The Actuarial Profession
making financial sense of the future

Should projections of mortality improvements be subject to a minimum value?

Steven Baxter, 26 February 2007

Should projections of mortality improvements be subject to a minimum value?

$$1 - \frac{q_{x,t}}{q_{x,t-1}}$$

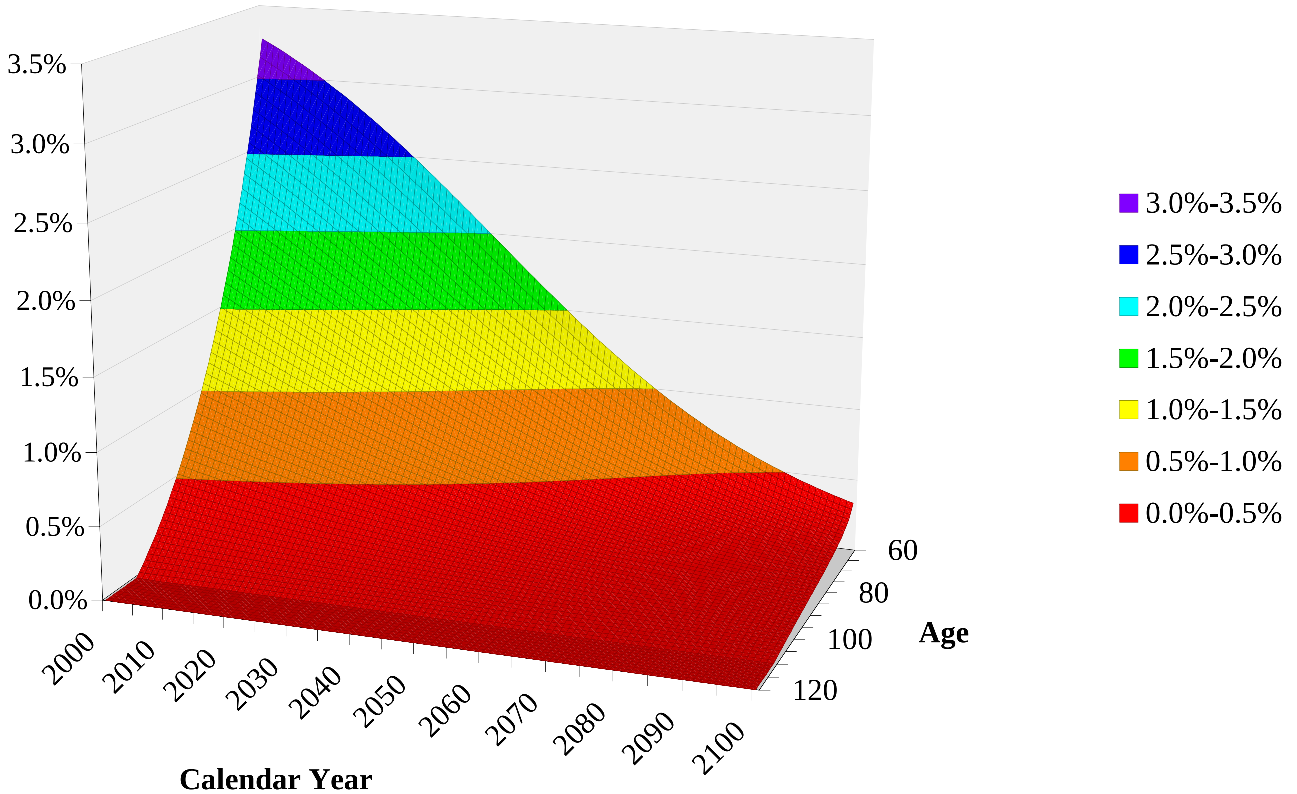
Should projections of mortality improvements be subject to a minimum value?

- 92 series projections
- Projections of “older-age life expectancy”
- Mortality rates
- Is the past a guide to the future?
- Implications

92 series projections (1)

Figure 1:

Annual rates of mortality improvement under 92 series projections

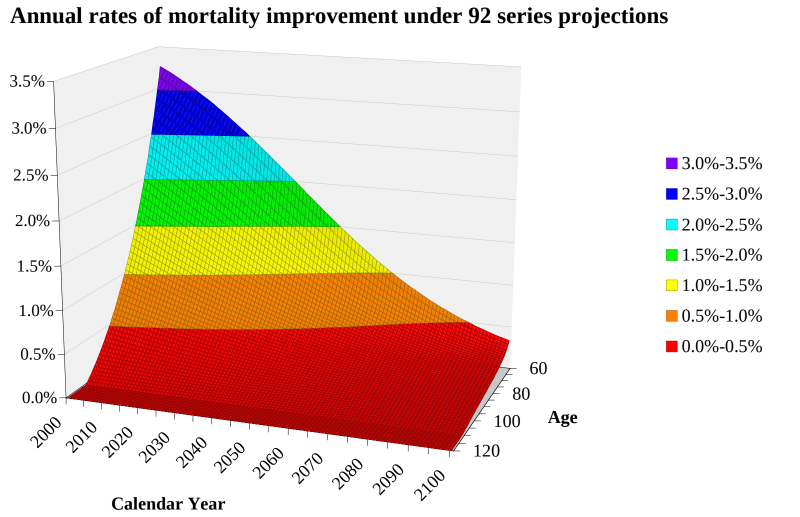


Source: Own calculations and CMIR 17

92 series projections (2)

- Mortality rates decrease to a lower (non-zero) limit at each age
- Speed of convergence to this limit varies by age
- A significant proportion (eg 55% at age 60) occurs in the first 20 years i.e. by 2012

Figure 1:



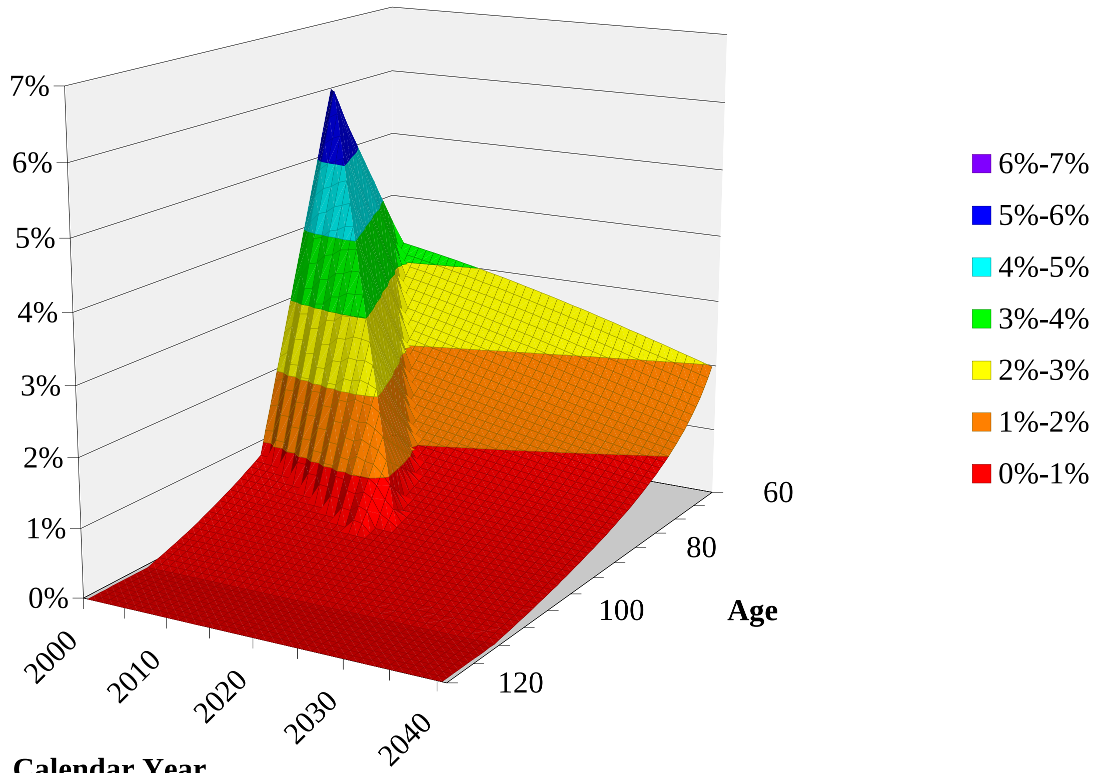
Source: Own calculations and CMIR 17

By using the 92 series projections actuarial valuations are currently incorporating an implicit assumption of a lower level of (long-term) future improvements at successive valuations.

