The Actuarial Profession
making financial sense of the future

Actuarial Profession Webinar

Launch of the new CMI Mortality Projections Model

Gordon Sharp, Richard Willets & Neil Robjohns

8th December 2009

Agenda

- Background to the Projections Model
- An Overview of the Model
- The Consultation Exercise
- The Effect of Adding Data for 2008
- Launch of the new Model: ‘CMI_2009’
- Next Steps
- Questions and Answers

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CMI Interim Cohort Projections

- Published in 2002; based on data to 1999
- Inevitably becoming increasingly out-of-date
- Still in near universal use for many applications
  - Often with adjustments (%s, combinations, floors, ..)
  - But reflect very different pattern from recent data
  - Difficult to judge for reasonability
  - Short & Medium Cohort now imply rapid tail-off in rates of improvement in future mortality

Recent Research - CMI & Others

- CMI looked for stochastic projection model
  - P-spline – but vulnerable to edge effects
  - Lee-Carter – but poor fit to UK data (cohort effects)
  - No projections in “00” Series tables
- CMI Library of Mortality Projections
- Many other approaches & models developing
  - Stochastic models; Mortality by Cause; By Disease

Towards a New Model

- Perceived Advantages of Interim Cohort Proj^{ns}
  - They offer a common currency
  - They can be easily modified
  - They can be applied to any base mortality table
- But significantly out-of-date

Working Party Goal

- To produce a projection model which shares the desirable features of the Interim Cohort Projections, but also:
  - reflects the latest experience on trends in mortality;
  - is relatively straightforward to understand and describe;
  - allows users the flexibility to modify projections to suit their own views and purpose; and
  - can be regularly updated over time to reflect emerging experience.

Members of the Working Party

- Richard Willets (chair)
- Adrian Gallop
- Joseph Lu
- Brian Wilson
- Neil Robjohns (secretariat)

Acknowledgements

- The CMI records its thanks to the Actuarial Profession for a research grant which was used to fund the initial development of the Model.

Working Party Output - Mid 2009

- Published in June / July 2009 for Consultation
  - A prototype version of the CMI Model: CPMv0.0
  - CMI Working Paper 38: Part I – Outline
  - CMI Working Paper 39: Part II – Detailed Analysis
  - A User Guide for CPMv0.0
  - Parameter Sensitivity Test results spreadsheet
- Consultation on the Model and its potential uses
  - 2 Consultation Meetings held in July
  - Written submissions invited - close on 31 August 2009

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Model Structure

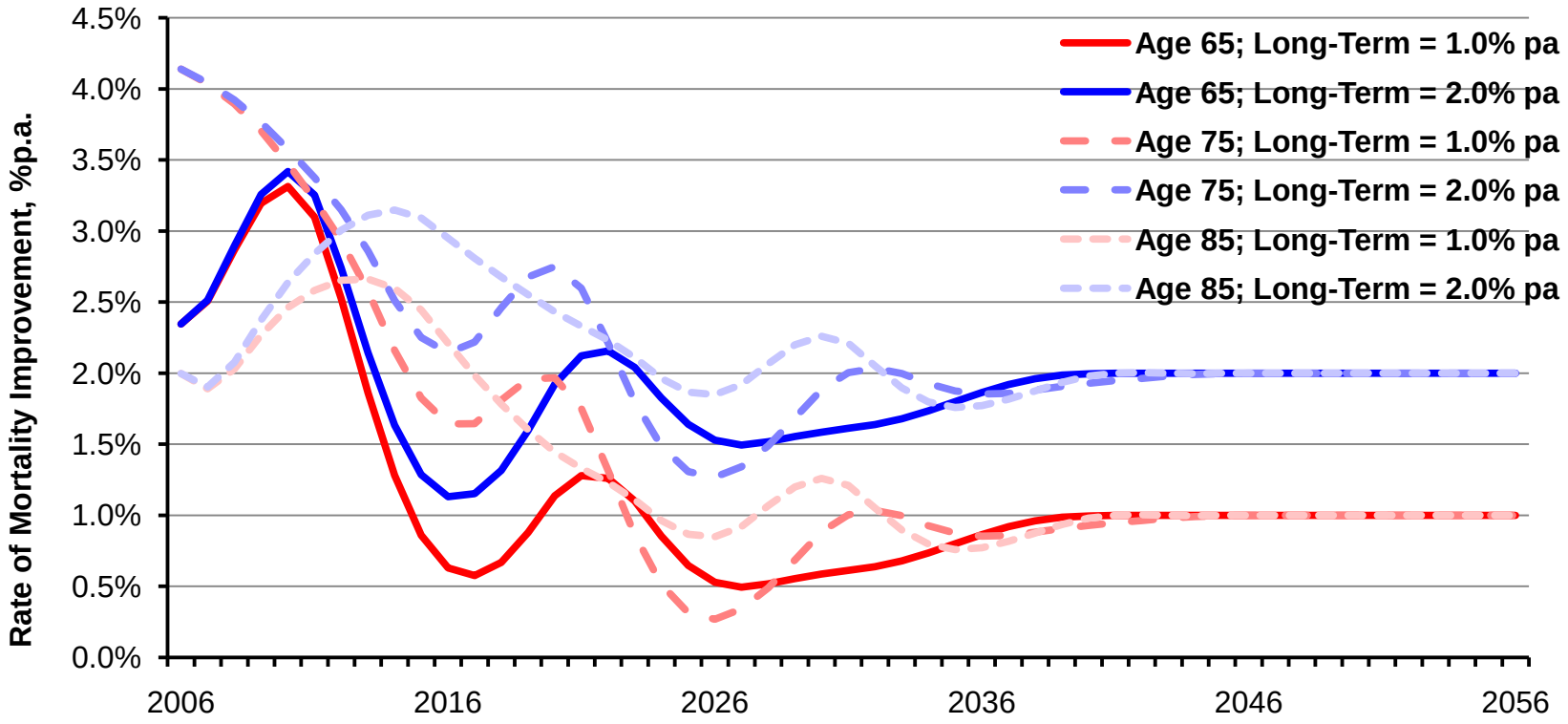
- Project annual mortality improvement rates
  - Relatively simple; Accessible; Flexible
  - Not a mathematical model of mortality fitted to data
- Deterministic projection driven by user inputs
  - Initial rates of mortality improvement
  - Long-term rate(s) of mortality improvement
  - Speed & pattern of convergence
  - Split projection by age or by year-of-birth cohort
- Core and Advanced parameter layers

Convergence to a Long-Term Rate

- In the short-term, the best guide to the likely pace of mortality improvement is the most recently observed experience
- In the long-term, the forces driving mortality change are likely to be very different; more subjective, better informed by expert opinion
- The Working Papers include research on:-
  - Mortality improvement by cause-of-death
  - Long-run average rates of change in a range of countries

Convergence to a Long-Term Rate

Modelled Mortality Improvement Rates
Sample ages and Long-Term Rates; source: CMI_2009_M



Advanced Parameter Layer

- Gives users considerable flexibility; allowing specification of:-
  - Initial Rates of Mortality Improvement
  - Cohort & Age/Period Components of Initial Rates
  - Long-term Rates of Improvement (by individual age & birth cohort)
  - Period of Convergence (by individual age & birth cohort)
  - Proportion of Convergence remaining after Mid-point (by individual age & birth cohort)
  - Initial Rates of Mortality

Core Parameter Layer

- Allows users to focus on two simplified parameters:-
  - A Long-Term Rate of Mortality Improvement
  - A Constant Addition to Rates of Mortality Improvement
- Default values are applied to other parameters
  - Initial Rates derived from Eng&Wal population data
- ‘Core Projections’ – i.e. those produced using only the Core Parameter layer – can be described using a prescribed naming convention

Naming Convention (Prototype Model)

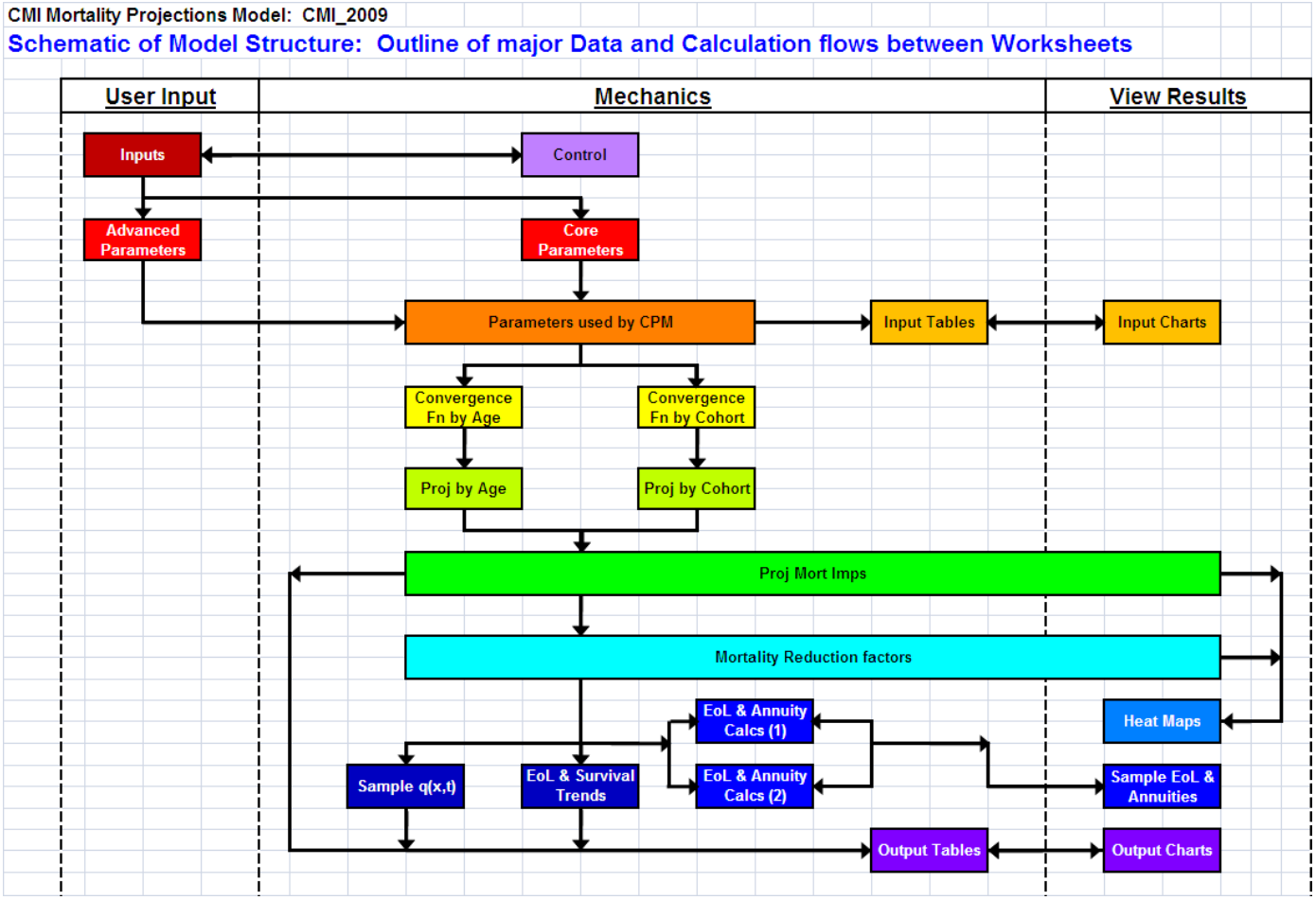
- Core Projections from prototype version of the Model were given names of the following form:-

CPMv0.0 [a%] + c% {gender}

where:-

- a% = Long-Term Rate of Mortality Improvement
- c% = Constant Addition to Rates of Improvement for all ages and calendar years (omitted if zero)

Sample Views: Flowchart (Data & Calcs)



Sample Views: Inputs Worksheet

CMI Mortality Projections Model: CMI_2009

User Input sheet for Selection of Mortality Projection Basis

Please set your basis by making selections or entering values in the yellow boxes.
First select level - Core or Advanced - for each of the main parameter groups, then enter values in the available input cells.
For Advanced Parameters, please also update values in the approriate cells of the "Advanced Parameter" worksheet.

