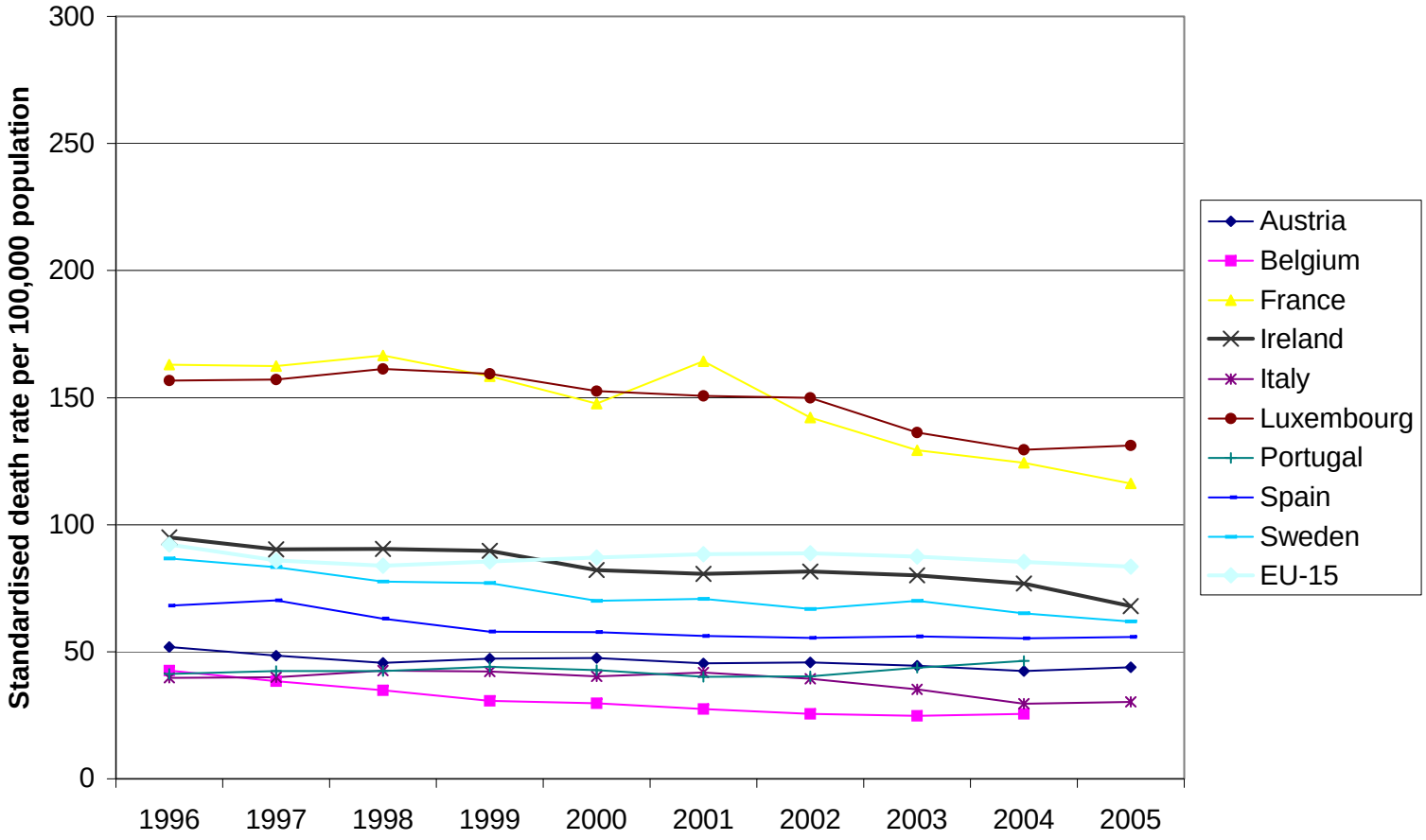
European age-standardised death rates – cancer - men



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 IIIM (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