Interim cohort projections (1)

Figure 3:

Annual rates of mortality improvement under 92 series interim cohort projections (medium cohort)



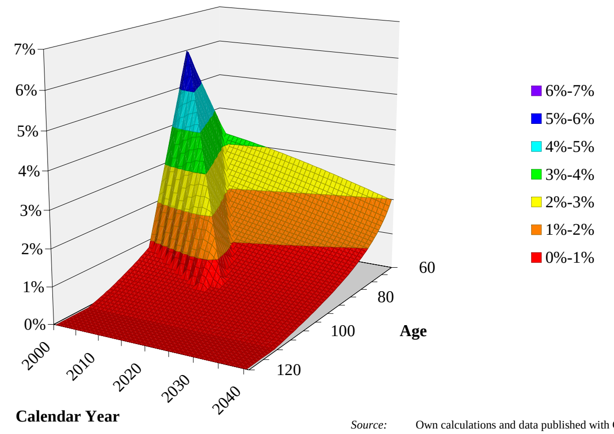
Source: Own calculations and data published with CMI WP1

Interim cohort projections (2)

- Increased rates of improvement to apply for a "cohort" born between 1910 and 1942, centred on 1926
- Increases apply for longest to those born in the centre of the "cohort" i.e. 1926
- Increased rates of improvement for 1993-2000 derived from experience data for life office pensioners
- From 2001 the rates of improvement reduce linearly to the end of the cohort period

Figure 3:

Annual rates of mortality improvement under 92 series interim cohort projections (medium cohort)



Source: Own calculations and data published with CMI WP1

Short Cohort = immediate tailing off of the cohort effect (end = 2010)
Medium cohort ~ a "middle of the road" estimate (end = 2020)
Long cohort = continue to see accelerated improvements for near enough every year of life for the 1926 generation (end = 2040)

Projecting mortality

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

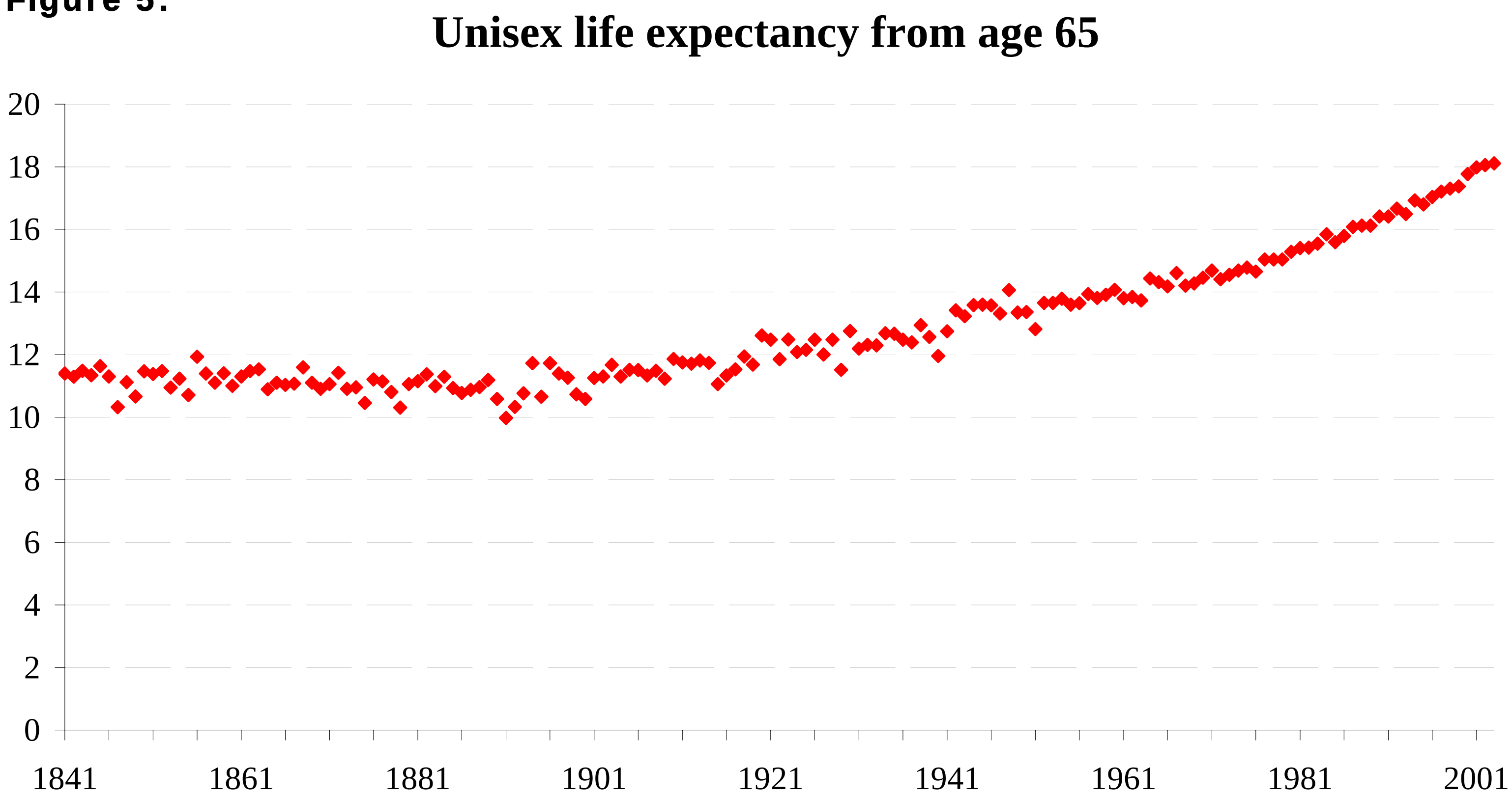
- For how long will the cohort generation continue to exhibit more rapid improvements in mortality rates?
  i.e. which of the short, medium and long cohort projections should be used (or should a "hybrid" be used)

Projecting life expectancy

- Life expectancy:
  - is something which our clients will have an opinion on
  - is highlighted in the Pension's Regulator Code of Practice
  - moves (broadly) in line with annuity values
- Big picture
- Use **period** life expectancies:
  - long history
  - considering period mortality improvements $1 - \frac{q_{x,t}}{q_{x,t-1}}$

England & Wales Period Life Expectancy

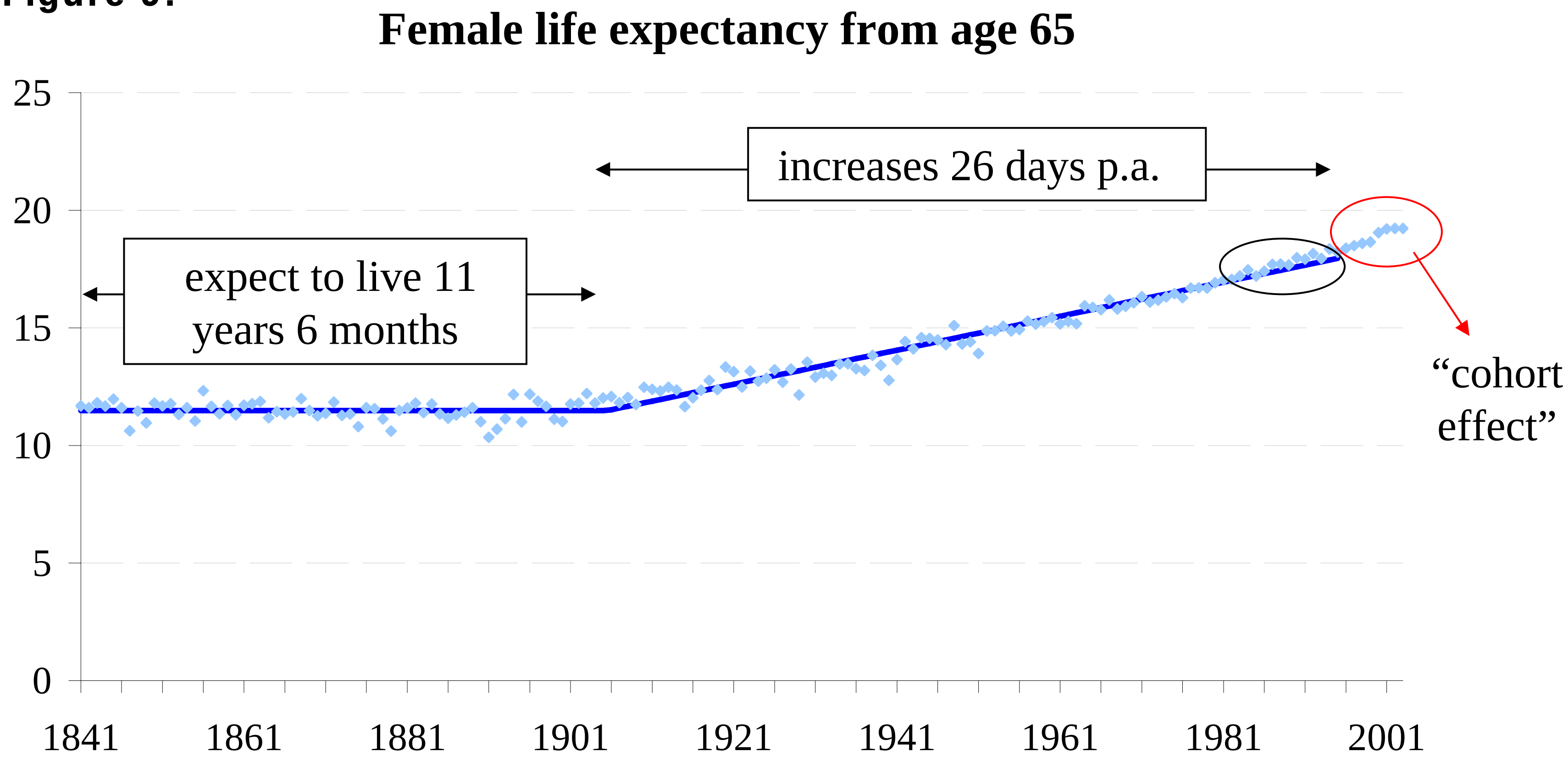
Figure 5:



Source: Human Mortality Database. University of California, Berkeley (USA), and Max Planck Institute for Demographic Research (Germany). Available at www.mortality.org or www.humanmortality.de (data downloaded on 30 November 2006).

