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## CMI Income Protection Experience & new graduations

Duncan Heald, SCOR Global Life SE  
Mark Paulson, CMI Secretariat



16 May 2018

### Agenda

- CMI Income Protection Committee activity
- Analysis of experience by other factors
  - Benefit amount
  - Policy duration
- Graduation of 2003-2010 claim inceptions experience
  - Methodology and challenges
  - Practical examples
  - Draft graduations
- Future work



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## CMI Income Protection Committee

- Joan Coverson (Gen Re) – chair
- Jaimal Amin (Pacific Life Re)
- Duncan Heald (SCOR Global Life)
- Andrew Keeling (UNUM)
- Gerard Kennedy (Southampton University)
- Chean Khoon Low (Legal & General)
- Nelly Thieba (FCA)
- Jonathan Welsh (Wesleyan)
- David Wilkie (InQA)
- Mark Paulson (Secretariat)



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## IP Graduations Sub-Committee

- Joan Coverson (Gen Re) – chair
- Jaimal Amin (Pacific Life Re)
- **Duncan Heald (SCOR Global Life)**
- Andrew Keeling (UNUM)
- **Gerard Kennedy (Southampton University)**
- **Chean Khoon Low (Legal & General)**
- **Nelly Thieba (FCA)**
- **Jonathan Welsh (Wesleyan)**
- **David Wilkie (InQA)**
- Mark Paulson (Secretariat)



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## Income Protection Committee activity

Date	Activity
July 2010	IPM 1991-98 graduations finalised (WP48)
February 2012	Experience report for 2003-2006 (WP60) Summary statement of revised methodology (WP59)
April 2014	IP Rate Table Tool released to help practitioners make use of published graduations
April 2014	Report and database of experience by cause of sickness, 1991-2009 (WP72)
March 2017	Experience report for 2007-2010 (WP96)
August 2017	Report on 2003-2010 experience by benefit amount and policy duration (WP102)
June 2018	New inceptions graduations expected to be released for consultation
2019	New terminations graduations expected to be released for consultation



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## Data collection

- Seeking outstanding 2011-16 data in one batch, then return to regular reporting
- Outstanding data **urgently requested** within next month (i.e. June 2018)
- 2011-16 experience report targeted for August 2018
  - Very ambitious, to fit timescales of other CMI investigations
- Engagement exercise sought feedback from major data contributors
  - Flexible data format:  
<https://www.actuaries.org.uk/learn-and-develop/continuous-mortality-investigation/cmi-data>
- Hope to expand analysis to incorporate additional fields in future

