Institute
and Faculty
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The Lost Generation… overstated (??) mortality improvements for younger lives

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16 May 2016

Aims of this presentation

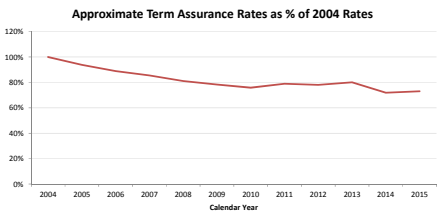|	
Materiality	How important are mortality improvement assumptions for pricing and valuation?
Modelling	What models are suitable for younger lives and what do existing models tell us?
Recent Trends	What does the historic data show and what is driving the recent trends?
Basis Risk	How can we determine a reasonable basis for insured lives?

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Some Background
- Life cover premium rates have tumbled

Approximate Term Assurance Rates as % of 2004 Rates

[Line chart showing term assurance rates declining from 100% in 2004 to approximately 75% in 2015, x-axis: Calendar Year 2004–2015, y-axis: 0%–120%]

Term assurance rates have dropped materially in recent years

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Some background...
- It is clear that we are living longer

Mortality Rates by Cause (All on 2nd axis)
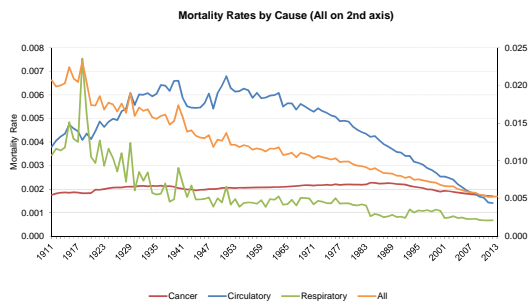
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Setting an improvement basis
- Mortality risk gets less attention than longevity

A Brief History Lesson...

SIAS paper "A Term Life"	2000	Suggested that improvements of 0.75%-1% for males and 0%-0.25% for females would be suitable for Term Assurance business
CMIR17 & working paper 1	1999-2002	Original CMI mortality improvements associated with the '92 series' of tables & the historically ubiquitous 'interim' cohort projections.
CMI working Papers 3, 15, 20, 25	2005-2007	CMI begin to explore Lee-Carter and P-Spline stochastic projection methodologies
CMI Model (WPs 38, 39, 41, 49, 54, 55, 64, 69, 79, 80, 84)	2009-2015	Move away from a stochastic methodology and develop a deterministic projection model (CMI_2015 is latest).

"The purpose of the CMI Mortality Projections Model is to allow users to produce projections of annual rates of mortality improvement, in particular in the context of <u>UK pension and annuity portfolios</u>". CMI_2015 User Guide

But what about younger, insured lives?

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Setting an improvement basis
- How much credit has been given for insured lives in the industry?

There does not appear to be much of a consensus for insured lives...

But it is important...
(particularly given today's margins)

It is likely that insurers (or reinsurers) have gradually been giving more credit for higher improvement rates

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Financial Sensitivity
- Defining a dummy term assurance portfolio

New business mix

		Term						
		5	10	15	20	25	30	35
	20	-	-	-	-	1%	-	-
	25	-	-	-	1%	3%	2%	2%
	30	-	-	1%	2%	5%	3%	1%
Age at Entry	35	1%	1%	2%	5%	8%	2%	-
	40	1%	2%	3%	7%	7%	1%	-
	45	1%	3%	5%	7%	2%	-	-
	50	1%	3%	5%	2%	-	-	-
	55	1%	3%	2%	-	-	-	-
	60	1%	1%	-	-	-	-	-

Sex	Smoker N	Y
Male	45%	10%
Female	35%	10%

Benefit	Total
Decreasing	50%
Level	50%

Assumptions

100% TMFNS00 as at 2000

1% per annum improvements from 2000 to 2015

2.5% discount rate

6% mortgage interest rate for DTA

£1bn of sum assured sold in 2012

Base case: Future improvements 2016+ of 0.5% per annum

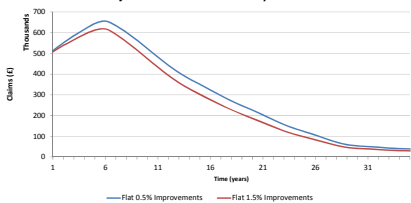*Sensitivity: Future improvements 2016+ of 1.5% per annum*