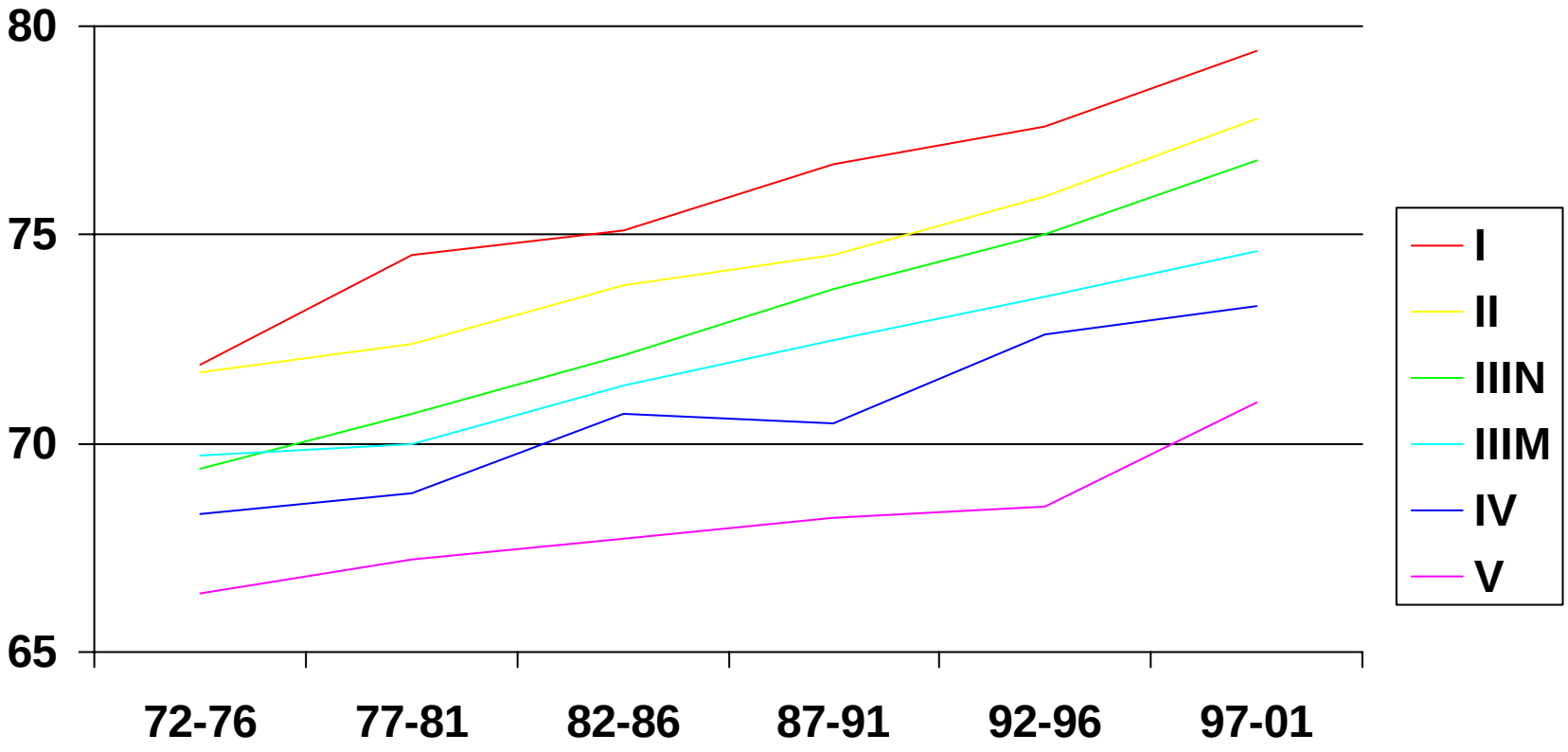
  Prevalence of moderate disability rises from 8% for class I to 23% for class V

  (Source: Health Survey for England, 2001 – UK Department of Health)