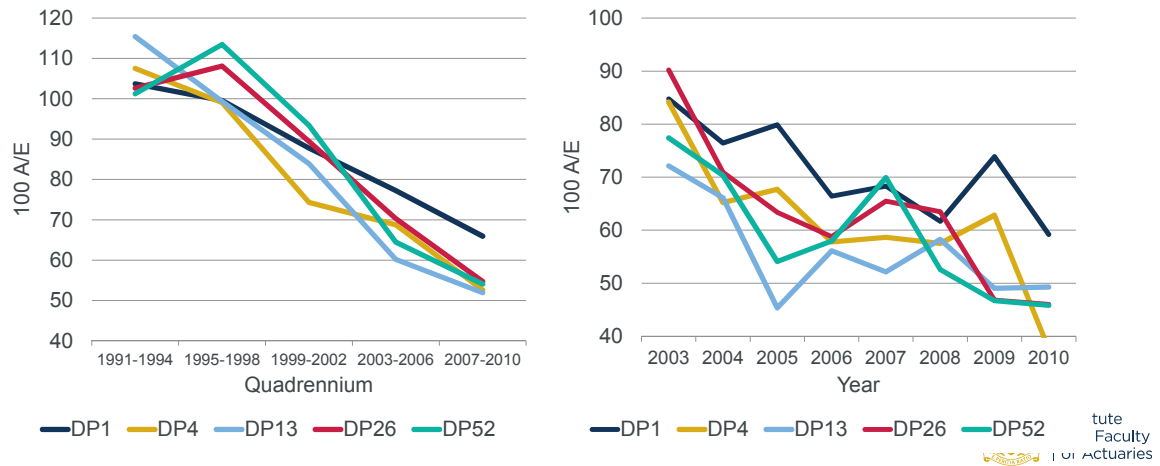


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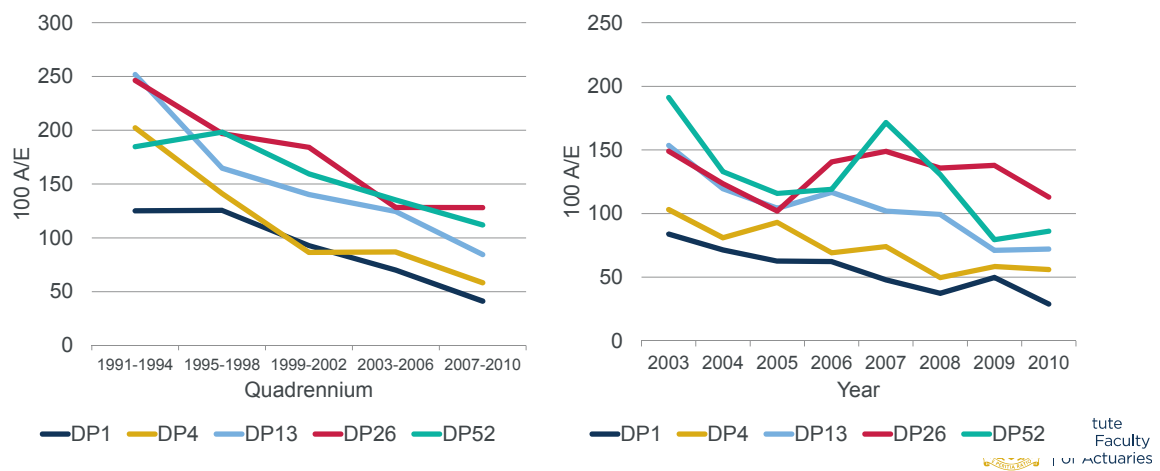
## Scene setting – experience by calendar year Inceptions – males (OC1)



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## Scene setting – experience by calendar year Inceptions – females (OC1)

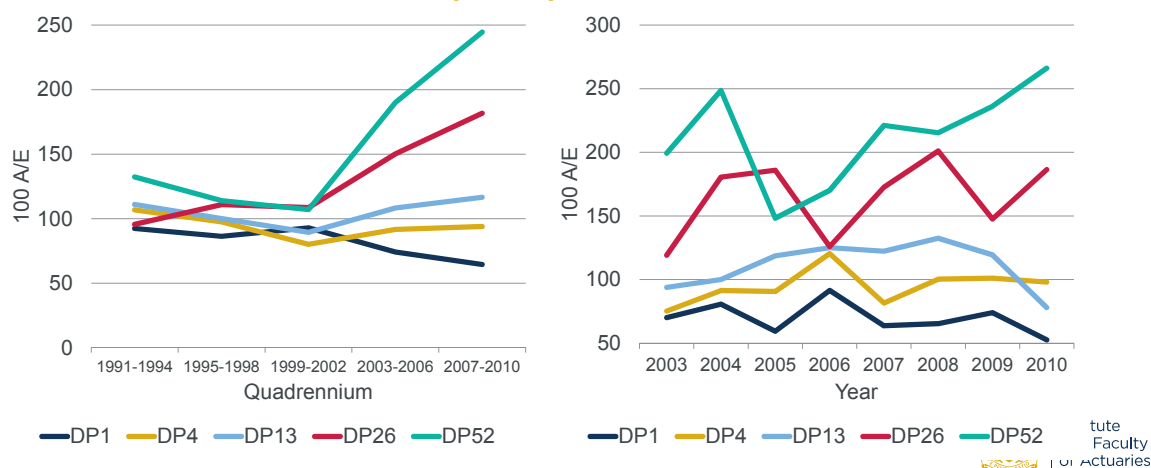


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## Scene setting – experience by calendar year