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Financial Sensitivity
- Increasing improvement rates by 1%

Projected Claims for our Dummy Portfolio

Basis	PV Claims	% Impact
0.5% improvements	£8.5m	-
1.5% improvements	£7.7m	-9.2%

Obviously a key assumption

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Financial Sensitivity
- Next, let's move to the CMI_2015 model

Overview of Model

Initial Rates of Improvement	Method of Convergence	Long-Term Improvement Rate
- Period component - Cohort component	- Period of convergence - % Change at mid-point	- Period component - (zero) Cohort component
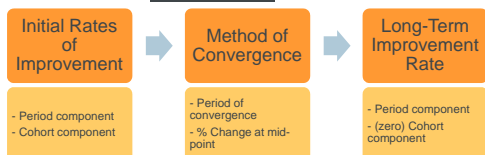
For simplicity, let's simply retain the default assumptions and choose a long-term rate of 1.5%

Do we have any expectations

In words: we are giving full credit for "longevity style" improvement rates

Will our liabilities decrease?

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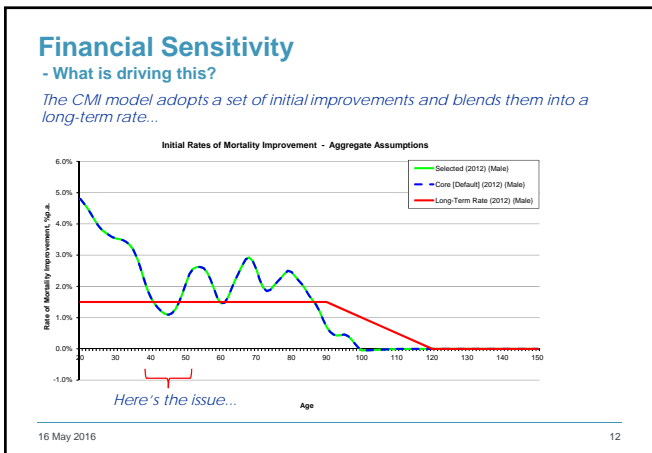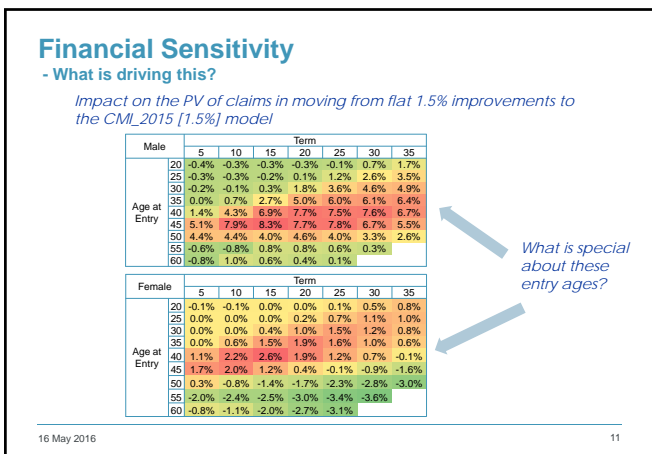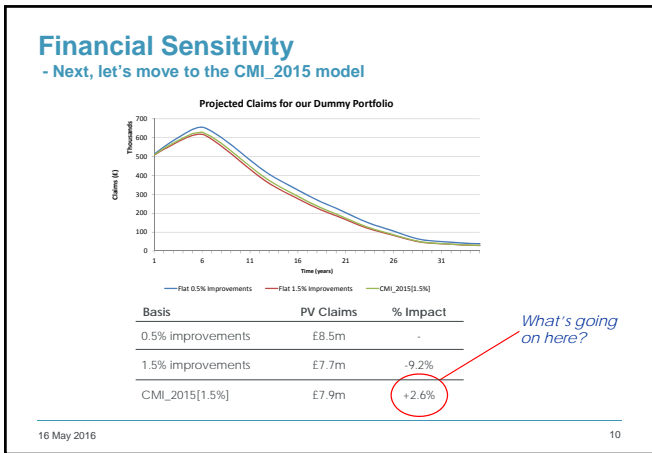
Financial Sensitivity
- Next, let's move to the CMI_2015 model

Projected Claims for our Dummy Portfolio

Flat 0.5% Improvements — Flat 1.5% Improvements — CMI_2015[1.5%]

Basis	PV Claims	% Impact
0.5% improvements	£8.5m	-
1.5% improvements	£7.7m	-9.2%
CMI_2015[1.5%]	£7.9m	+2.6%

What's going on here?