UK ONS Longitudinal Study

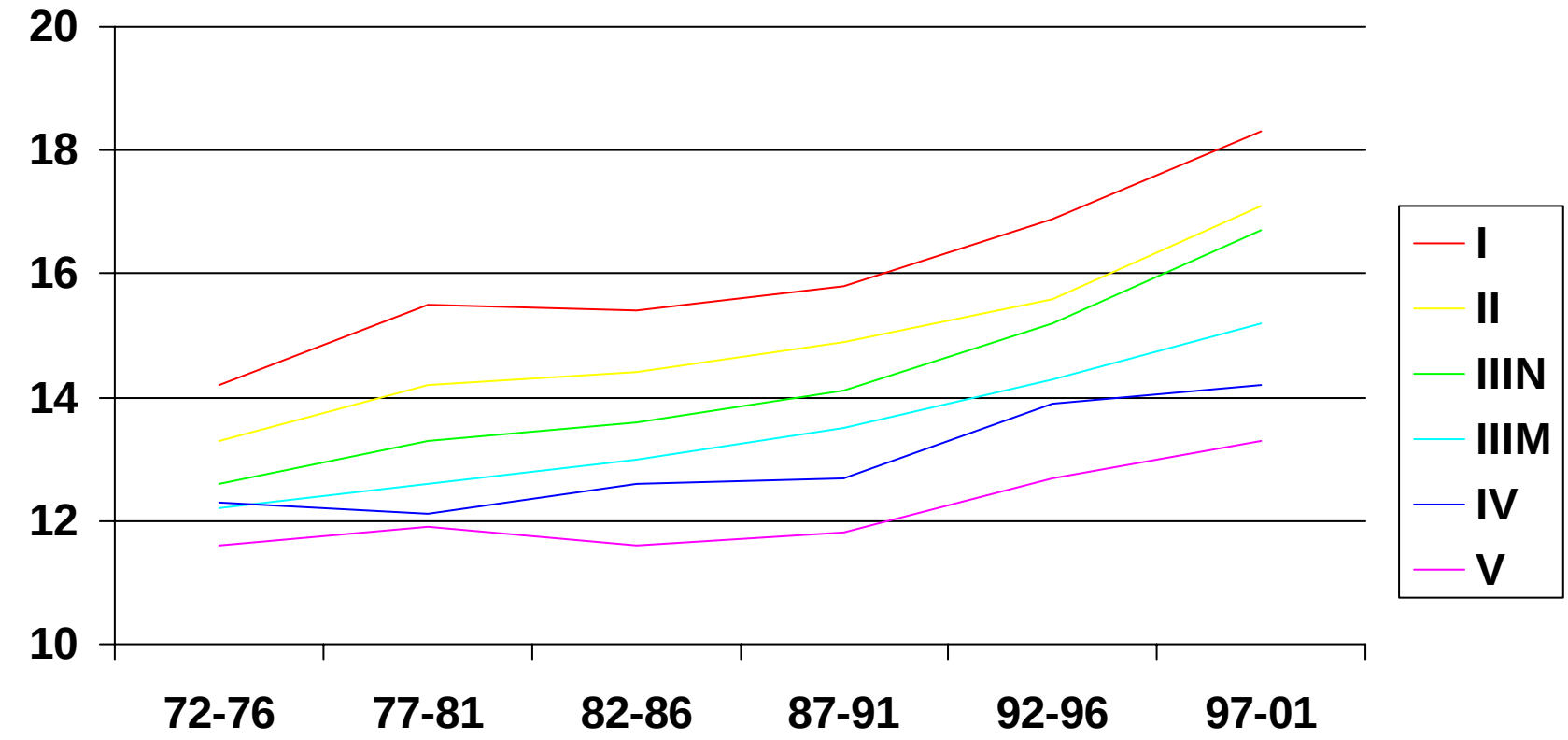
- Office of National Statistics in the UK
- Study involving c. 1% of the population in England and Wales – chosen by DOB
- Study commenced in 1972 and is continuing
- Latest available data is for 2001
- If unclassified – spouse's / parent's classification is used
- Social class at date of entry to the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

Male Life Expectancy at Birth by Social Class (England & Wales)