Female Period Life Expectancy (1)

Figure 9:

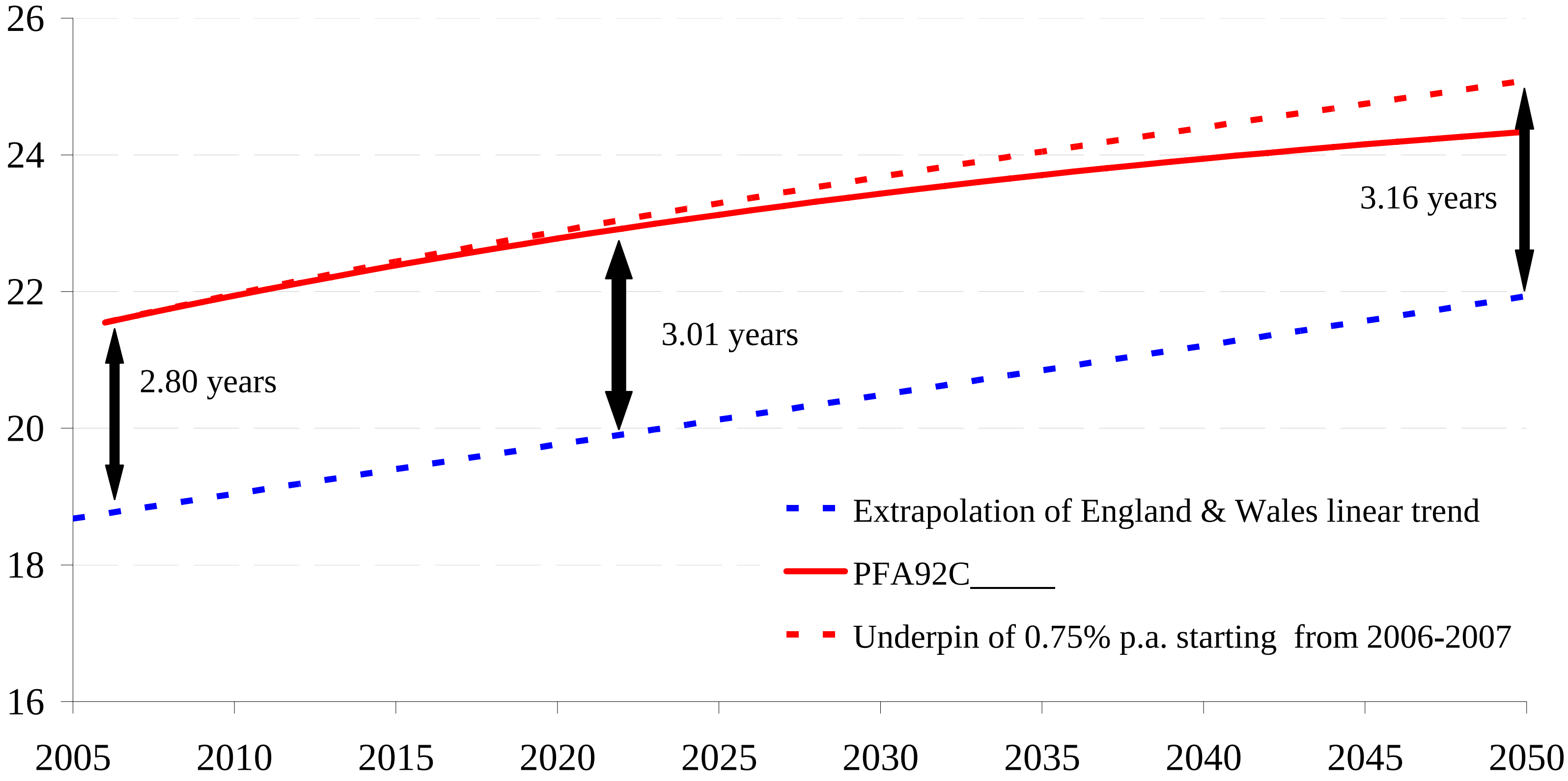


Source: Own calculations based on data from Human Mortality Database, University of California, Berkeley (USA), and Max Planck Institute for Demographic Research (Germany). Available at www.mortality.org or www.humanmortality.de (data downloaded on 30 November 2006).

Female Period Life Expectancy (2)

Figure 11:

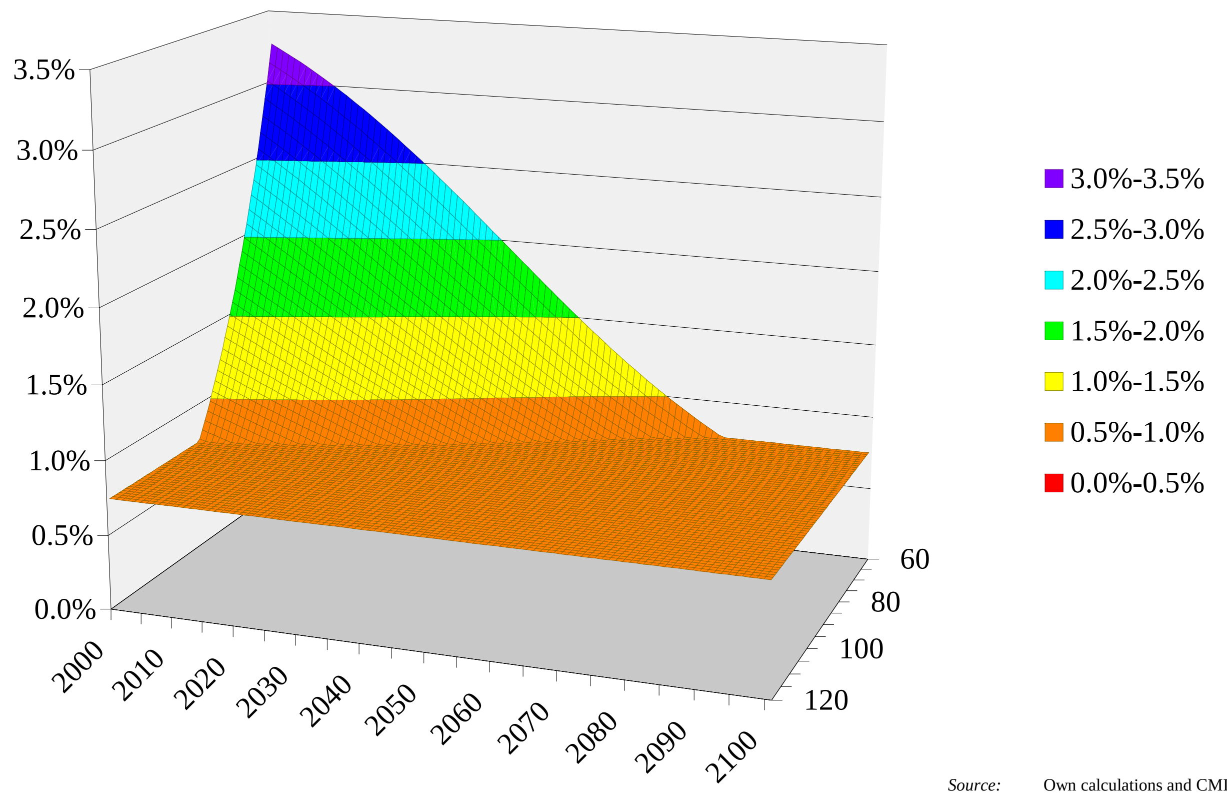
Projected changes in female life expectancy from age 65 over time



Source: Own calculations.

Illustration of applying an underpin

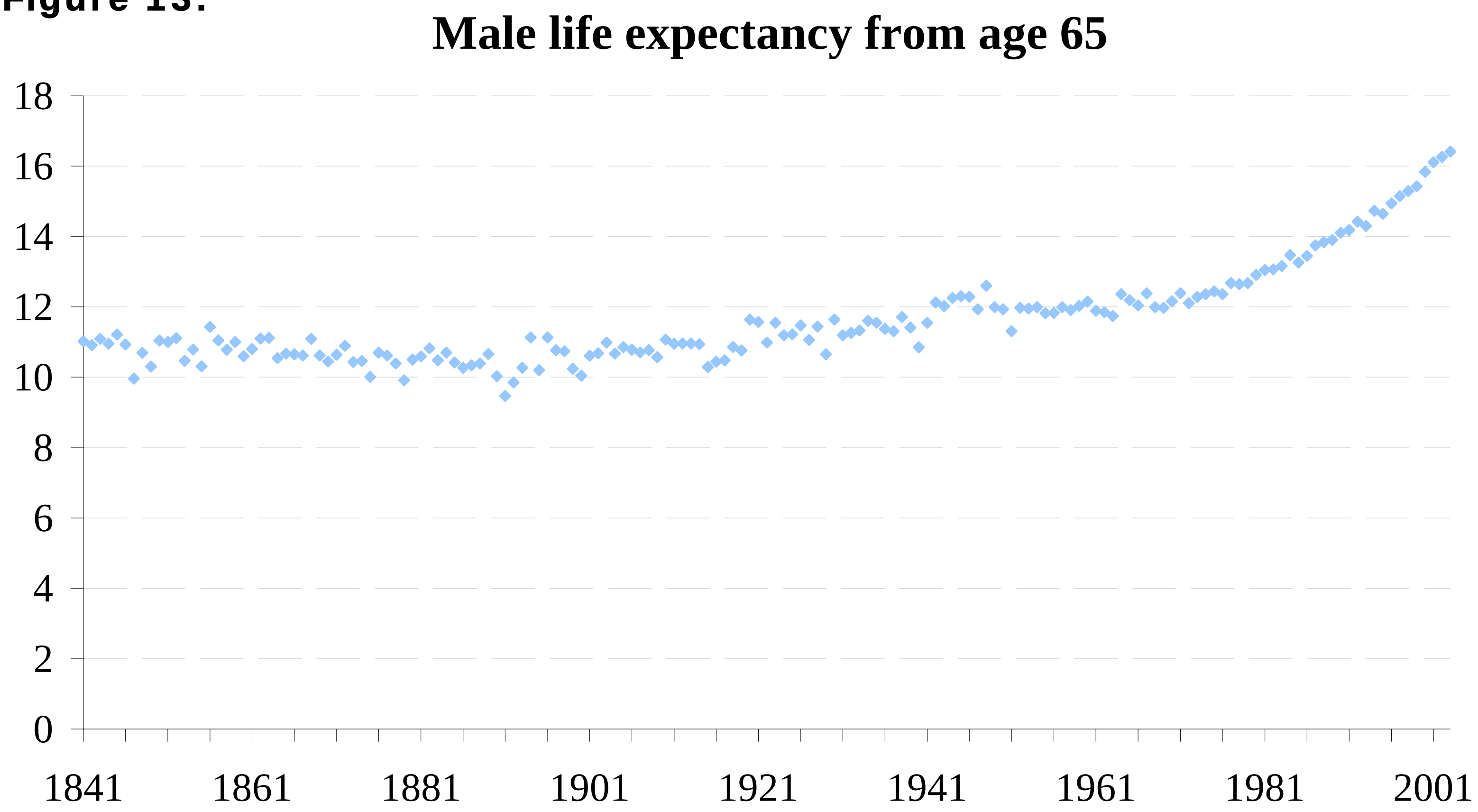
Annual rates of mortality improvement under 92 series projections with a minimum of 0.75% p.a. at all ages