Parameter Group			Core	Advanced	Location for Advanced Parameters
Gender					
Gender	Male				
Base Rates of Mortality					
Parameter Level	Core				
Base Table of Mortality Rates		Table Name or Reference	PCxA00		
Timing Definition		q_x applies to lives attaining age x exact on	01/07/2000		
Initial Rates of Mortality Improvement					
Parameter Level	Core				
Table of Initial Rates of Mortality Improvement		Table Name or Reference	Default		
Timing Definition		Underlying q^*_x applies to lives attaining age x exact on	01/01/2006		
Long-Term Rates of Mortality Improvement					
Parameter Level	Core	Please enter a value for the Core parameter for Long-Term Rates of Mortality Improvement			
Table or Core Parameter for Long-Term Rates		Long-term Rate of Mortality Improvement up to age 90	?		
Convergence					
Parameter Level	Core				
Table of Convergence Parameters		Table Name or Reference	Default		
Constant Additional Rate of Mortality Improvement					
Additional Rate, %pa	0.00%	Applies to all ages and years in the projection			
Projection Name					
Base Mortality	100% PCMA00 (Core) for life aged x exact on 01/07/2000				
Projection	CMI_2009_M [?]				

Sample Views: Inputs Worksheet

CMI Mortality Projections Model: CMI_2009

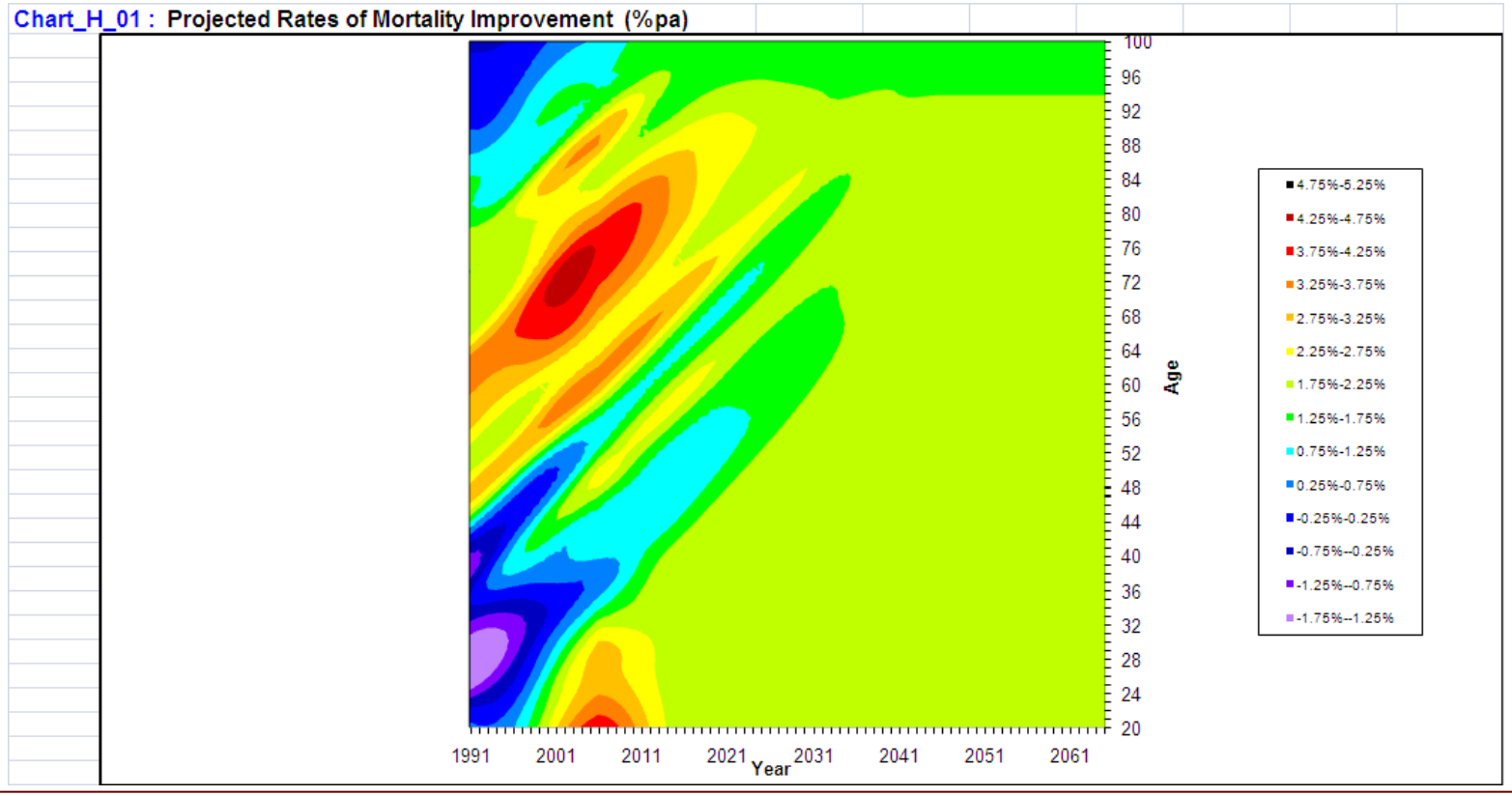
User Input sheet for Selection of Mortality Projection Basis

Please set your basis by making selections or entering values in the yellow boxes.
First select level - Core or Advanced - for each of the main parameter groups, then enter values in the available input cells.
For Advanced Parameters, please also update values in the approriate cells of the "Advanced Parameter" worksheet.

Parameter Group			Core	Advanced	Location for Advanced Parameters
Gender					
Gender	Male				
Base Rates of Mortality					
Parameter Level	Advanced				
Base Table of Mortality Rates		Table Name or Reference		PCxA00	Column 5
Timing Definition		q_x applies to lives attaining age x exact on		01/07/2000	
Initial Rates of Mortality Improvement					
Parameter Level	Advanced				
Table of Initial Rates of Mortality Improvement		Table Name or Reference		User_Ref	Columns 11 to 26, 38 and 41
Timing Definition		Underlying q^*_x applies to lives attaining age x exact on		01/01/2006	
Long-Term Rates of Mortality Improvement					
Parameter Level	Advanced				
Table or Core Parameter for Long-Term Rates		Table Name or Reference		User_Ref	Columns 47 and 50
Convergence					
Parameter Level	Advanced				
Table of Convergence Parameters		Table Name or Reference		User_Ref	Columns 53, 54, 57 and 58
Constant Additional Rate of Mortality Improvement					
Additional Rate, %pa	0.00%	Applies to all ages and years in the projection			
Projection Name					
Base Mortality	100% PCxA00 (Advanced) for life aged x exact on 01/07/2000				
Projection	CMI_2009_M [Advanced: IR(User_Ref); LTR(User_Ref); Conv(User_Ref); Timing = 01/01/2006]				

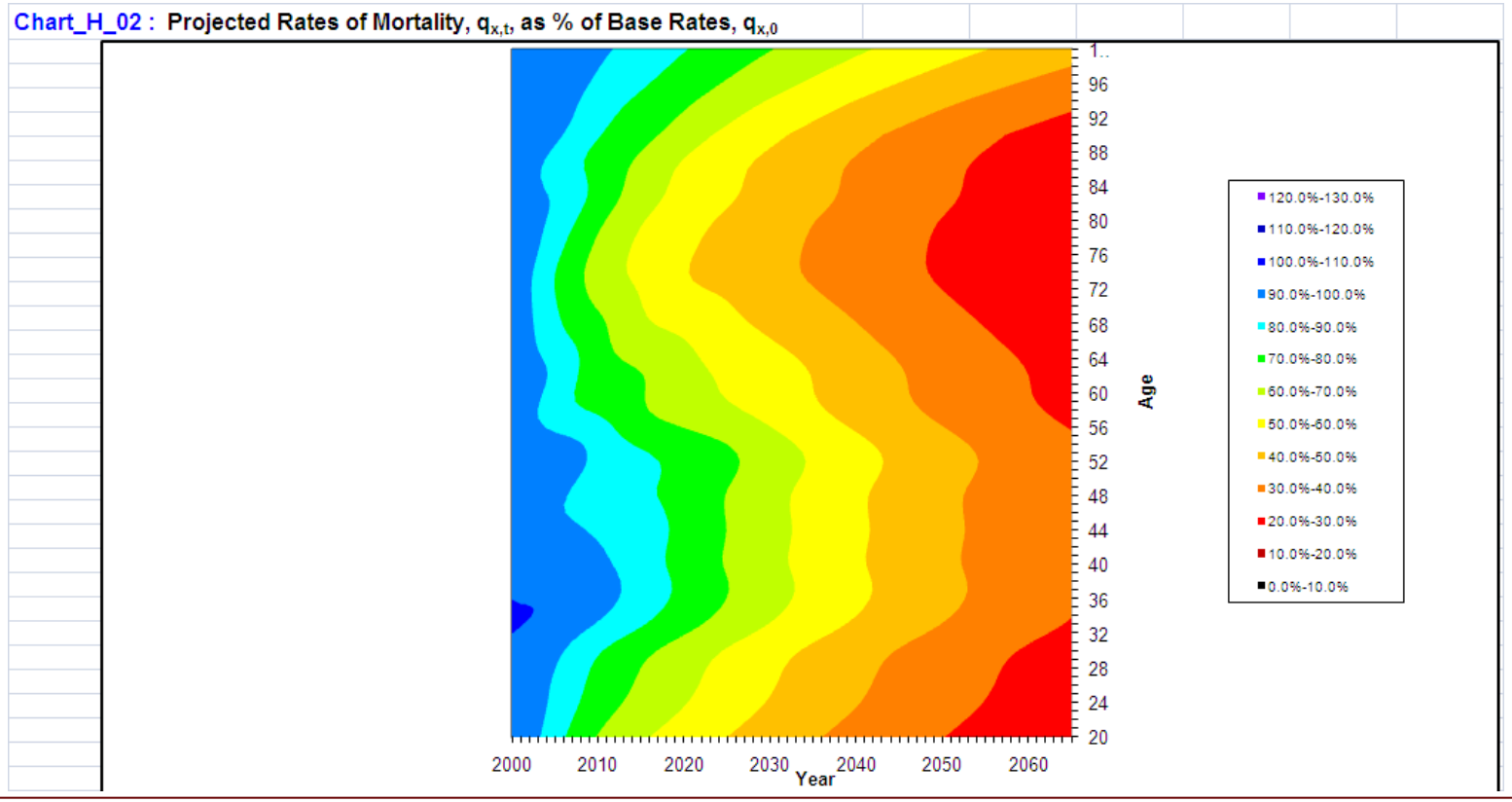
Sample Views: Outputs (Tables)