### Recoveries – females (OC1)



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## Experience in 2003-2010 by benefit amount and by policy duration

Expertise  
Sponsorship  
Thought leadership  
Progress  
Community  
Sessional Meetings  
Education  
Working parties  
Volunteering  
Research  
Shaping the future  
Networking  
Professional support  
Enterprise and risk  
Learned society  
Opportunity  
International profile  
Journals  
Supporting

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## Extending analyses to include other factors

Contained in regular analyses	Also available now	We would like in future
Calendar year	Benefit amount	Smoker status
Age	Benefit payment frequency	Distribution channel
Sex	Benefit rate percentage	Definition of sickness
Deferred period	Policy duration	Limited payment term?
Occupation class	Policy term	Benefit guarantee?
Sickness duration (terminations only)	Cause of sickness	



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## Extending analyses to include other factors

Contained in regular analyses	Also available now	We would like in future
Calendar year	<b>Benefit amount (WP102)</b>	Smoker status
Age	Benefit payment frequency	Distribution channel
Sex	Benefit rate percentage	Definition of sickness
Deferred period	<b>Policy duration (WP102)</b>	Limited payment term?
Occupation class	Policy term	Benefit guarantee?
Sickness duration (terminations only)	Cause of sickness (WP72)	



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## Analysis methodology

- Standard methodology (see WP59) applied to subsets of data
- For inceptions, duplicates removed only within each subset

### Benefit amount bands

Band	Initial annual amount
1	£0 - £5,000
2	£5,001 - £8,000
3	£8,001 - £12,000
4	£12,001 - £20,000
5	£20,001 +

- Spread data evenly
- Sum amounts for duplicate policies

### Policy duration groups

Duration (curtate years)
0
1
2 – 4
5 – 9
10 +

- Intuitive groupings, not evenly spread
- Take longest duration for duplicates
- Assume commence 1 July



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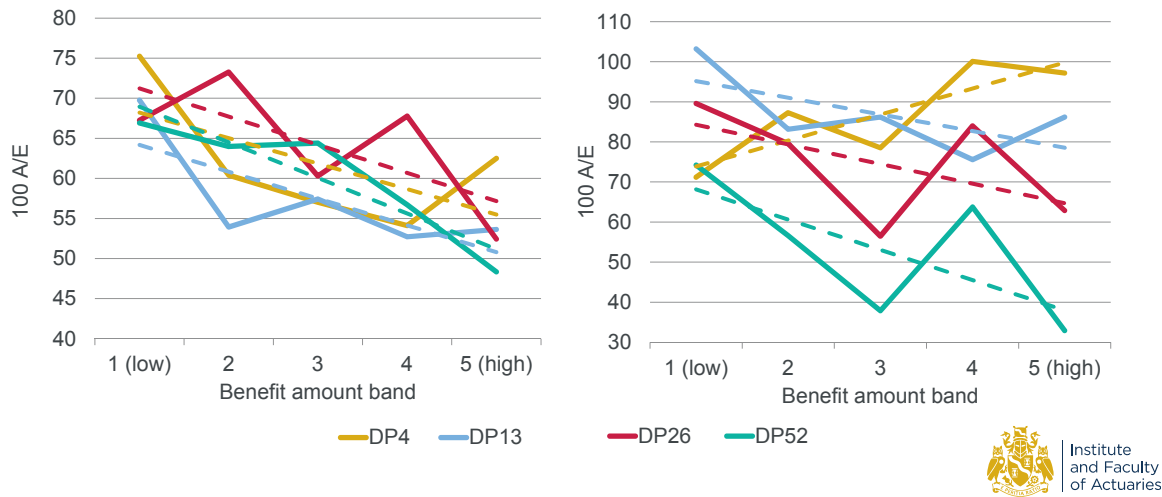
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## Results of experience by benefit amount band