Source: Own calculations and CMIR 17

Male Period Life Expectancy (1)

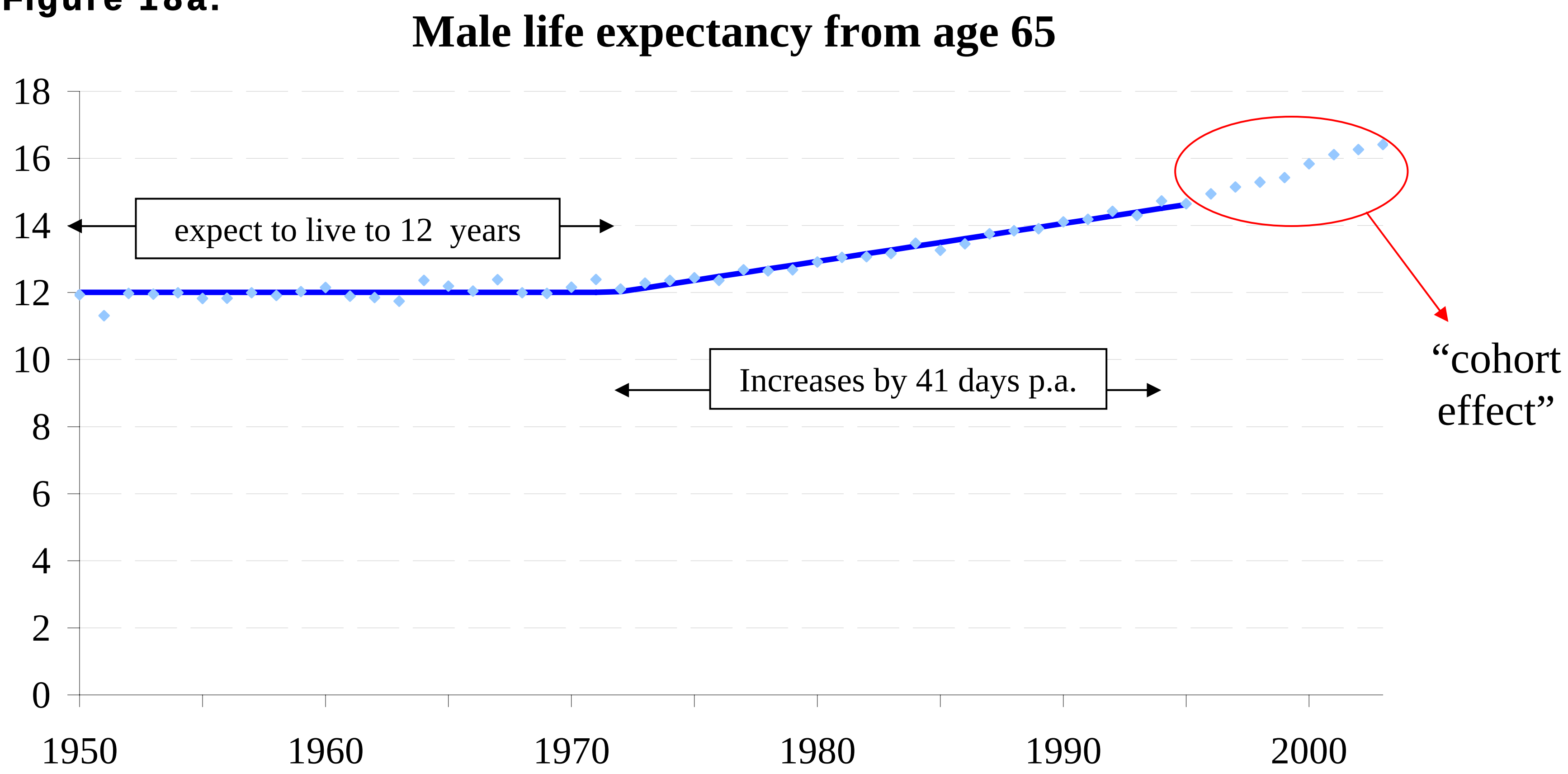
Figure 13:



Source: Own calculations using data from Human Mortality Database, University of California, Berkeley (USA), and Max Planck Institute for Demographic Research (Germany). Available at www.mortality.org or www.humanmortality.de (data downloaded on 30 November 2006).

Male Period Life Expectancy (2)

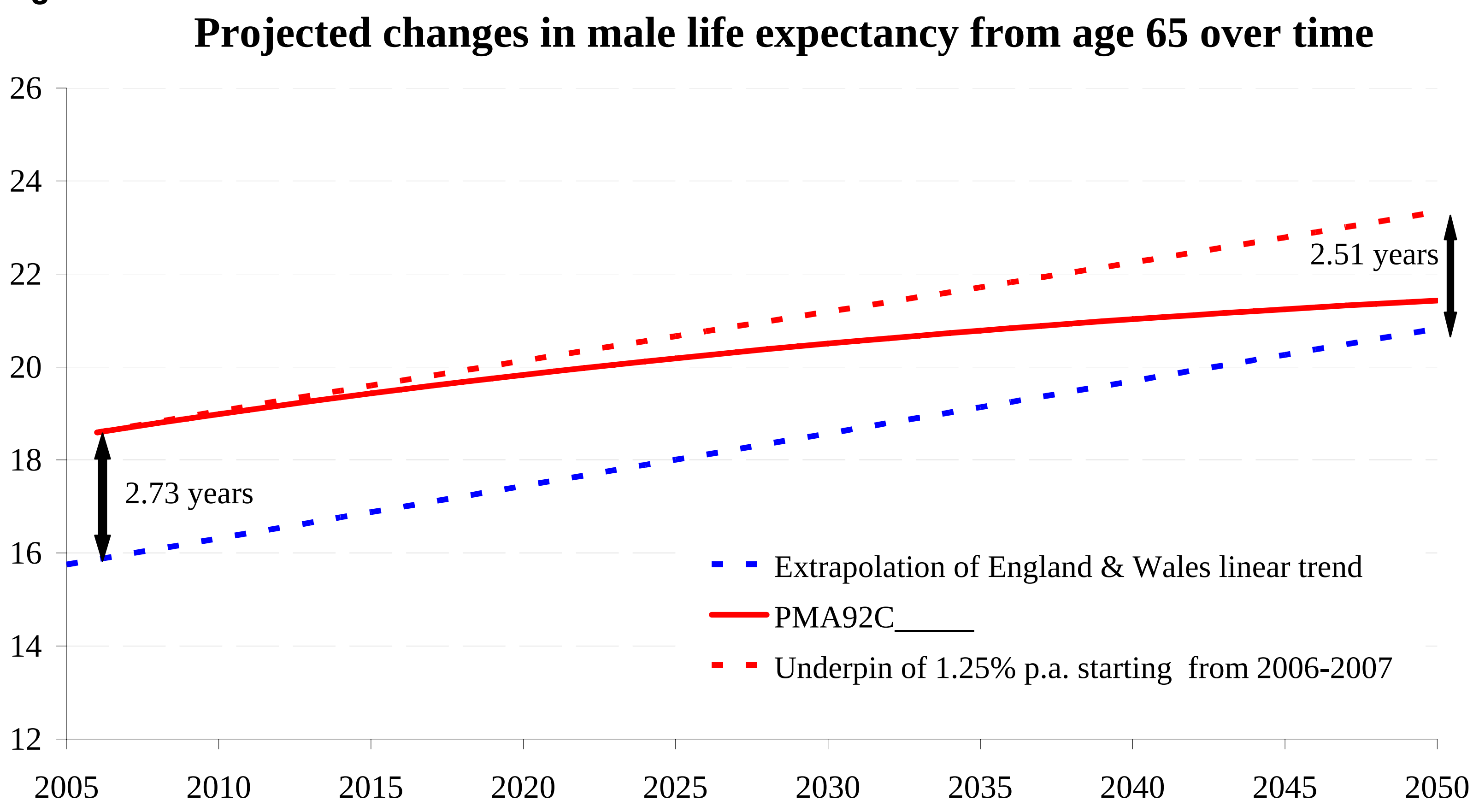
Figure 18a:



Source: Own calculations using data from Human Mortality Database, University of California, Berkeley (USA), and Max Planck Institute for Demographic Research (Germany). Available at www.mortality.org or www.humanmortality.de (data downloaded on 30 November 2006).