Actual & Projected Mortality Improvement Rates
Projection: CMI_2009_M [2.0%]



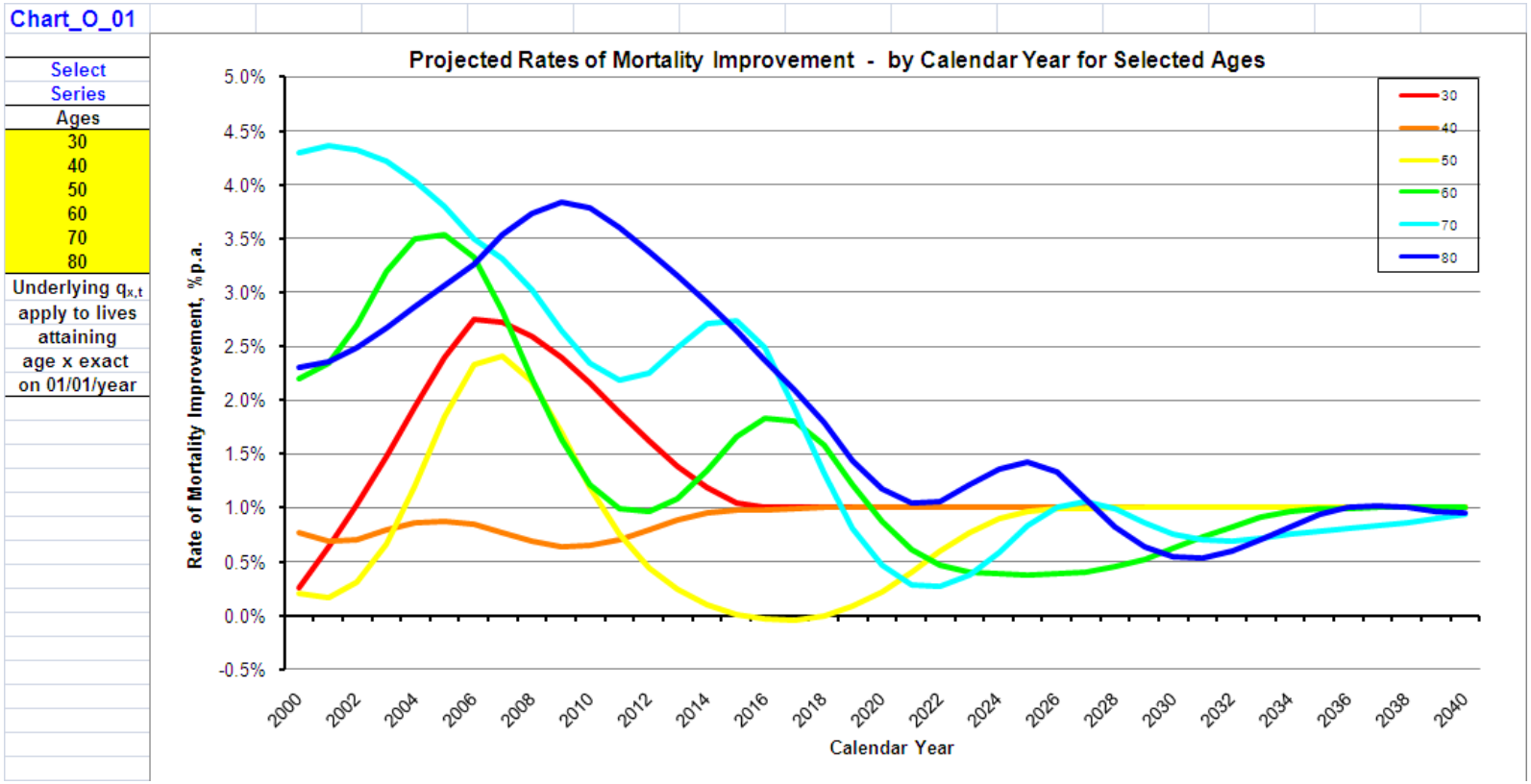
Sample Views: Outputs (Tables)

Actual & Projected Mortality Reduction Factors
Projection: CMI_2009_M [2.0%]



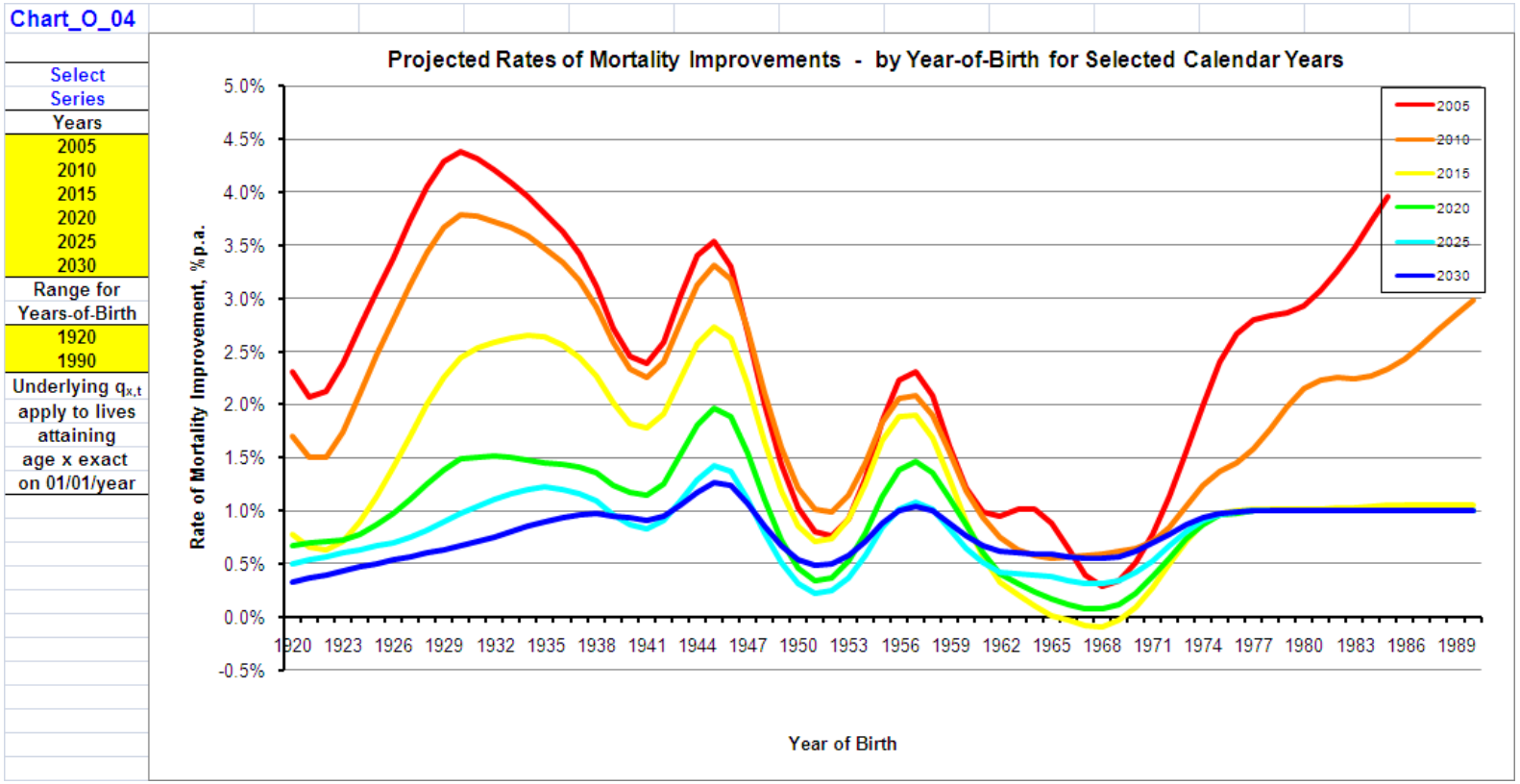
Sample Views: Outputs (Charts)

Projected Rates of Mortality Improvement
Projection: CMI_2009_M [1.00%]



Sample Views: Outputs (Charts)

Projected Rates of Mortality Improvement
Projection: CMI_2009_M [1.00%]



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Responses to the Consultation

- Meetings in Edinburgh & London
- 31 written responses received
- 24 addressed the specific consultation questions
  - Broad range of firms represented
  - Bias towards firms involved in pensions consultancy (14)
  - Life offices (7), Reinsurer (1), Banks (2)
  - No response from regulators or ‘non-actuarial’ groups
- 7 related to specific issues
- Responses will not be published in full
  - Summary provided in WP41; comments not attributed

Responses to the Consultation

(a) Do you agree that the CMI should be producing such a mortality projections model for use by practising actuaries?

- Unanimously positive response!
- Rationale typically included:
  - The need to replace the Interim Cohort Projections
  - The need for a model (always) reflecting recent data
  - The value of the Model as a 'Common Currency'
  - A view that the CMI is uniquely placed for this initiative
- Clear mandate to proceed to 'final' version

Responses to the Consultation

(b) Do you agree with the broad structure of the proposed Model?

- Strong & widespread support for basic structure
  - Two-level design caters well for a broad range of users
  - Blending over time, from current to assumed long-term rates of mortality improvement, is generally seen as intuitive and relatively easy to communicate
  - Majority support for deterministic model
- Maintain broad structure as it is
  - Some alterations suggested, no consensus for change

Responses to the Consultation

(c) Do you have any comments or suggestions on the proposed structure of the Model?

- Two most common issues (minorities)
  - Convergence methodology (reflect recent trend?)
  - Need for measures of uncertainty
- Maintain structure as per CPMv0.0
  - Both issues considered in detail in developing CPMv0.0
  - Both would add significant complexity to Model
- But encourage research to quantify uncertainty

Responses to the Consultation

(d) Do you agree with proposed number (two) of parameters at Core level and the choice these Core parameters?