Expertise  
Sponsorship  
Thought leadership  
Progress  
Community  
Sessional Meetings  
Education  
Working parties  
Volunteering  
Research  
Shaping the future  
Networking  
Professional support  
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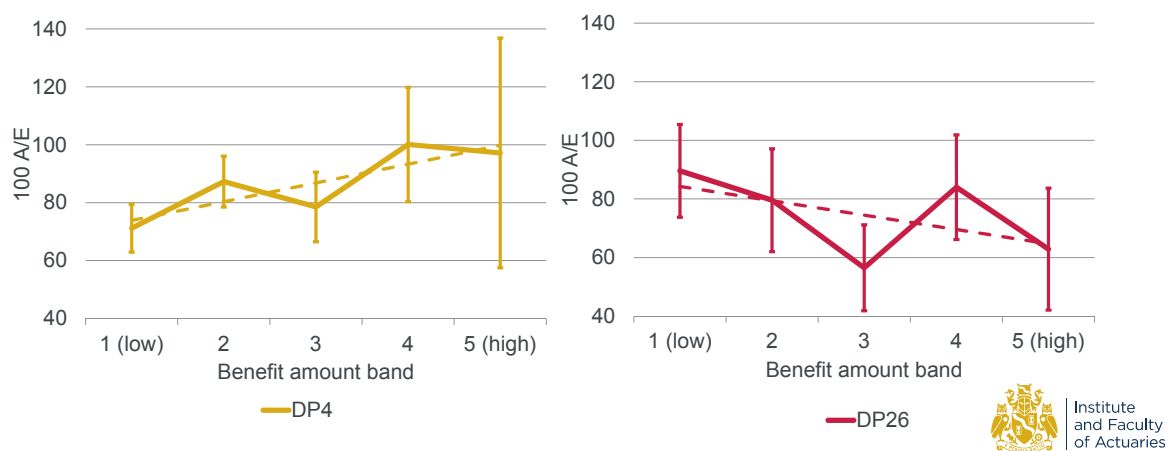
## Claim inceptions experience, males, OC1 (l), OCs2-4 (r)



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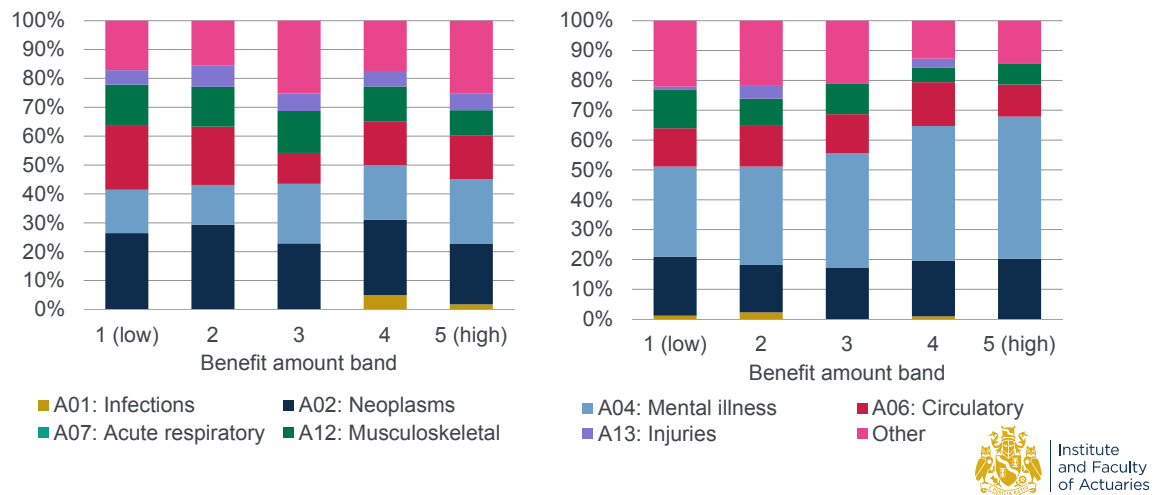
## Claim inceptions experience, males, OCs2-4