Male Period Life Expectancy (3)

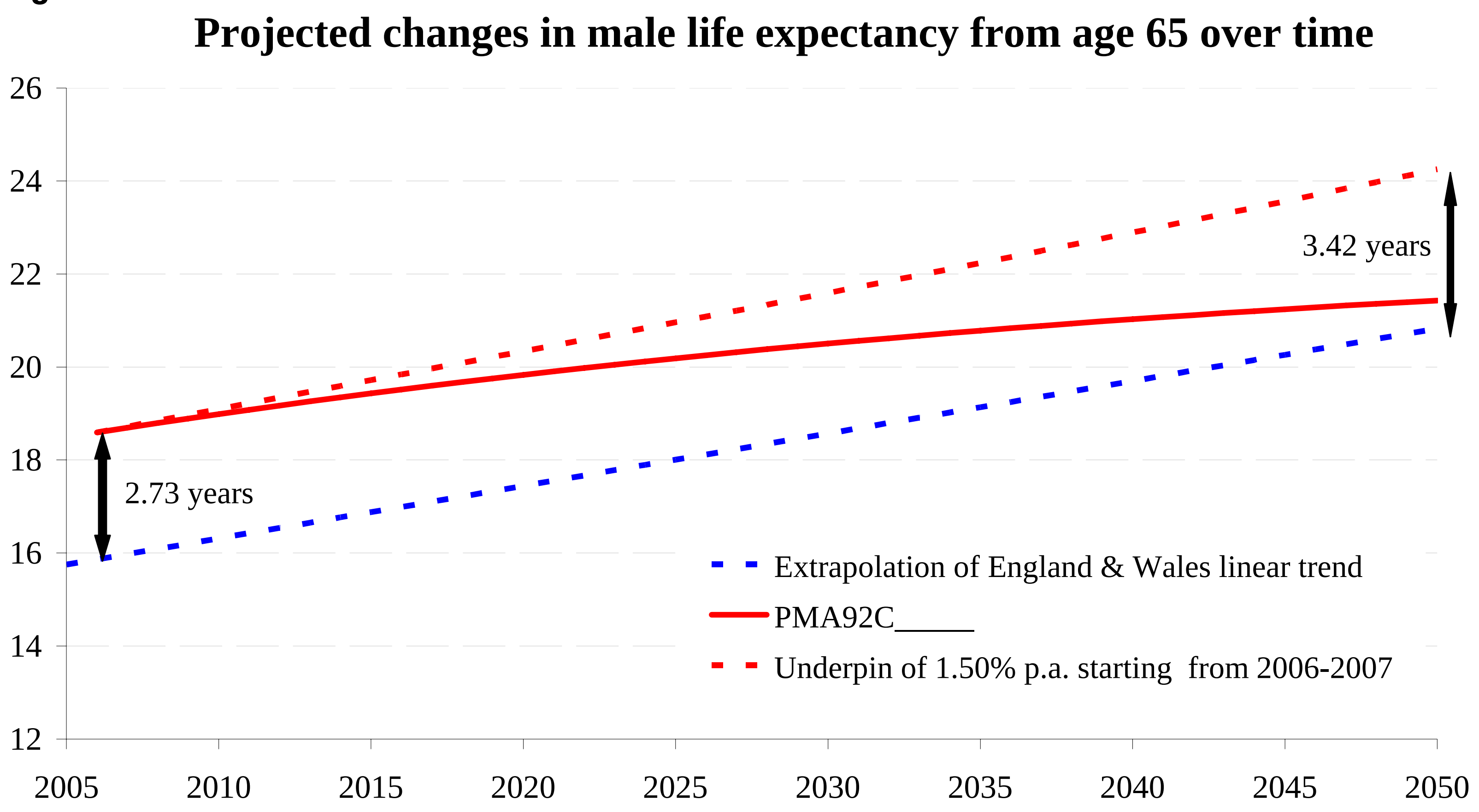
Figure 20:



Source: Own calculations.

Male Period Life Expectancy (4)

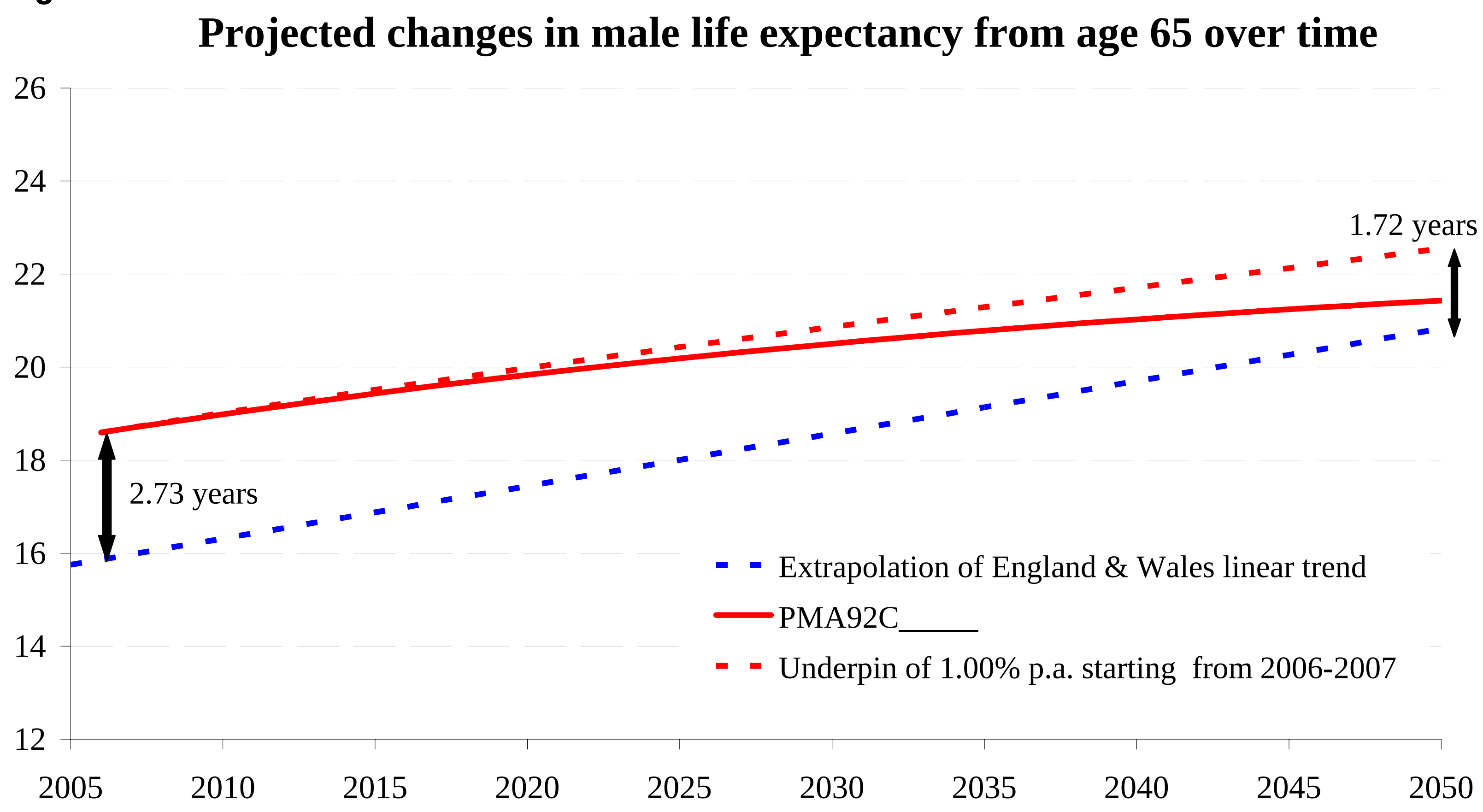
Figure 20a:



Source: Own calculations.

Male Period Life Expectancy (5)