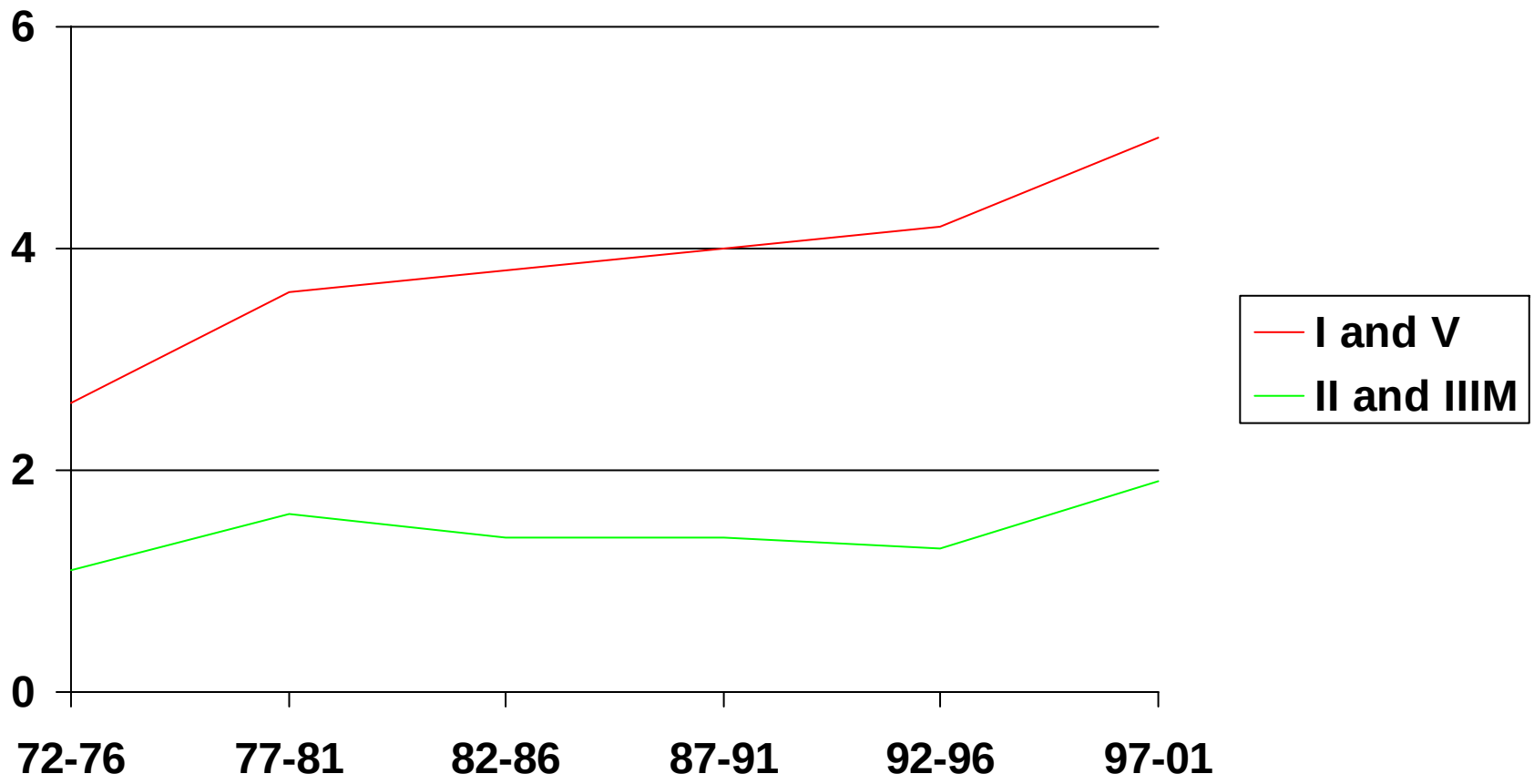
Source - Office of National Statistics Longitudinal Study

Male Life Expectancy at Age 65 by Social Class (England and Wales)