- Response broadly symmetrical around proposal
  - Add Parameter (convergence; high age LTR) 10
  - Agree with proposal 11
  - Remove Parameter (constant addition) 5
- Maintain structure as per CPMv0.0
  - Results less sensitive to proposed extra parameters
  - Impossible to satisfy everyone!

Responses to the Consultation

(e) Do you feel it would be useful to allow users to vary the long-term rate over time?

- Response split roughly 50:50
  - Some support for extra flexibility ...
  - ... but ‘nice to have’ rather than ‘must have’
  - Some concern that extra complexity not justified

- Maintain structure as per CPMv0.0
  - Insufficient support to pursue extra flexibility in LTR

Responses to the Consultation

(f) Do you have any comments or suggestions on the default values given to parameters?

- Many indicated broad support for proposed values
- But half of the responses raised specific issues:
  - Use of population, rather than insured / pensioner data
  - Default shape for convergence (50% at mid-point)
  - Tapering rates of mortality change to zero at high ages
  - Derivation of separate age/period & cohort components
- Expanded justification of approach / value

Responses to the Consultation

(g) Do you have any comments or suggestions on the proposed naming convention?

- General support for proposed naming convention
  - and for informal naming of Advanced Projections
- Challenge set to find names:
  - with greater intuitive meaning (for non-actuaries)
  - with easier expression (more 'catchy')
- Revised Naming Convention set out
  - Refer to new version of Model as 'CMI_2009'

Naming Convention (Revised)

- Core Projections from the first live version of the Model can be given names of the following form:-

  CMI_2009_x [a%] + c%

  where:-

  - _x is '_M' for males or '_F' for females
  - a% = Long-Term Rate of Mortality Improvement
  - c% = Constant Addition to Rates of Improvement for all ages and calendar years (omitted if zero)

Responses to the Consultation

(h) Do you anticipate you would use this Model in practice? If so, for what purpose would you use it?

- All respondents indicated they would use Model
  - 75% expect to use it directly to produce projections
  - 25% expect to use it indirectly as means of expressing, benchmarking and communicating projection bases
  - Pension consultancy response weighted more heavily to direct use; insurer response weighted to indirect use

- Strengthens mandate to proceed to 'final' version

Responses to the Consultation

(i) Do you have any thoughts on how the proposed Model should be developed in the future?

- Calls for further research, but no dominant topics:
  - Further future mortality scenarios by cause-of-death
  - Alternative data sets / analysis by socio-economic group
  - Analysis of drivers of mortality change (cohort features)
  - Further analysis to support setting long-term rate
  - Further research & development of stochastic models
- Support further research, but outside current scope

Responses to the Consultation

(j) Should the CMI maintain the proposed Model as new data becomes available? If so, should this be each year, or at some lesser frequency?

- Strong demand for regular review; different timing:
  - Full annual updates 9
  - Annual review, but only update if material 7
  - Less frequent (2 to 5 years, average 3) 7
- Seek to balance timely review against new data, with desired stability for the model structure and for projections in common use

Responses to the Consultation

(k) Do you have any other comments?

- A variety of issues were raised, including:
  - Interaction with the CMI Library of Projections
  - Some form of hind-casting / back-testing of the Model
  - Provision of further training for Users (Model & research)
  - Documentation to help users meet TAS-M
  - Release of underlying data and analysis tools
- All requests have been considered
  - Some are actively in progress;
  - Others marked as possible topics for future research

Summary of Consultation Responses

- Strong support for the Model
- Widespread intention to adopt / use the Model
- General support for broad structure of the Model
- Majority support for parameter default values set
- Calls for further / ongoing research
- Desire for annual review against emerging data …
- with stability for structure & benchmark projections

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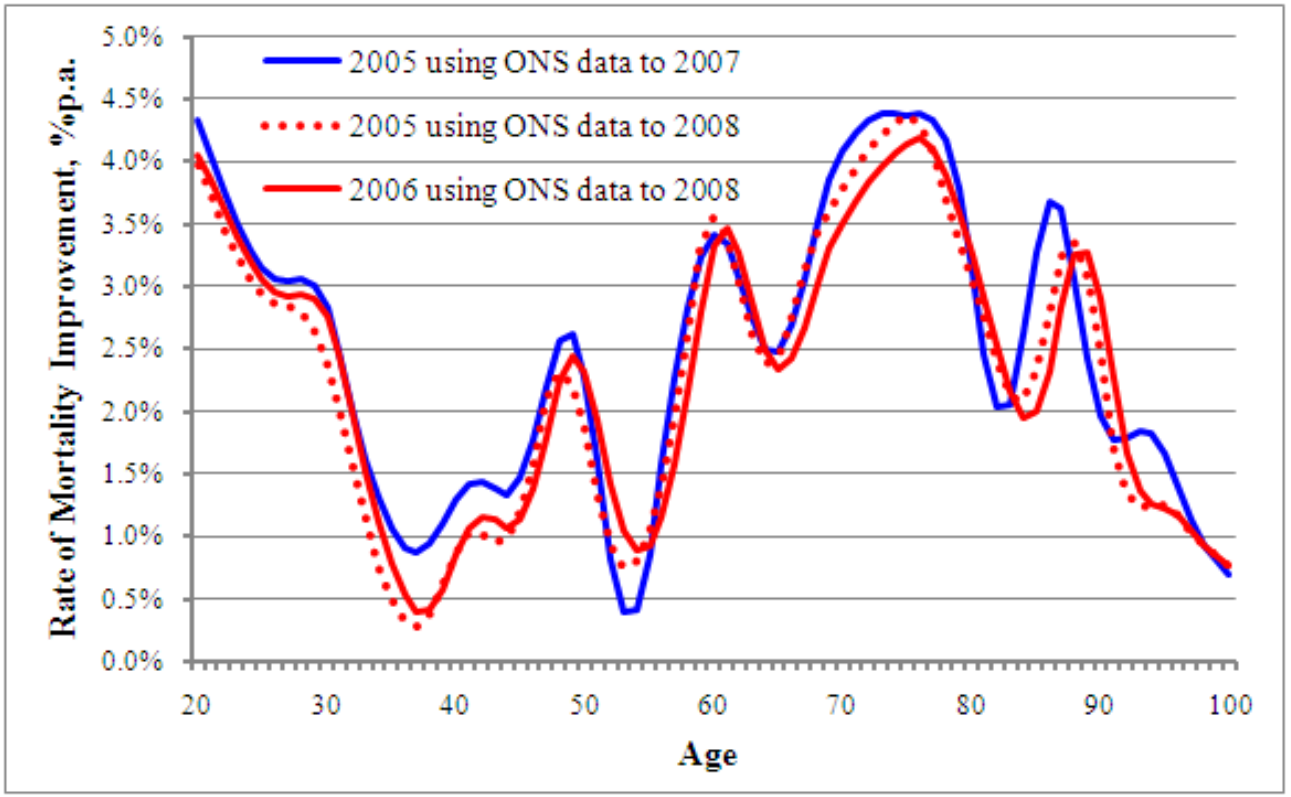
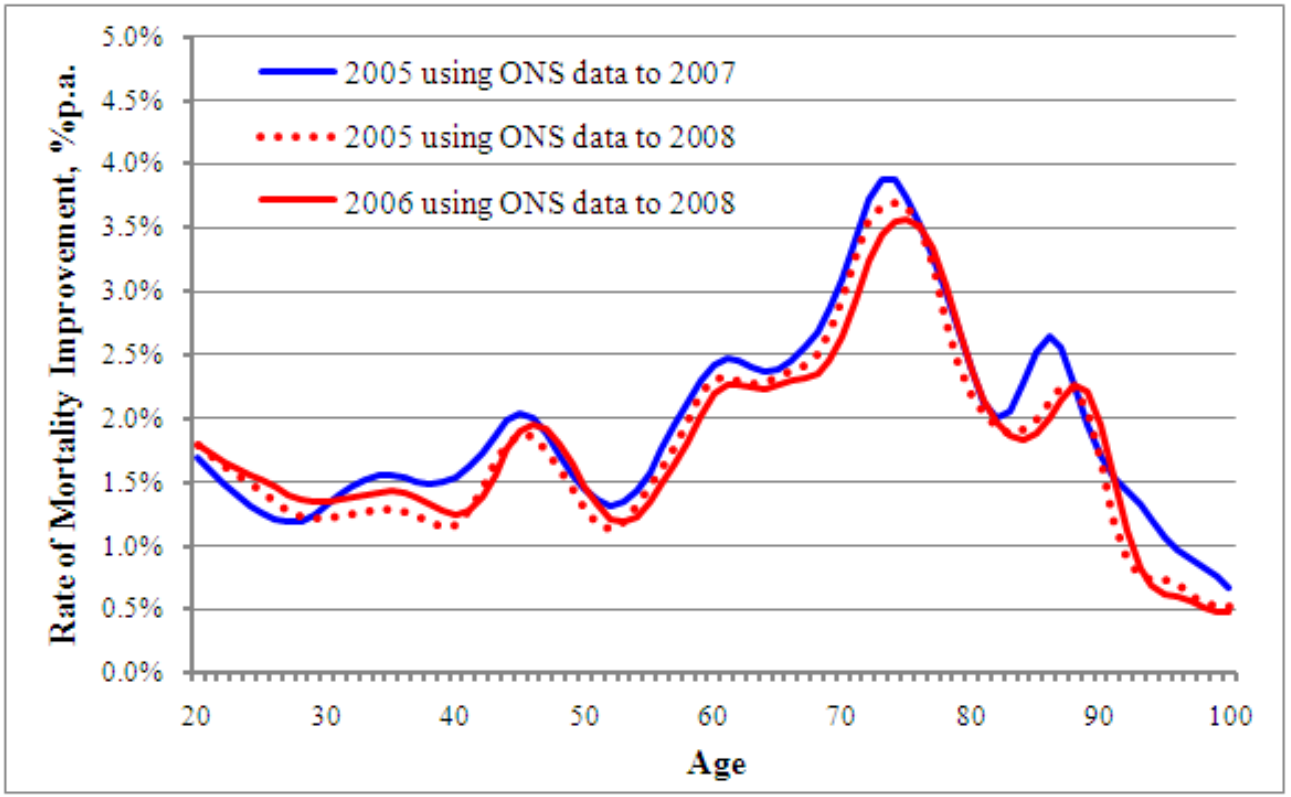
Estimated Mortality Improvement Rates

Annual Rates of Mortality Improvement, by age, 2005 & 2006
P-Spline models; Population of England & Wales; Males