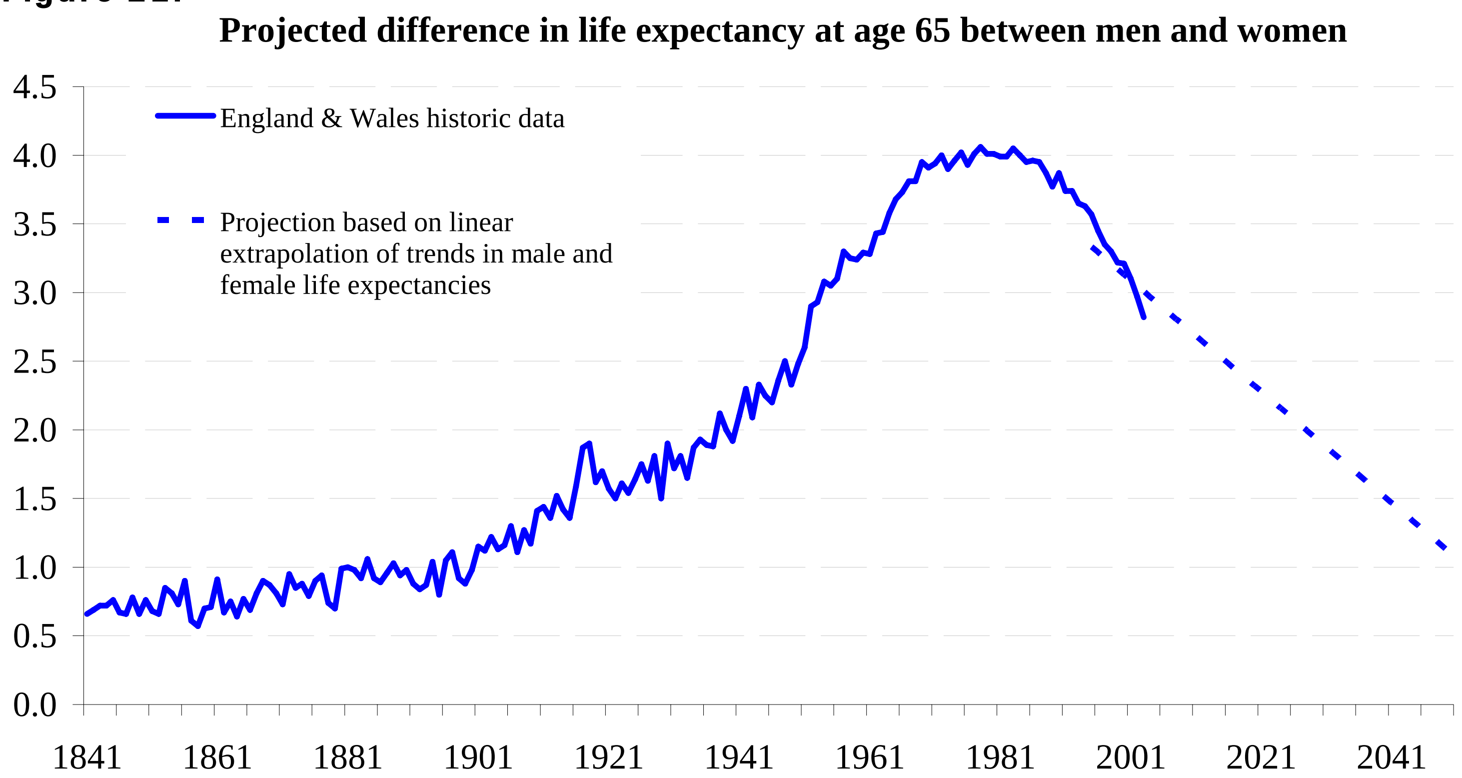
Figure 20b:



Source: Own calculations.

Projected differences in period life expectancies

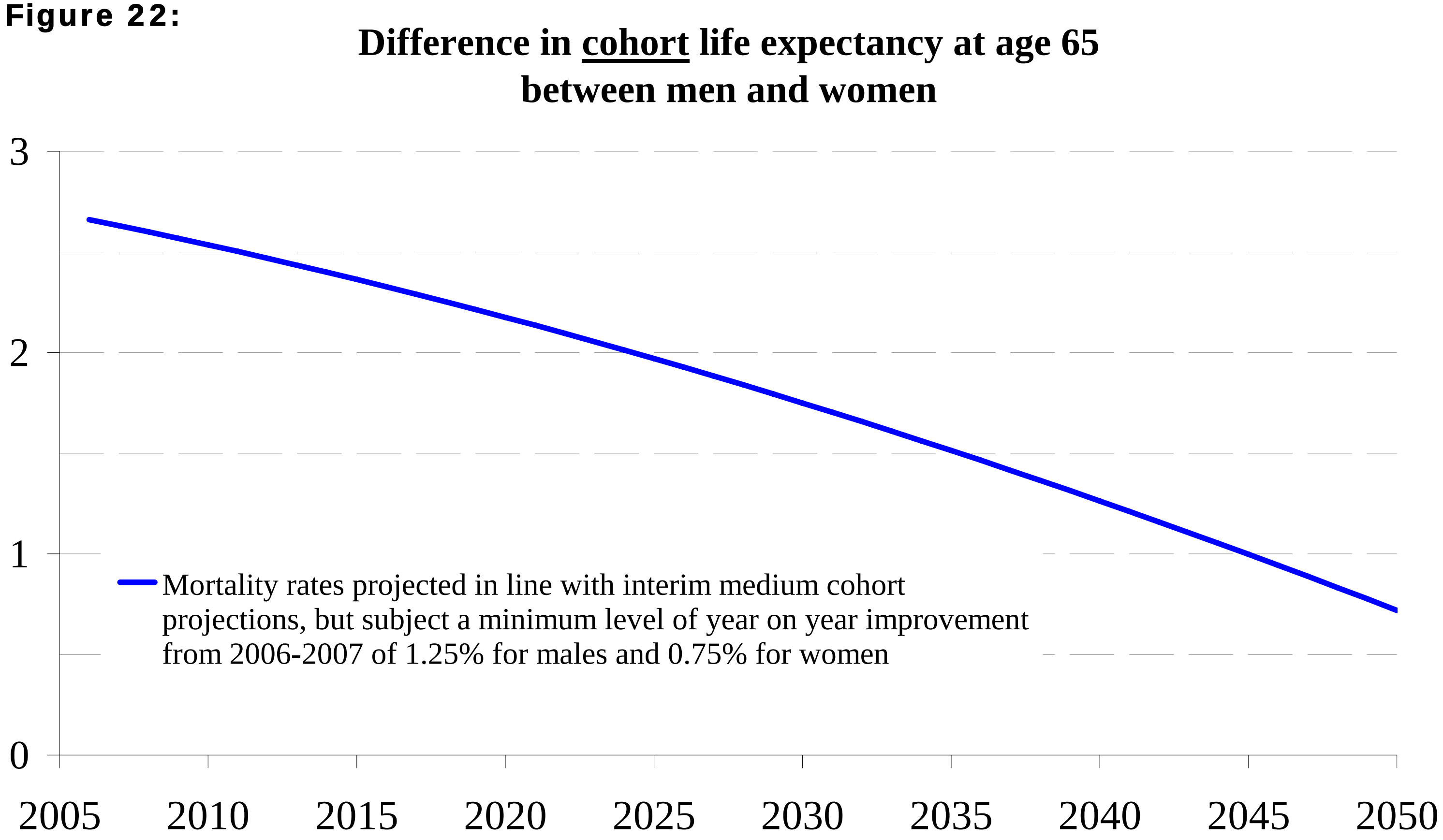
Figure 21:



Source: Own calculations using data from Human Mortality Database. University of California, Berkeley (USA), and Max Planck Institute for Demographic Research (Germany). Available at www.mortality.org or www.humanmortality.de (data downloaded on 30 November 2006).

Projected differences in cohort life expectancies

Figure 22:



Why might you want to assume a different level of improvement?

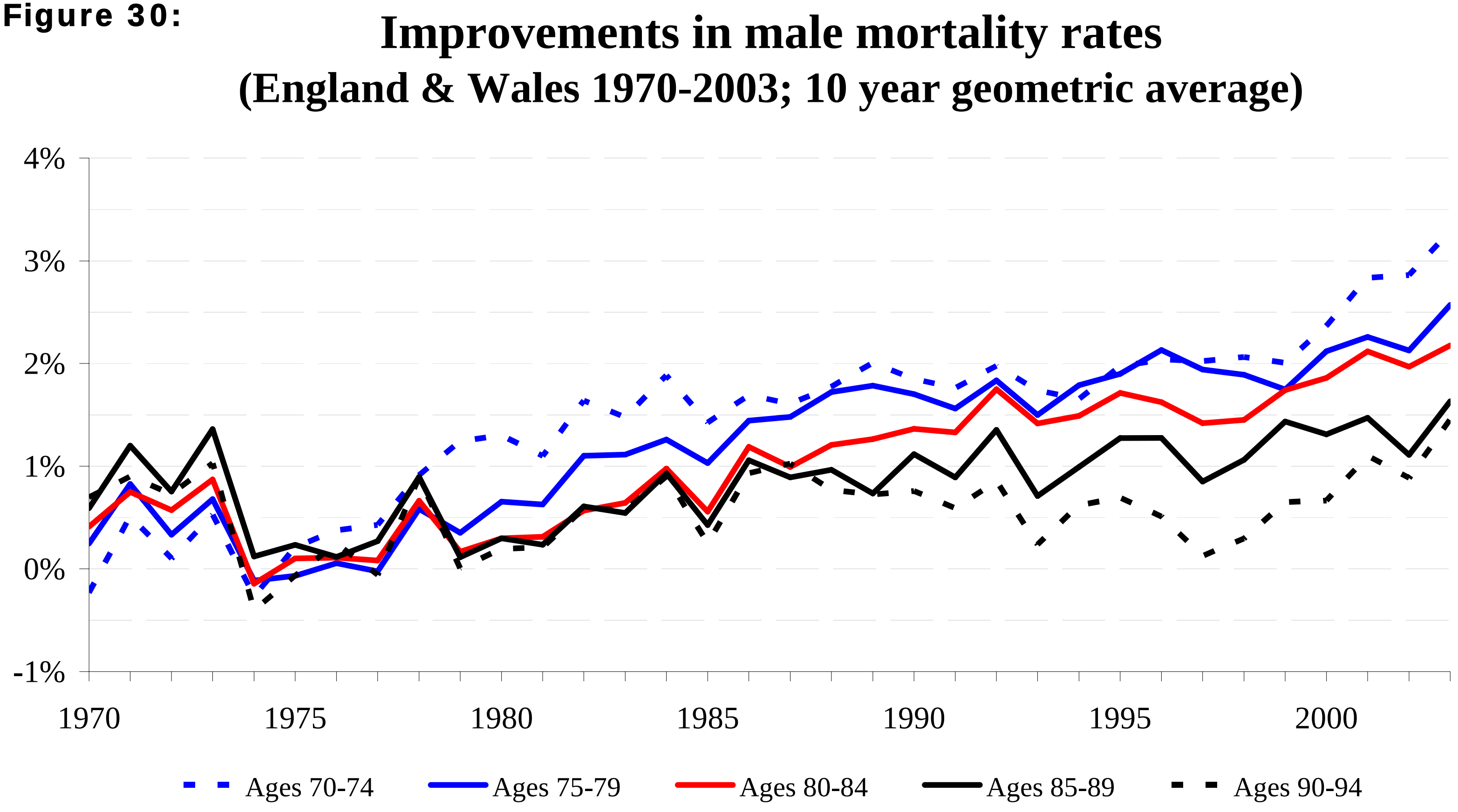
- Life expectancies at other ages
- Trends in underlying mortality rates
- Past as a guide to future