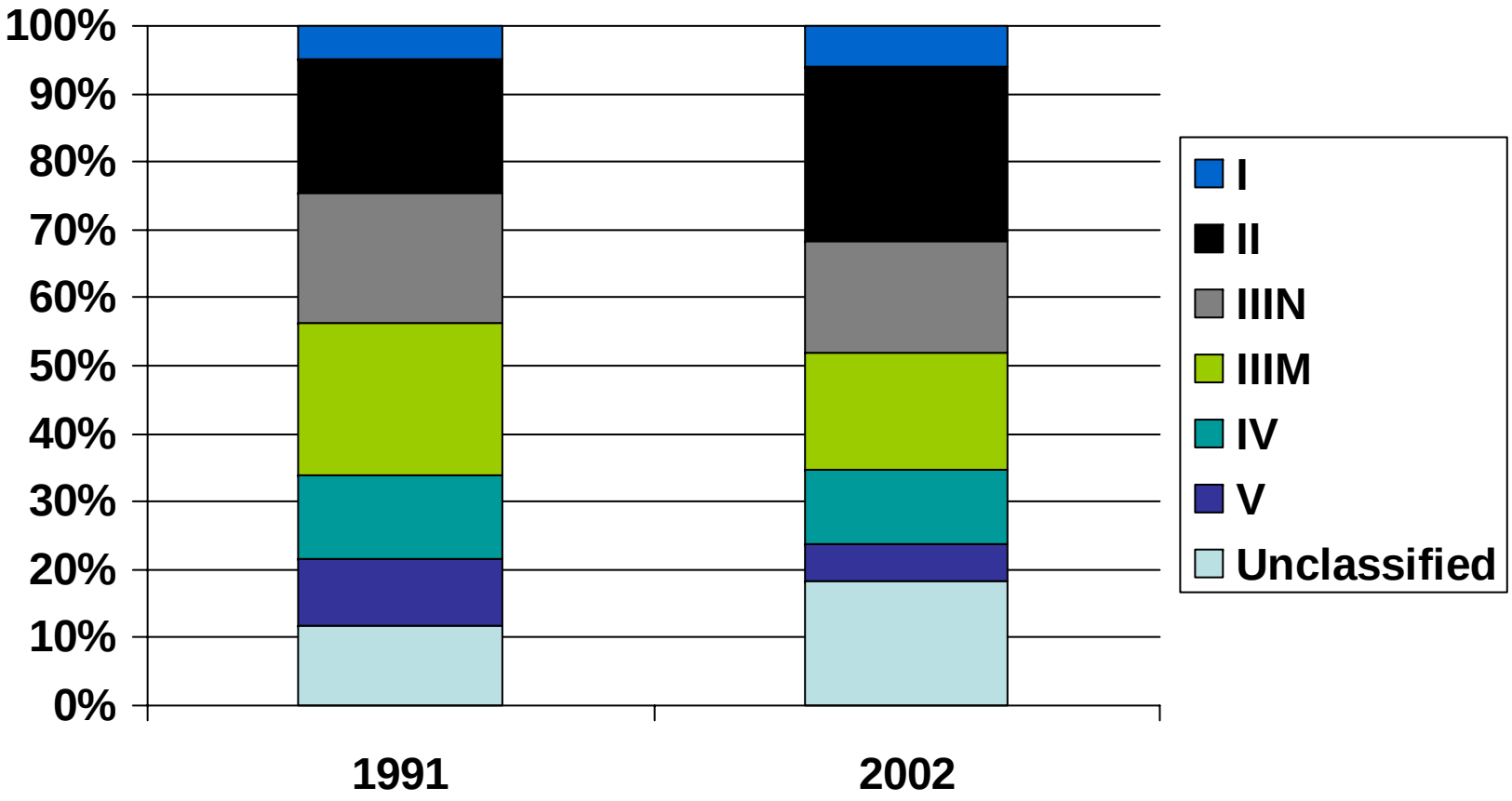


Source - Office of National Statistics Longitudinal Study

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