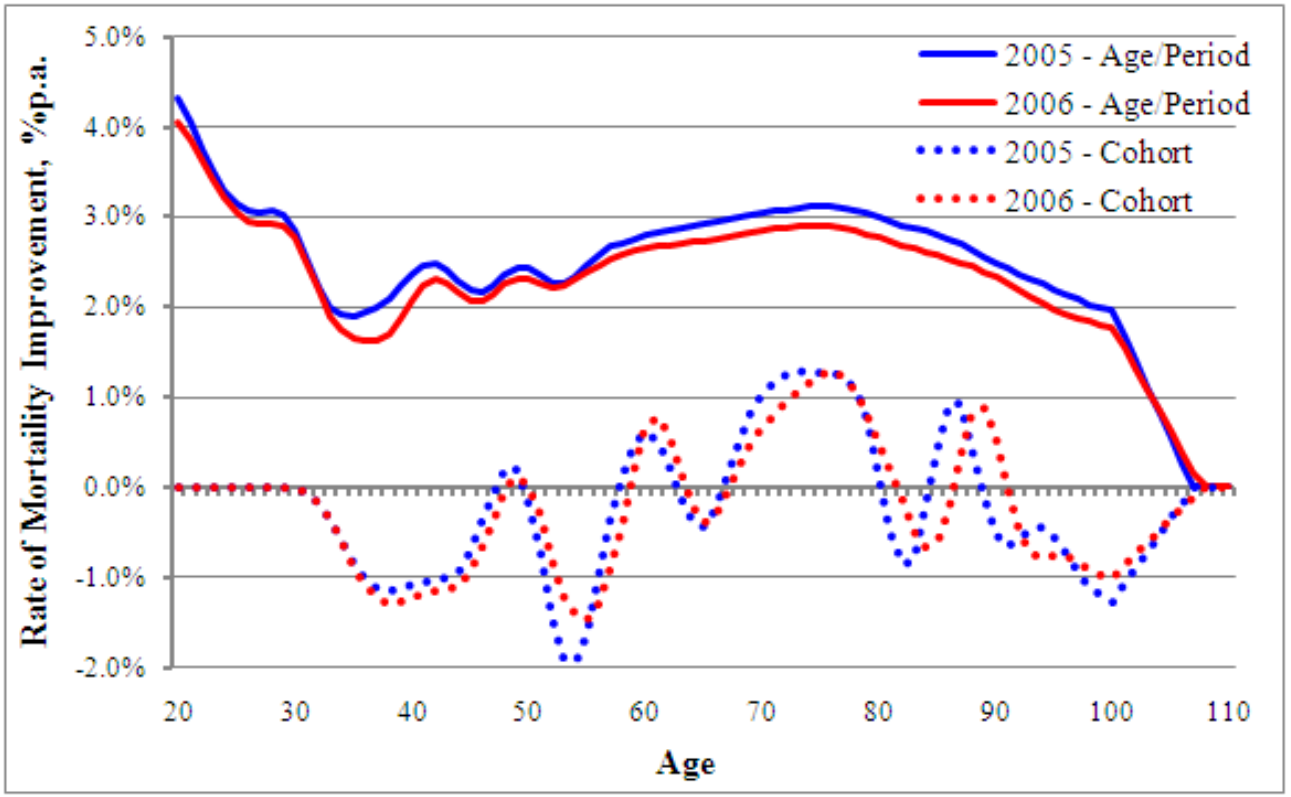
Estimated Mortality Improvement Rates

Annual Rates of Mortality Improvement, by age, 2005 & 2006
P-Spline models; Population of England & Wales; Females



Estimated Mortality Improvement Rates

Age/Period and Cohort Components of Mortality Improvement
By age; 2005 & 2006; Population of England & Wales; Males



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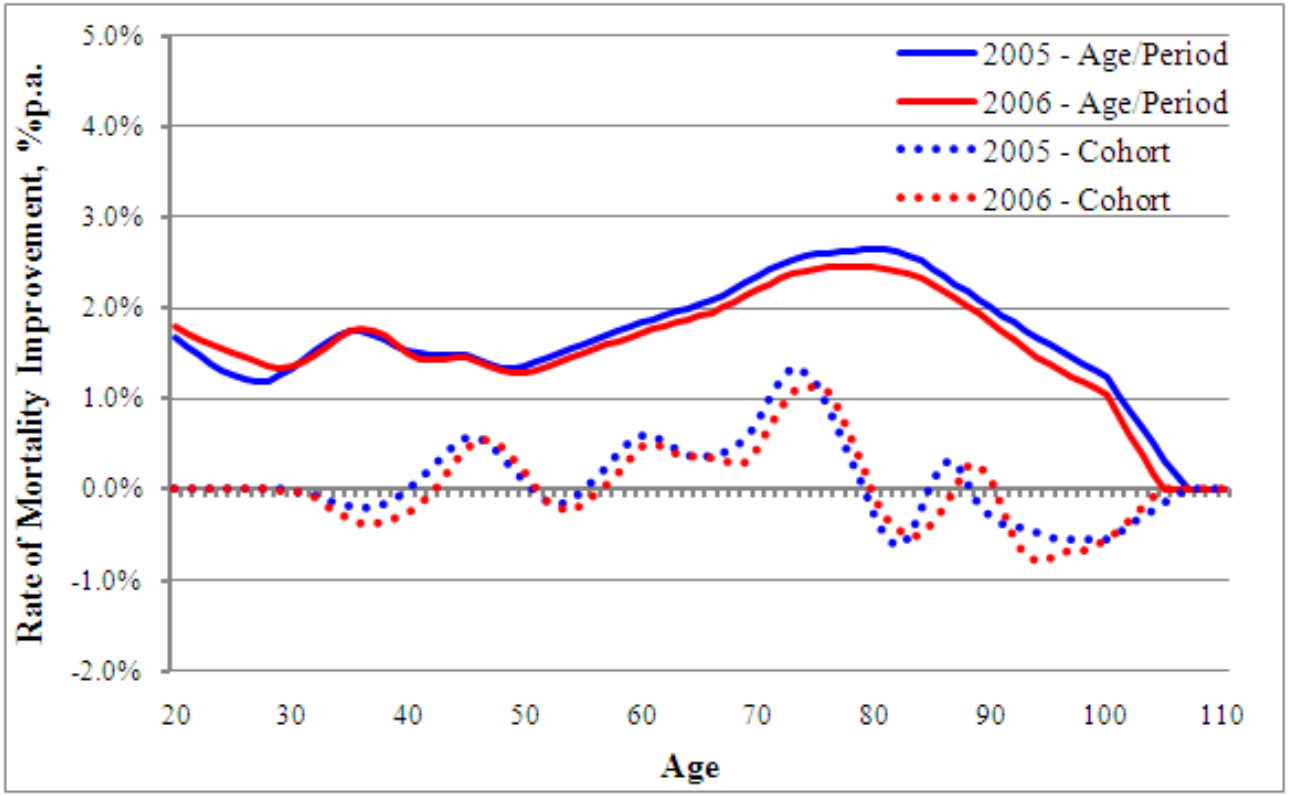
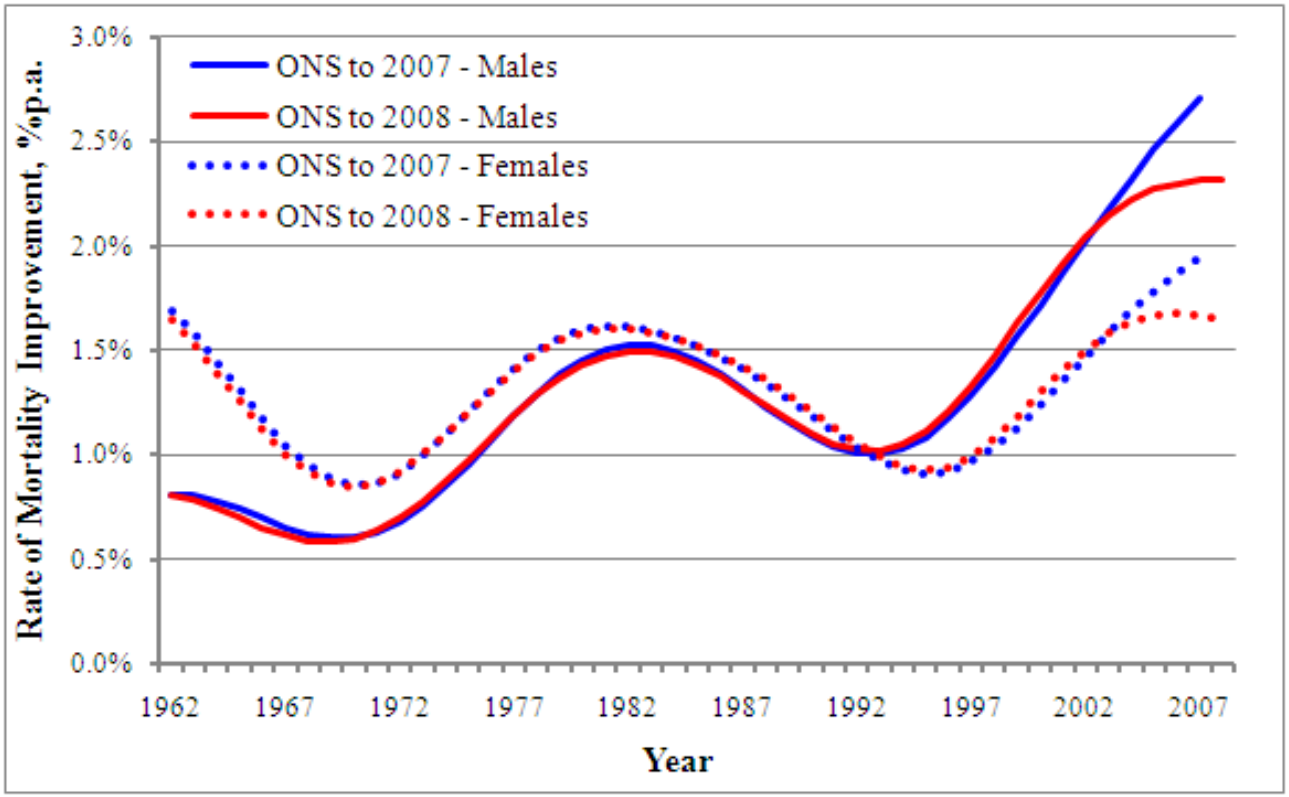


Estimated Mortality Improvement Rates

Estimated Period Component of Mortality Improvement, 1962-2008
Population of England & Wales



The Effect of Adding Data for 2008

- Addition of data leads to revision of estimates
  - Estimates slightly reduced for recent improvement rates
  - Revisions fall within expected range
  - … and show methodology gives relatively stable results
- Cohort EoLs fall on average by:
  - around 0.4% for males
  - around 0.7% for females
  - [+1% on long-term rate increases EoL by 5% at age 65]

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Working Party Output - 25 Nov 2009