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Financial Sensitivity
- What is driving this?

Impact on the PV of claims in moving from flat 1.5% improvements to the CMI_2015 [1.5%] model

Male

Age at Entry	Term 5	10	15	20	25	30	35
20	-0.4%	-0.3%	-0.3%	-0.3%	-0.1%	0.7%	1.7%
25	-0.3%	-0.3%	-0.2%	0.1%	1.2%	2.6%	3.5%
30	-0.2%	-0.1%	0.3%	1.8%	3.6%	4.6%	4.9%
35	0.0%	0.7%	2.7%	5.0%	6.0%	6.1%	6.4%
40	1.4%	4.3%	6.9%	7.7%	7.5%	7.6%	6.7%
45	5.1%	7.9%	8.3%	7.7%	7.8%	6.7%	5.5%
50	4.4%	4.4%	4.0%	4.6%	4.0%	3.3%	2.6%
55	-0.6%	-0.8%	0.8%	0.8%	0.6%	0.3%	
60	-0.8%	1.0%	0.6%	0.4%	0.1%		

Female

Age at Entry	Term 5	10	15	20	25	30	35
20	-0.1%	-0.1%	0.0%	0.0%	0.1%	0.5%	0.8%
25	0.0%	0.0%	0.0%	0.2%	0.7%	1.1%	1.0%
30	0.0%	0.0%	0.4%	1.0%	1.5%	1.2%	0.8%
35	0.0%	0.6%	1.5%	1.9%	1.6%	1.0%	0.6%
40	1.1%	2.2%	2.6%	1.9%	1.2%	0.7%	-0.1%
45	1.7%	2.0%	1.2%	0.4%	-0.1%	-0.9%	-1.6%
50	0.3%	-0.8%	-1.4%	-1.7%	-2.3%	-2.8%	-3.0%
55	-2.0%	-2.4%	-2.5%	-3.0%	-3.4%	-3.6%	
60	-0.8%	-1.1%	-2.0%	-2.7%	-3.1%		

What is special about these entry ages?

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Financial Sensitivity
- What is driving this?

The CMI model adopts a set of initial improvements and blends them into a long-term rate...

Initial Rates of Mortality Improvement - Aggregate Assumptions

— Selected (2012) (Male)
-- Core [Default] (2012) (Male)
— Long-Term Rate (2012) (Male)

Here's the issue...

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Financial Sensitivity
- What is driving this?

The convergence can be shown in heat map form:
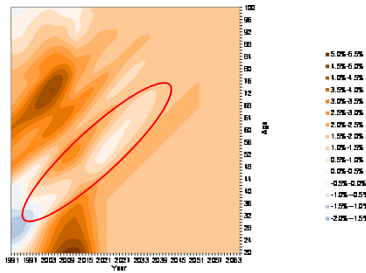
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Exploring this further
A more detailed look at recent trends

$$\mu_{x,t} = \frac{deaths_{x,t}}{population_{x,t}}$$
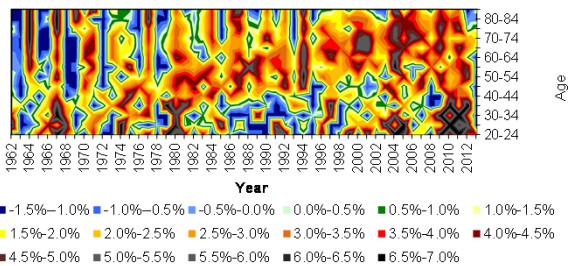
$$improv_{x,t} = 1 - \frac{\mu_{x,t}}{\mu_{x,t-1}}$$
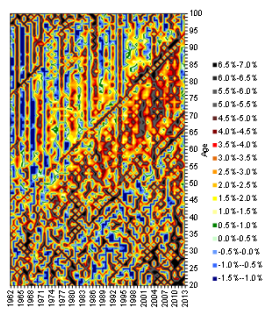
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Exploring this further
A detailed look at recent trends