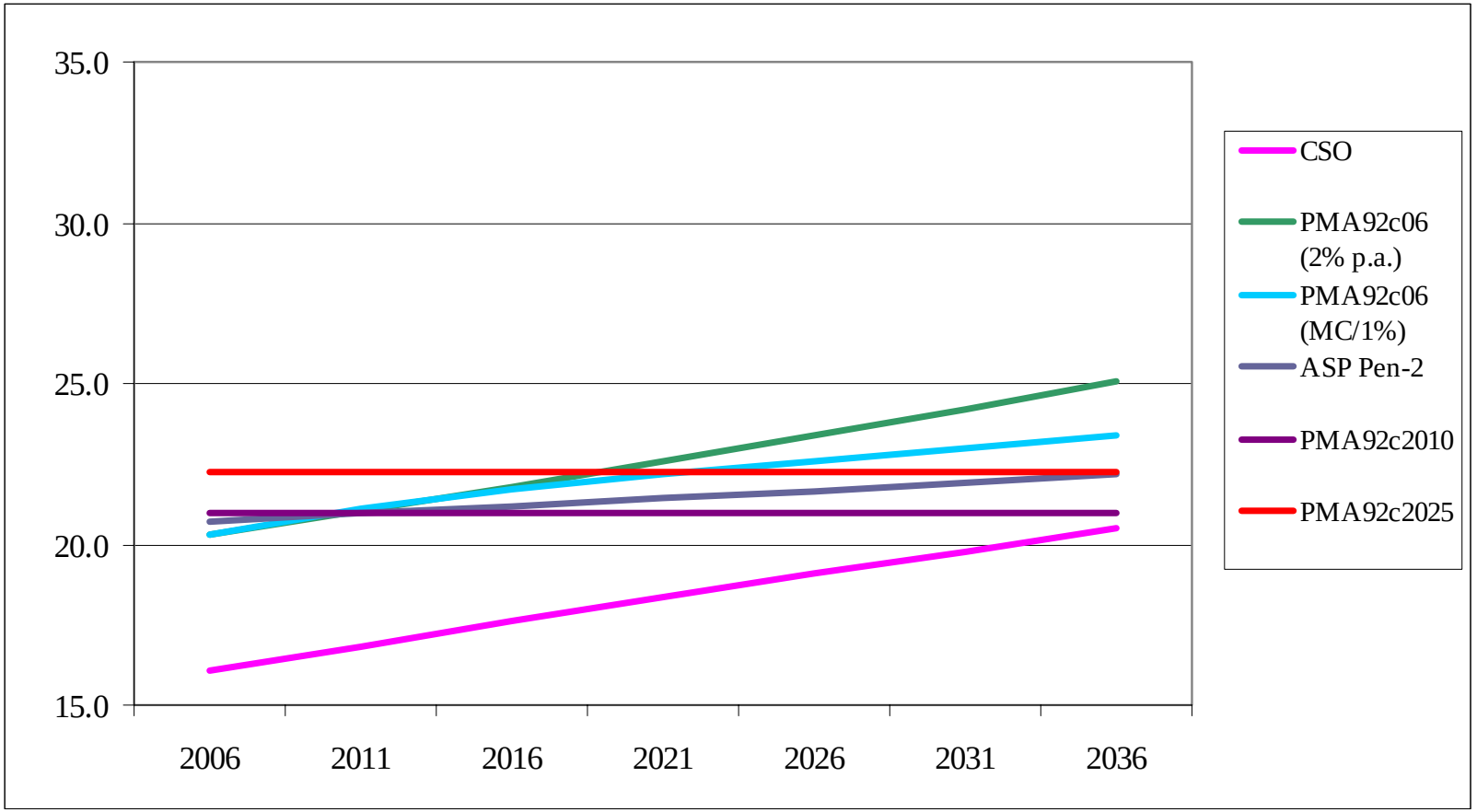
Methods and rates of improvement used

- 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

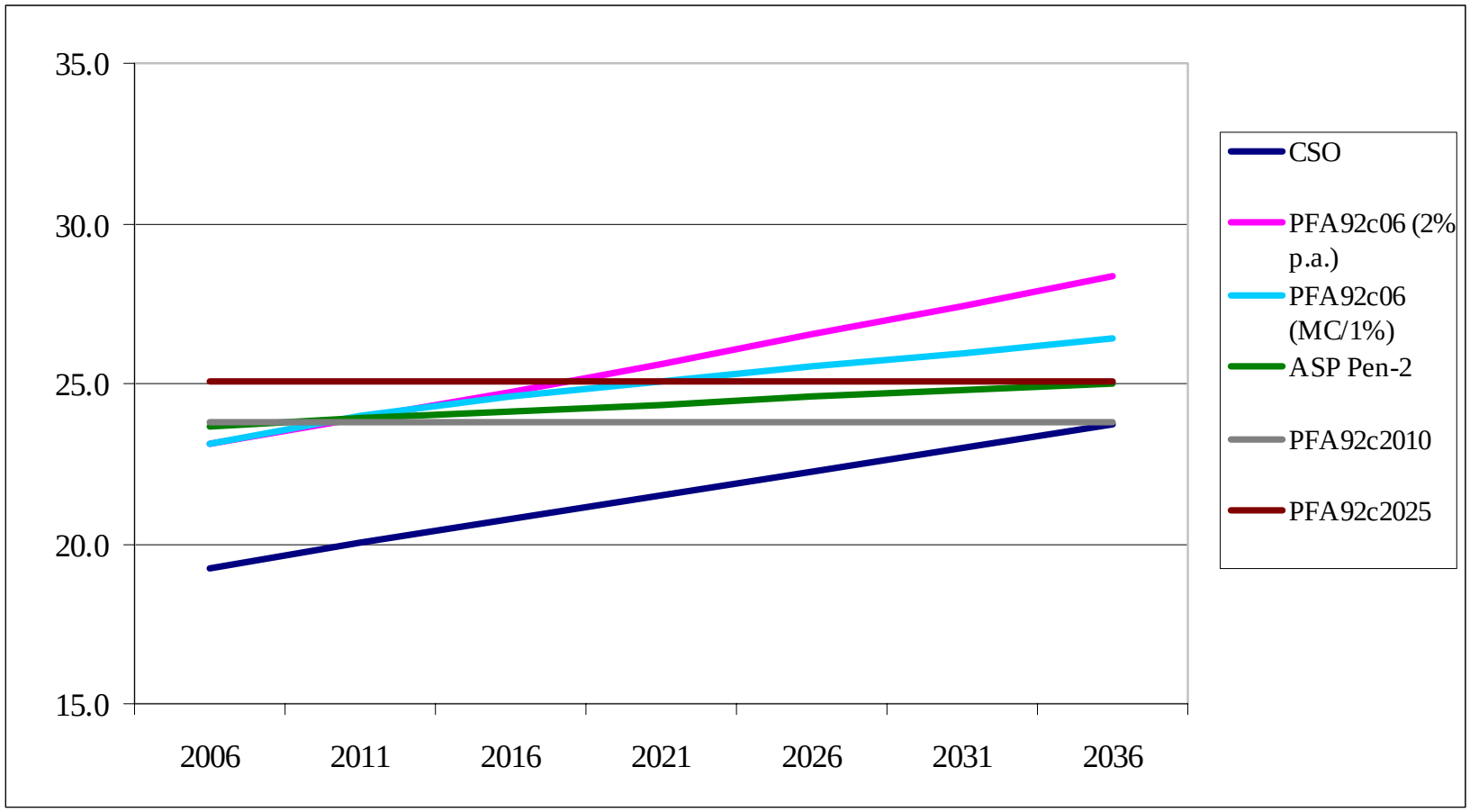