- CMI Working Paper 41
  - Summary of feedback received from consultation
  - Commentary, setting out working party responses
  - The effect of adding data for 2008
- An updated version of the Model & User Guide
  - Updated for 2008 data, but no other material change
  - Revised naming convention: CMI_2009 (not CPM v1.0)
  - User Guide includes documentation of default values
  - Updated Parameter Sensitivity Test results spreadsheet

Comparison of Projections

Projected Expectation of Life, e_{65} , for age 65 exact as at 31/12/2009
Base Mortality : 100% PCMA00 for age exact on 01/07/2000

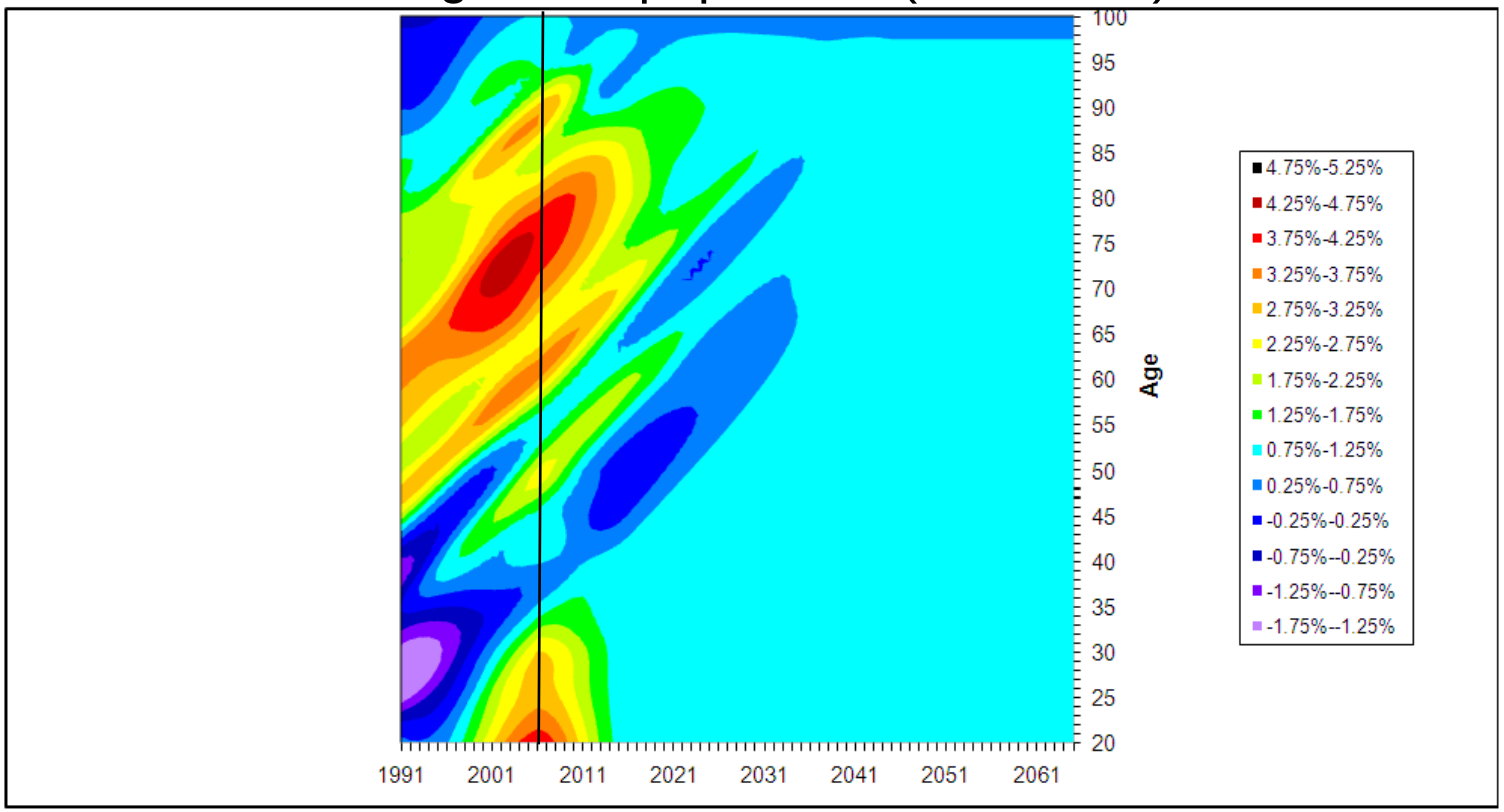
x%	CMI_2009_M [x%]	Medium Cohort, x% Underpin	Long Cohort, x% Underpin
0%	21.5	21.6	23.2
1%	22.6	22.1	23.5
2%	23.8	23.6	24.4
3%	25.1	26.0	26.3

- Broad similarity of CMI_2009 and Medium Cohort ?
  - Yes, when LTR = Underpin; age = 65; gender = males
- But patterns of projected mortality improvement vary significantly
  - So EoL comparisons vary significantly by age and over time

Heat Map: CMI_2009_M [1.0%]

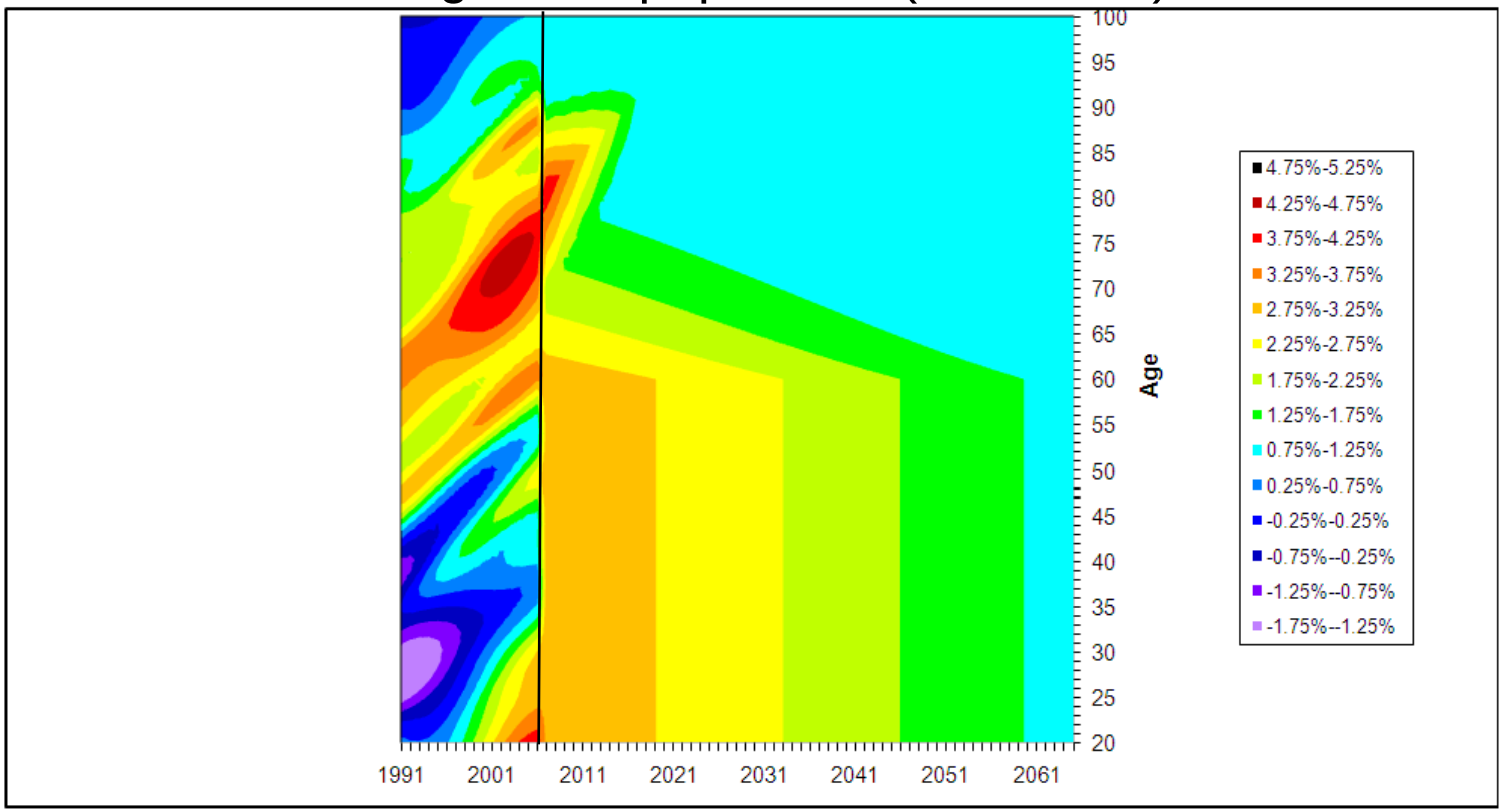
Actual & Projected Mortality Improvement Rates; Males