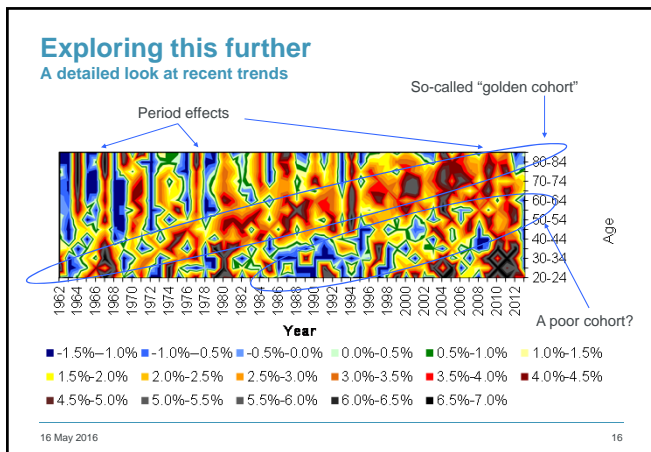➤ We can clearly see cohort and period effects

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Exploring this further
A detailed look at recent trends

So-called "golden cohort"

Period effects

A poor cohort?

Age

Year

- ■ -1.5%–-1.0%
- ■ -1.0%–-0.5%
- □ -0.5%-0.0%
- □ 0.0%-0.5%
- ■ 0.5%-1.0%
- □ 1.0%-1.5%
- □ 1.5%-2.0%
- ■ 2.0%-2.5%
- ■ 2.5%-3.0%
- ■ 3.0%-3.5%
- ■ 3.5%-4.0%
- ■ 4.0%-4.5%
- ■ 4.5%-5.0%
- ■ 5.0%-5.5%
- ■ 5.5%-6.0%
- ■ 6.0%-6.5%
- ■ 6.5%-7.0%

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Recent Year of Birth Cohort Effects
The key questions...

Cause	What are the drivers of the more recent cohort effects?
	Inevitable post golden cohort hangover?
	Obesity? Diabetes? Alcohol? AIDS?
Relevance	Are they relevant for insured lives?
	- Does underwriting help?
	- Are they related to socio-economic class?
Persistence	Will they persist?
	- Is there age dependence?
	- Is there time dependence?

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Recent Year of Birth Cohort Effects
Obesity Prevalence

Male   *Female*

Source: Health Survey for England

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Recent Year of Birth Cohort Effects
Diabetes Prevalence

Male *Female*

Source: Health Survey for England

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Recent Year of Birth Cohort Effects
Heavy Drinking Prevalence

Male *Female*

Source: Health Survey for England

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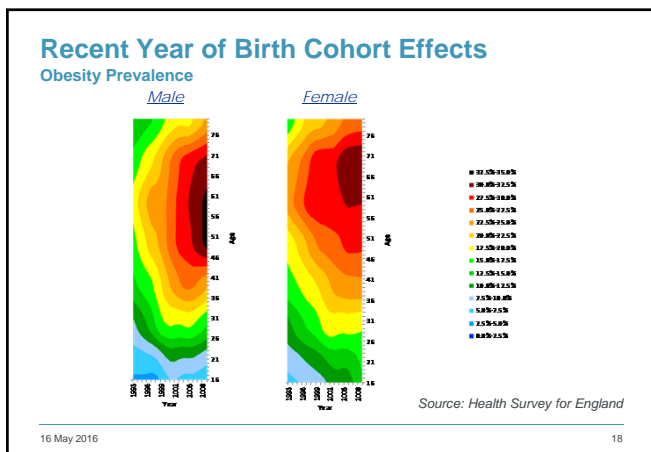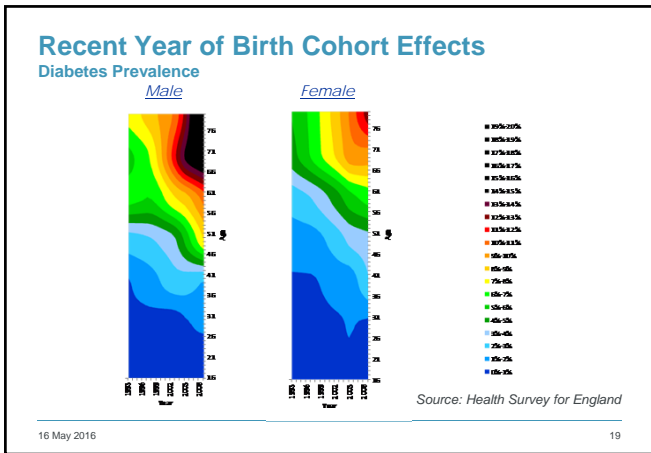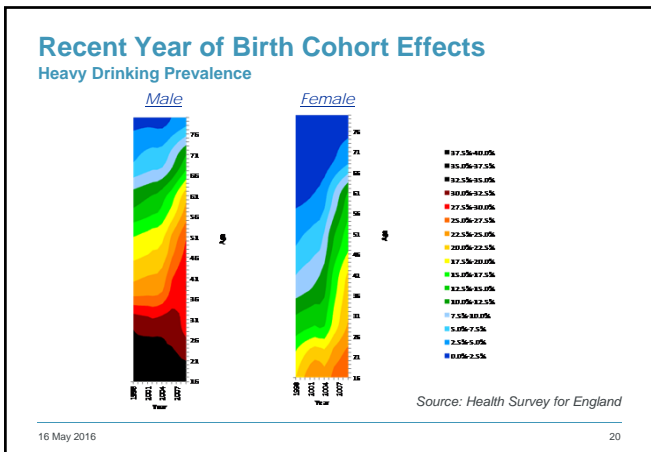
Recent Year of Birth Cohort Effects
AIDS Deaths