Period vs. Cohort approach

- 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.

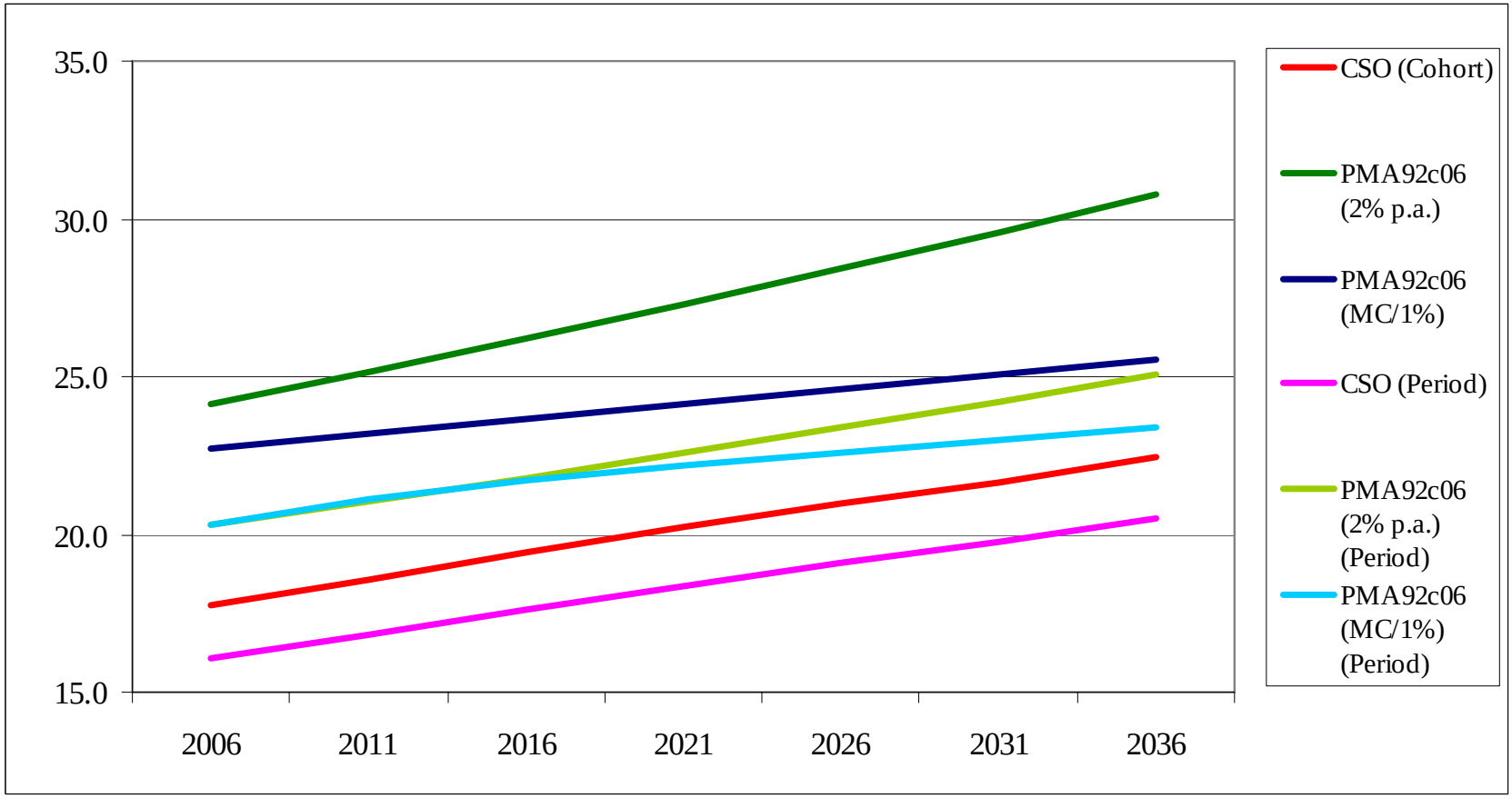
Period method - projected Male e(65)