Period life expectancies at other ages

Age	Underpin needed to ensure projections broadly keep pace with population trend	
	Male	Female
55		0.75%-1%
60	1.5%	0.75%
65	1.25%	0.75%
70	1.25%	0.5%-0.75%
80	1%-1.25%	0.5%-0.75%
90	0.25%-0.5%	0.25%-0.5%

Trends in mortality rates (1)

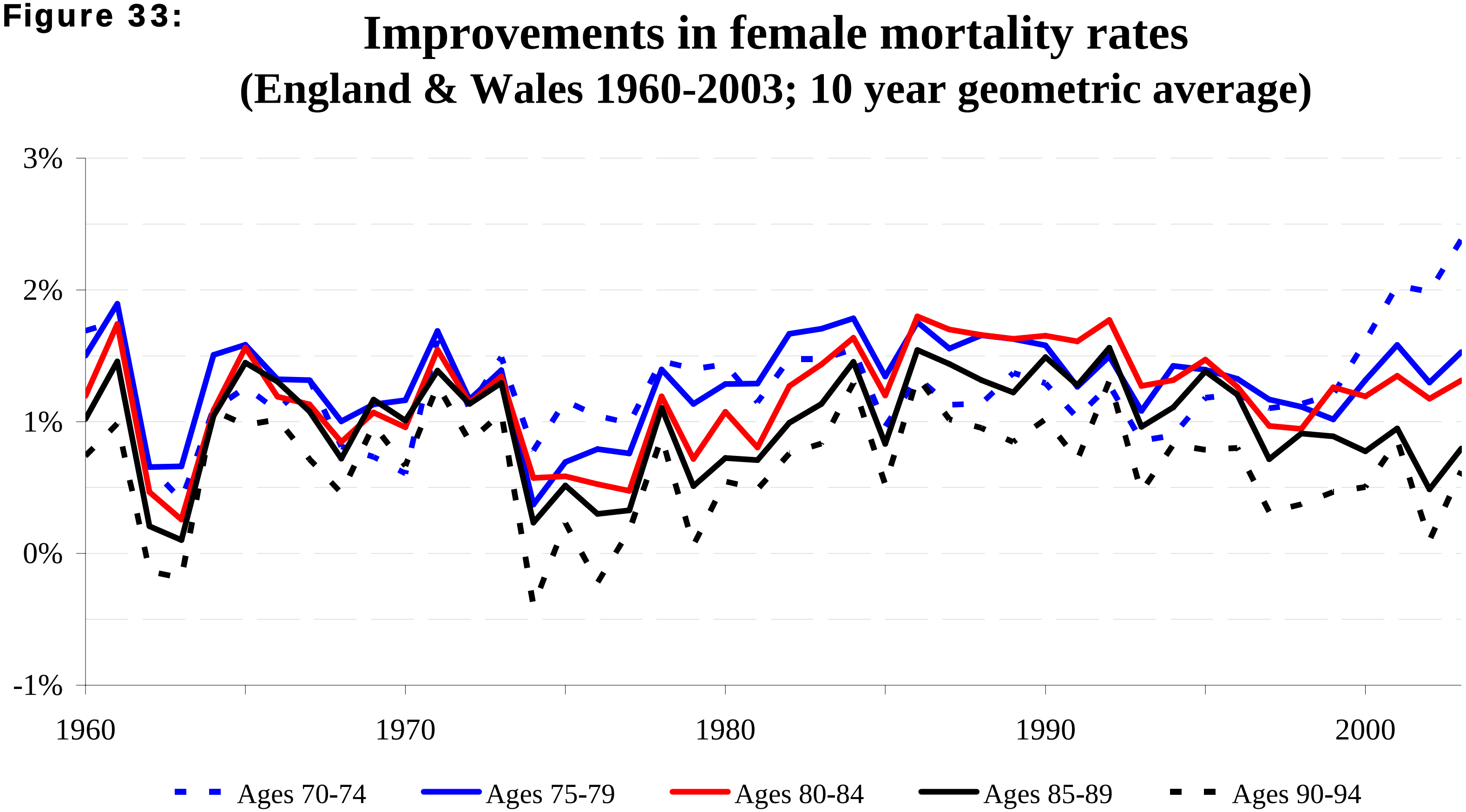
Figure 30:



Source: Own calculations using data from Human Mortality Database University of California, Berkeley (USA), and Max Planck Institute for Demographic Research (Germany). Available at www.mortality.org or www.humanmortality.de (data downloaded on 30 November 2006).

Trends in mortality rates (2)

Figure 33:



Source: Own calculations using data from Human Mortality Database University of California, Berkeley (USA), and Max Planck Institute for Demographic Research (Germany). Available at www.mortality.org or www.humanmortality.de (data downloaded on 30 November 2006).

Trends in mortality rates (3)

Age Group	Average rate of annual mortality improvement (1960-2001)	
	Male	Female
65-69	1.7%	1.2%
70-74	1.4%	1.2%
75-79	1.2%	1.3%
80-84	1.0%	1.3%
85+	0.8%	0.8%

Source: Longevity in the 21st Century, Willets et al (2004)

Past a guide for the future?

"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 J Olshansky

Past a guide for the future? Epidemiological and health transitions (1)

Health transition	
pre 1850	higher standard of living manifests – housing, clothing
1850-1900	sanitation
1900-	rapid economic development – public health, biomedicine

Epidemiological transition	
1575 - 1900	Less frequent and less devastating mortality crises
1750 - 1890	Communicable diseases wane (smallpox, typhoid,..)
1850-1940	Respiratory diseases decline; significant falls in infant mortality; TB decline
1900 - ?	Cardiovascular diseases take centre-stage

Past a guide for the future? Epidemiological and health transitions (2)

	Deaths per 10,000 (males, 75+)		
	1970	**2000**	**Change**
Cardiovascular disease (Circulatory system)	719	405	↓ 44%
Respiratory diseases	274	211	↓ 23%
Cancers	201	222	↑ 10%
All other causes	128	137	↑ 7%
TOTAL	**1322**	**975**	**↓ 26%**

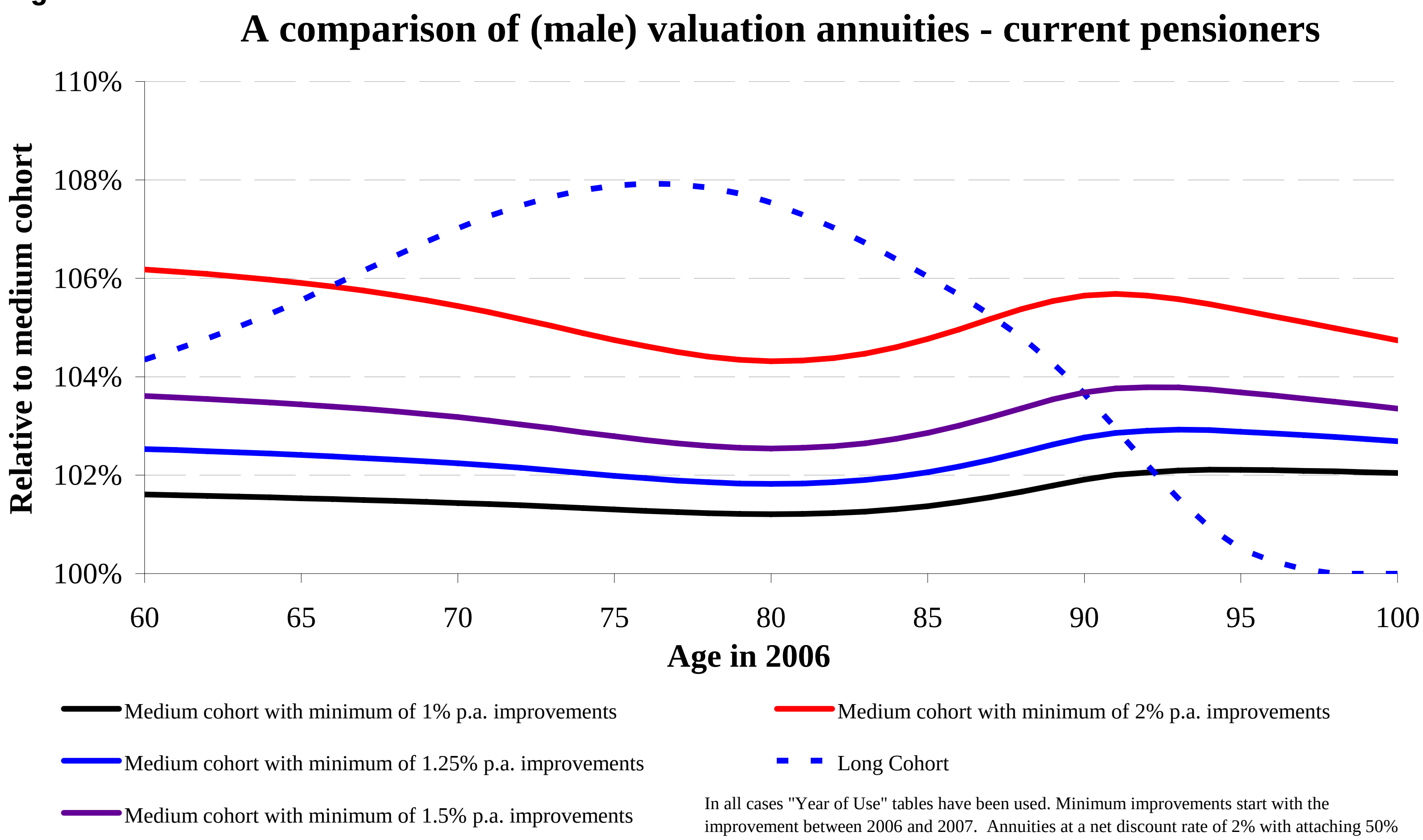
Source: Own calculations based on ONS data