Actual = Eng & Wal population (smoothed) to 2006



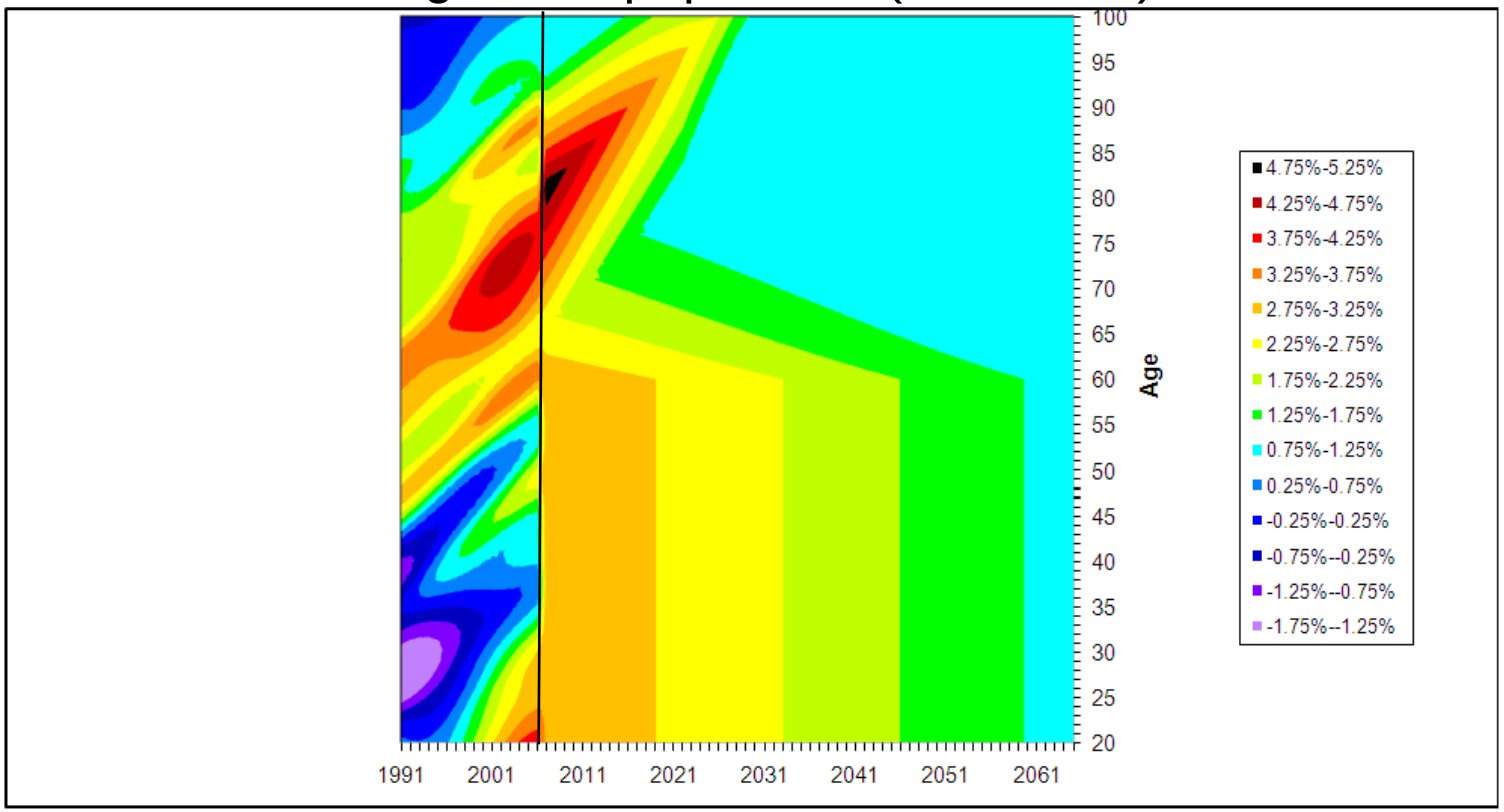
Heat Map: Medium Cohort,1.0% underpin

Actual & Projected Mortality Improvement Rates; Males
Actual = Eng & Wal population (smoothed) to 2006



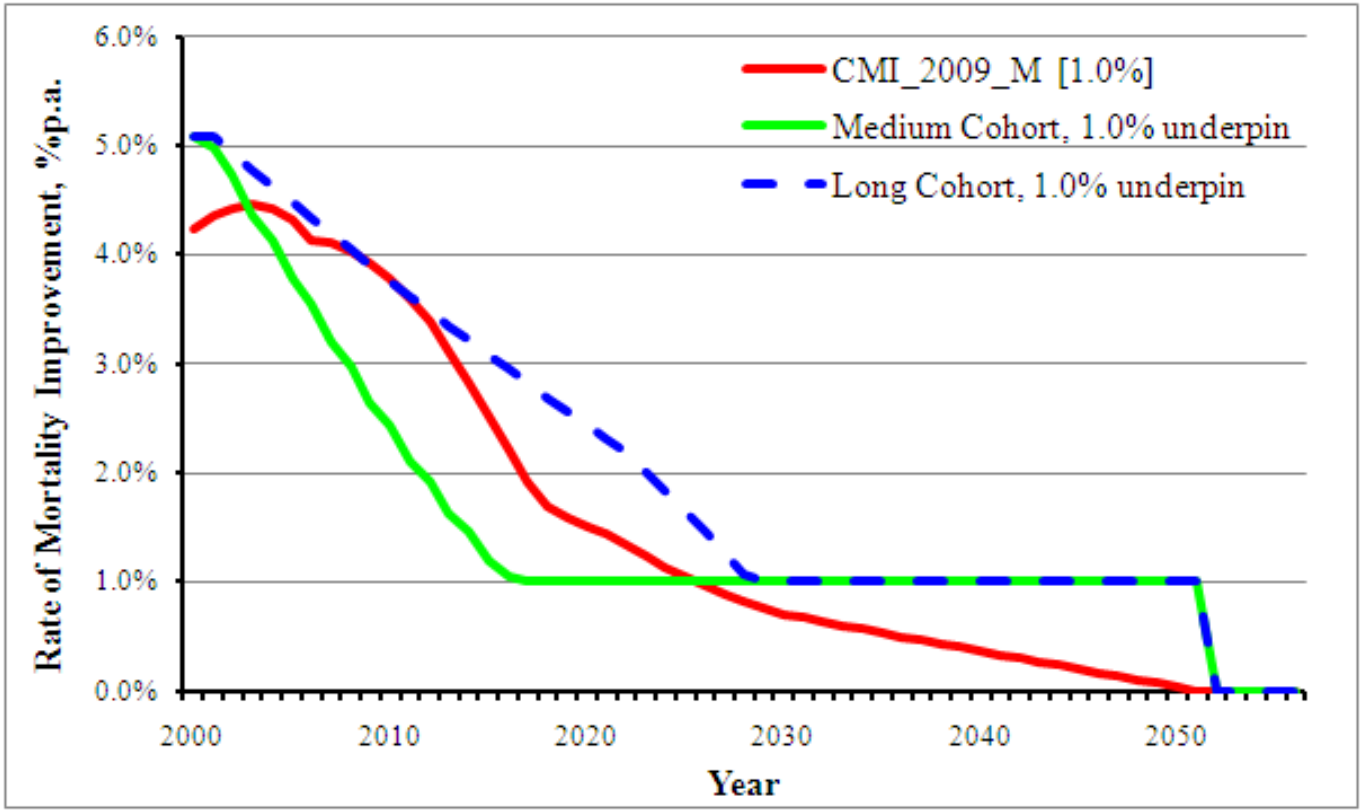
Heat Map: Long Cohort,1.0% underpin

Actual & Projected Mortality Improvement Rates; Males
Actual = Eng & Wal population (smoothed) to 2006



Comparison of Projections

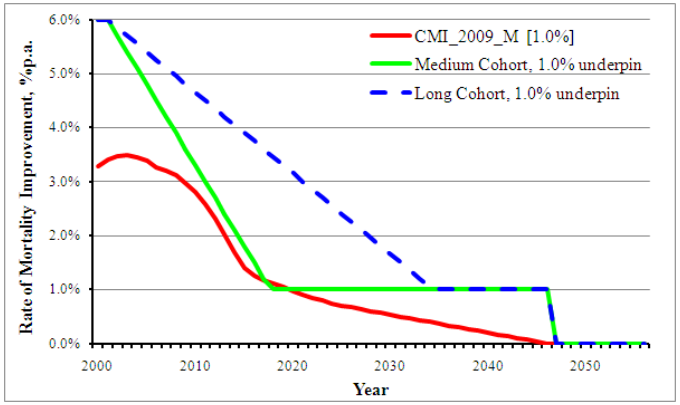
Actual & Projected Mortality Improvement Rates; Males
For Cohort born in 1931



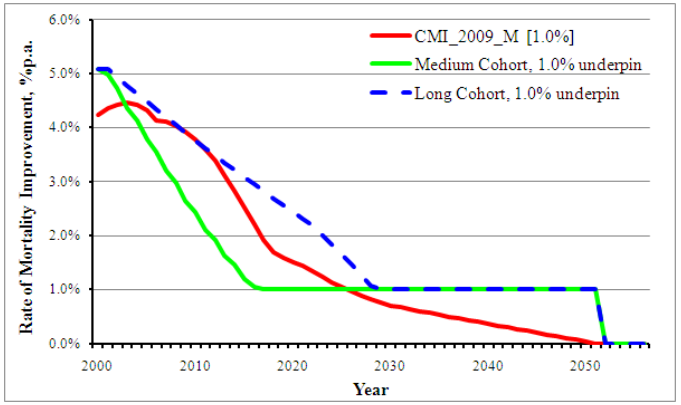
Comparison of Projections

Actual & Projected Mortality Improvement Rates; Males
For Cohorts born in 1926, 1931, 1936 and 1941

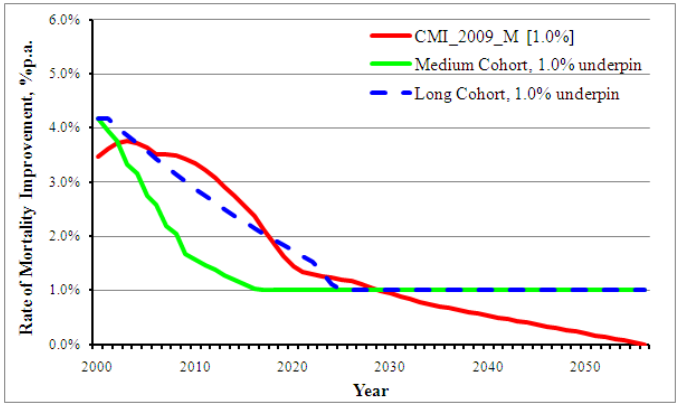
1926



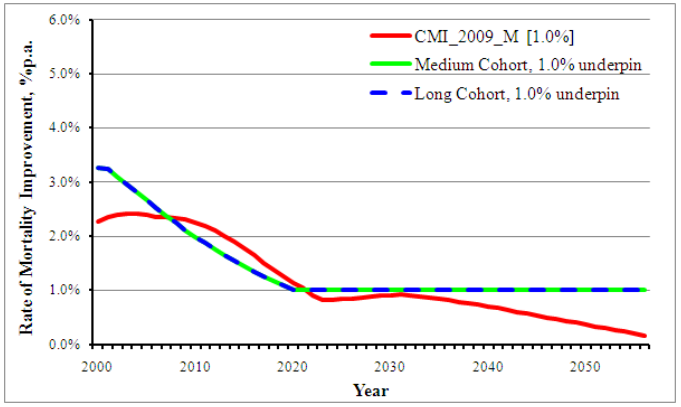
1931



1936



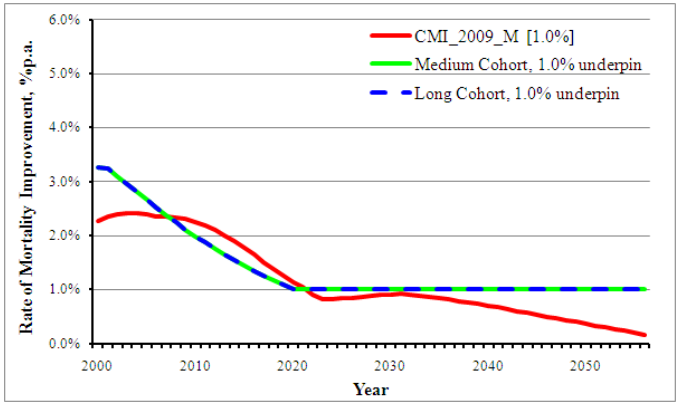
1941



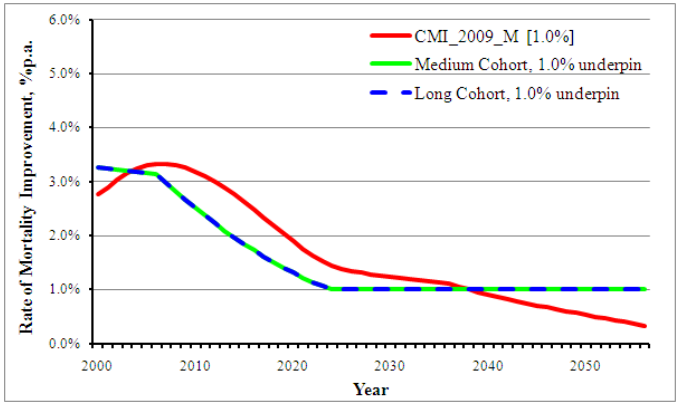
Comparison of Projections

Actual & Projected Mortality Improvement Rates; Males
For Cohorts born in 1941, 1946, 1951 and 1956