Proportion of male deaths associated with HIV/AIDs

Source: ONS & Health Protection Agency Data

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Recent Year of Birth Cohort Effects
Relevance for Insured Lives

Is this poor cohort of lives relevant for insured products?

No!	Yes!
Underwriting is protective	Not protective against weight <u>gain</u> We only apply ratings at certain cut-off BMI levels
Many of these trends may not be relevant for higher socio-economic classes	Trends by socio-economic class can work both ways
AIDS has now been managed successfully	
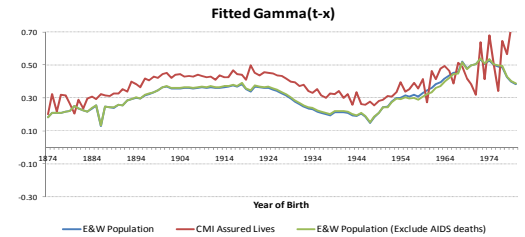
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Recent Year of Birth Cohort Effects
Relevance for Insured Lives

$$\log \mu(x,t) = a(x) + k(t) + \gamma(t-x)$$

Fitted Gamma(t-x)

Year of Birth

— E&W Population   — CMI Assured Lives   — E&W Population (Exclude AIDS deaths)
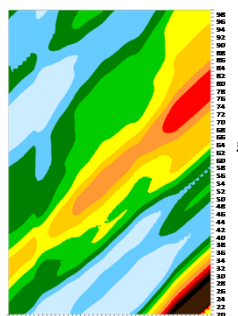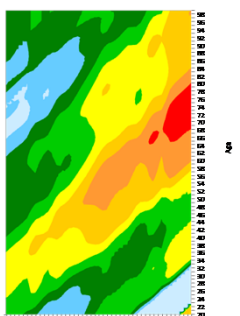
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Recent Year of Birth Cohort Effects
Relevance for Insured Lives

England & Wales Population   *CMI Assured Lives*

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The Impact of Smoking Cessation
Relevance for Insured Lives

Problem	We rate for smoking status but... Much of the historic improvements are associated with giving up
Data	Population data is not segregated by smoking status
Possible Solution	Develop a multi-state prevalence model and project separately for smokers and non-smokers
Impact	Ignoring movements in smoking prevalence will over-estimate mortality improvements

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Conclusions

Importance	This is a key assumption for term assurance business
Financial impact	It is not obvious that "longevity style" models will give lower liabilities
Cohort vs Period	Beware of models that don't consider cohort effects
Smoking	For insured lives we cannot give (much) credit for giving up smoking
Recent cohort effects	The extent to which these will persist is of course unknown
Basis Risk	Trends inferred from the population should be considered carefully

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Questions   Comments

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