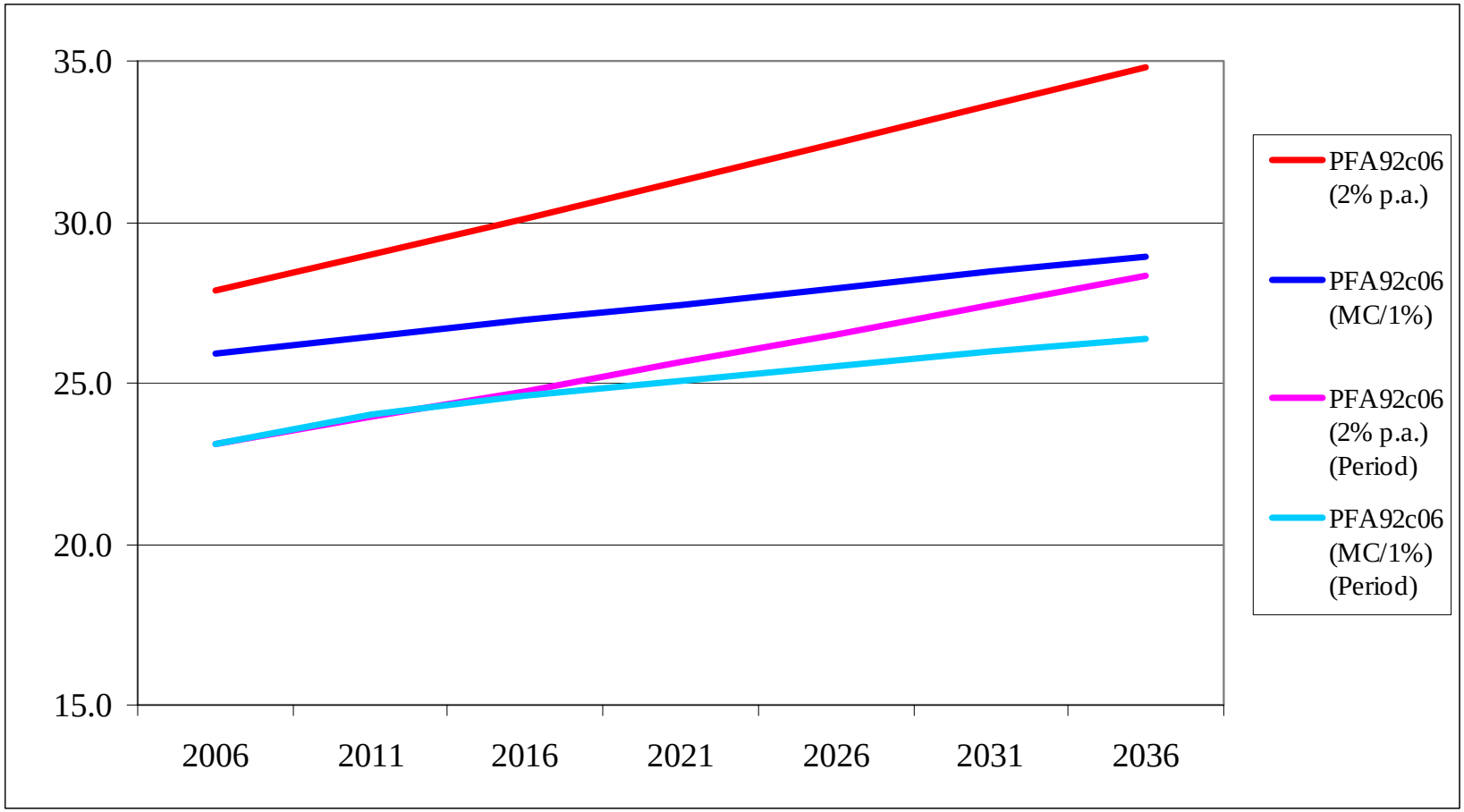
Period method - projected Female e(65)



Effect of introducing cohort method - projected Male e(65)



Effect of introducing cohort method - projected Female e(65)



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