Implications (1)

- Simple approach suggested here:
  - adopt 92 series improvements
  - make an allowance for the cohort effect
  - make an allowance for continuation of general improvements via a (non-zero) minimum
- Implications for pension scheme valuations
- New techniques on horizon for projecting trends in mortality

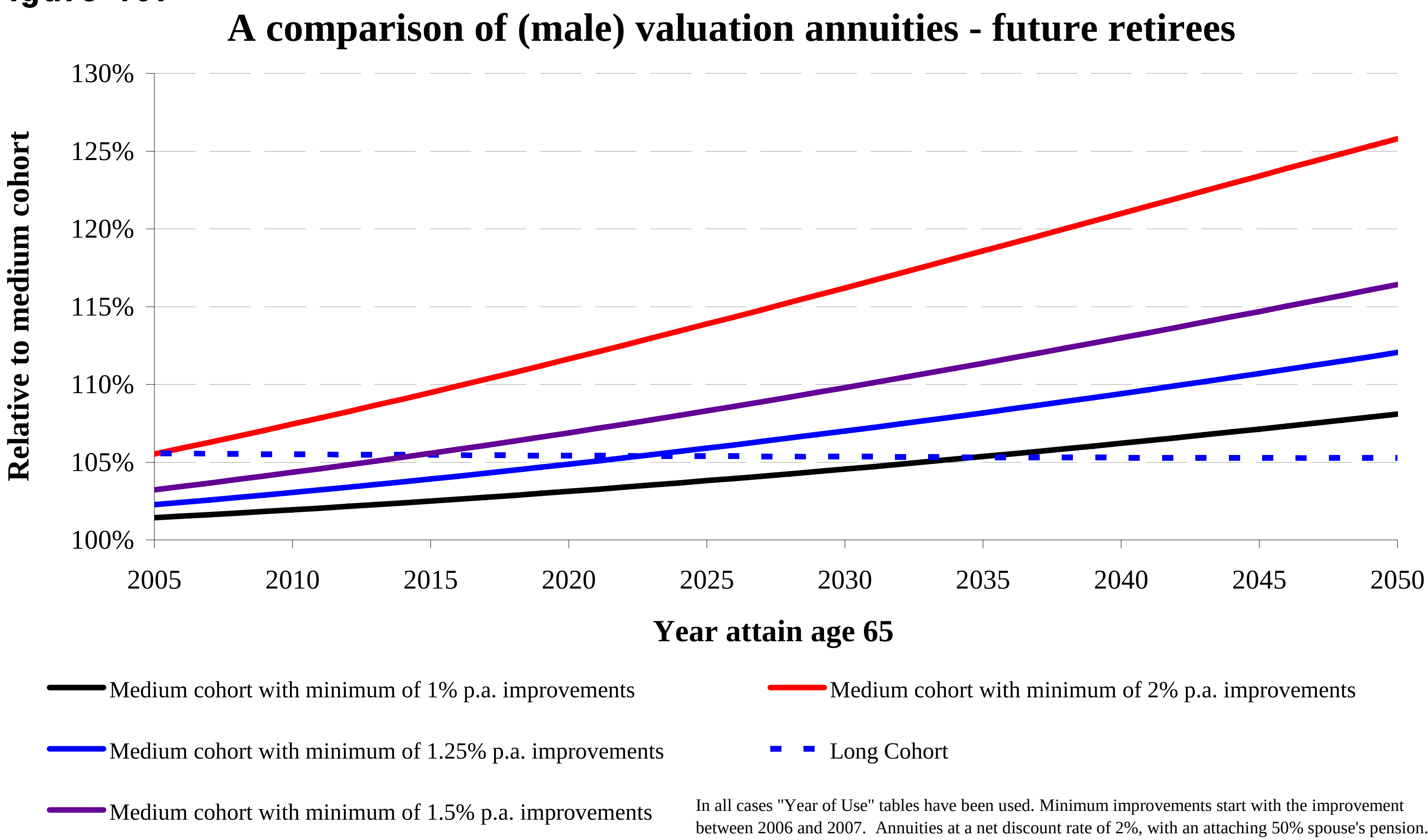
Implications (2)

Figure 39:



Implications (3)

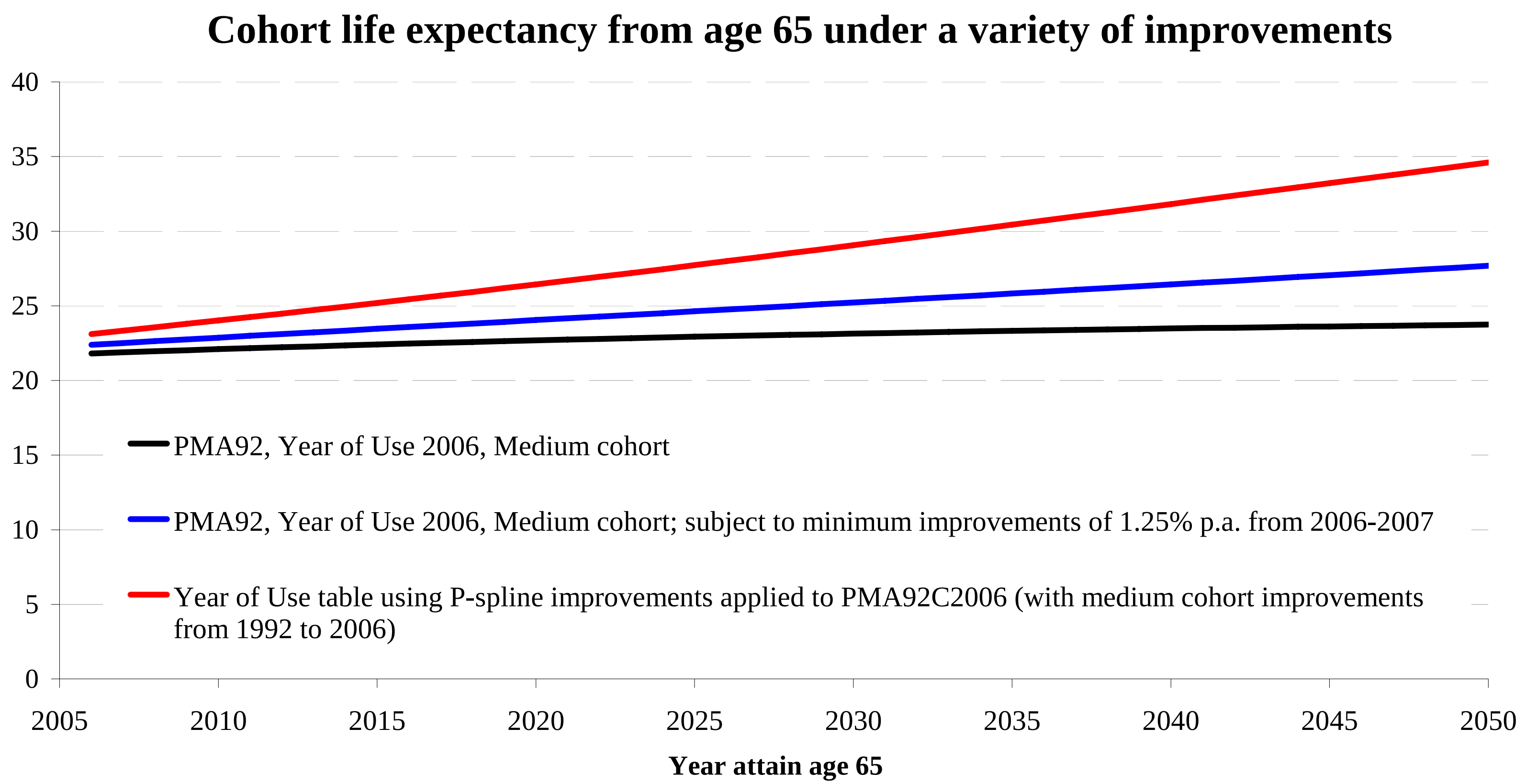
Figure 40:



In all cases "Year of Use" tables have been used. Minimum improvements start with the improvement between 2006 and 2007. Annuities at a net discount rate of 2%, with an attaching 50% spouse's pension.

Implications (4)

Figure 42:



P-spline improvements are based upon age-cohort projections using the entire male assured lives dataset for the period 1947-2003 (parameters: porda=2,dxa=5,posa=60, pordy=5,dxy=5, posy=1943,bdeg=3, forecast=100). For ages 95 and above improvements have been held constant at the value at age 95.

Should projections of mortality improvements be subject to a minimum value?

- Original 92 series projections give life expectancies which do not keep pace with historic trends
- A simple, pragmatic, solution is to subject mortality improvements to a single minimum value at all ages
- Historic trends in life expectancy suggest a minimum of:
  - 0.75% p.a. for women
  - 1.25% p.a. for men
- Simplifies underlying age structure
- **What are your views?...**