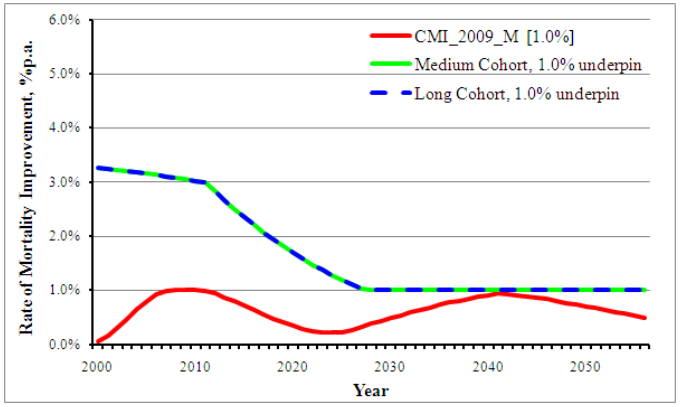
1941



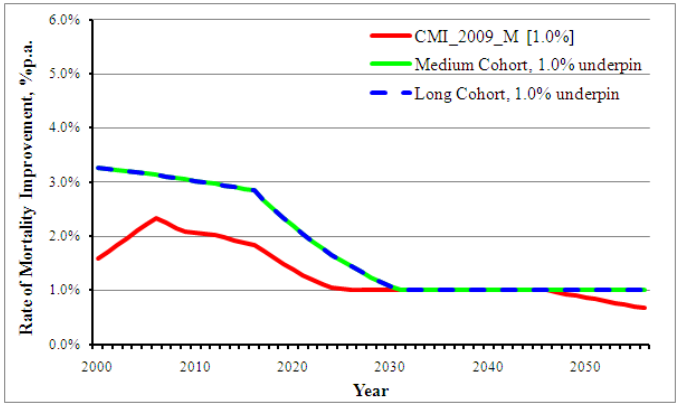
1946



1951

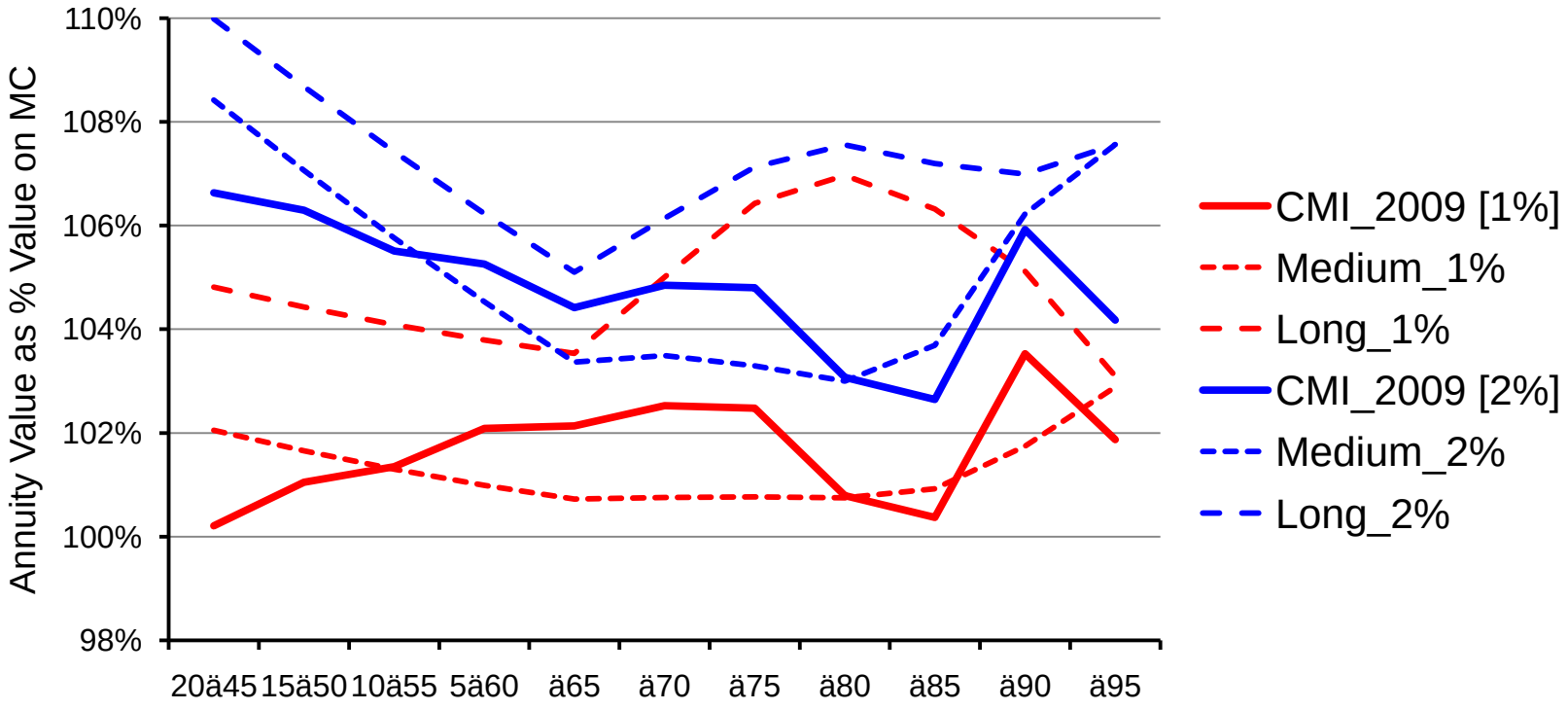


1956



Comparison of Projections

Projected Cohort Annuity Values relative to Medium Cohort males; age exact as at 31/12/2009; value at 5%p.a.
Base Mortality : 100% PCMA00 for life aged x exact on 01/07/2000



Agenda

- Background to the Projections Model
- An Overview of the Model
- The Consultation Exercise
- The Effect of Adding Data for 2008
- Launch of the new Model: ‘CMI_2009’
- Next Steps
- Questions and Answers

Maintenance & Development

- Limited Annual Updates
  - Core default for Initial Rates of Mortality Improvement
  - Incorporate each successive year's population data
  - Late October ? (dependent on ONS publication dates)
- Periodic General Reviews
  - Review structure and all default parameters
  - Avoid potential confusion / disruption of frequent change
  - Do 'when necessary' (maximum interval of 5 years)
  - Continuing feedback from users is encouraged!

Possible Future Research Work

- Key potential research topics include:
  - Quantifying uncertainty, including in initial rates
  - Alternative datasets – variation within the population
  - ‘Hind-casting’ / back-testing the Model
  - Further future mortality scenarios by cause-of-death
  - Analysis of drivers of mortality change (cohort features)

- May be advanced by the CMI and others

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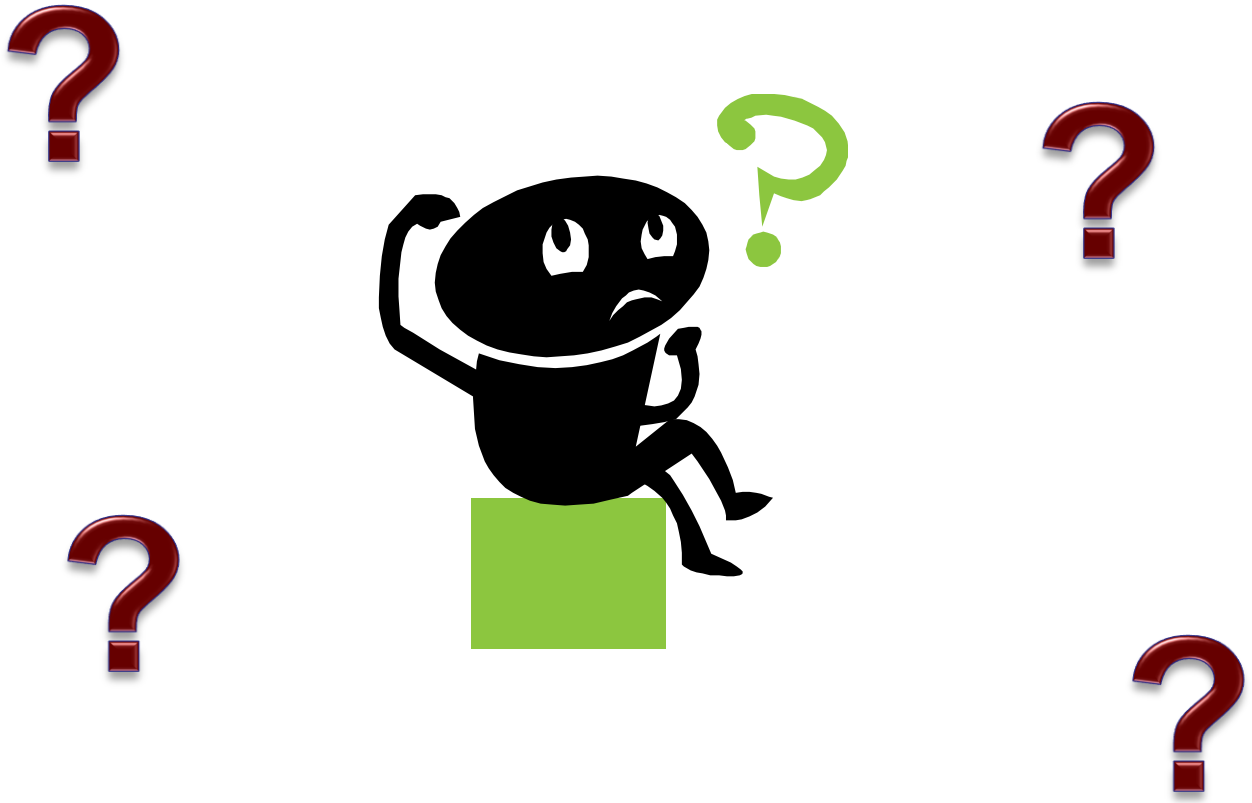
Questions & Answers



The Actuarial Profession
making financial sense of the future

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Launch of the new CMI Mortality Projections Model

Gordon Sharp, Richard Willets & Neil Robjohns

8th December 2009