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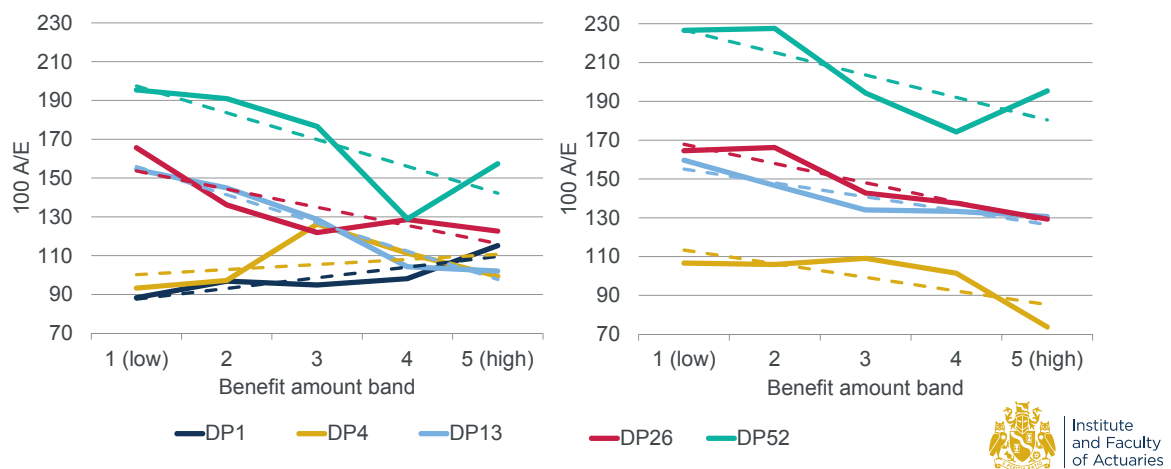
## Claim inceptions by cause, males, DP13 (left), DP52 (right)



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## Claimant recovery experience, males, OC1 (l), OCs2-4 (r)



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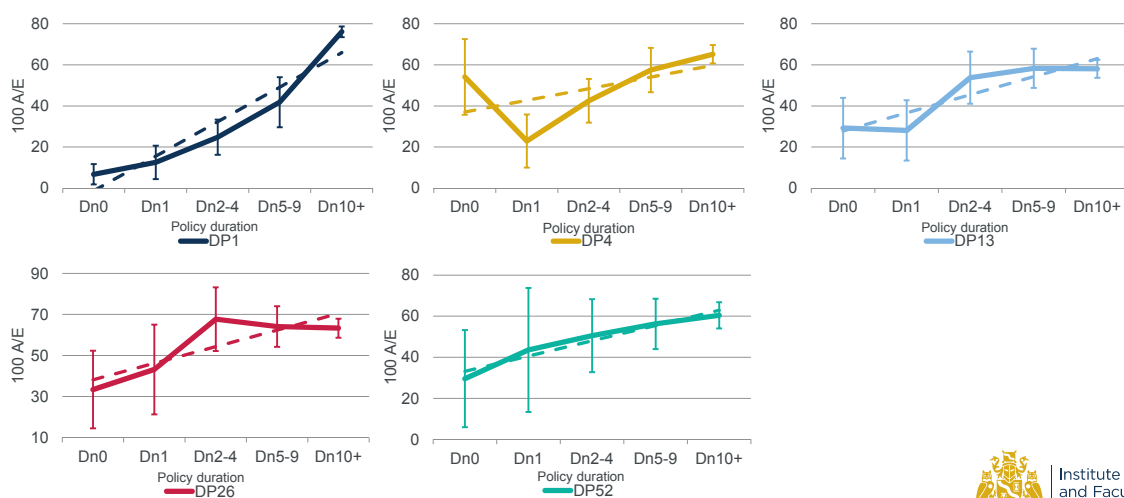
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## Results of experience by policy duration

Expertise  
Sponsorship  
Thought leadership  
Progress  
Community  
Sessional Meetings  
Education  
Working parties  
Volunteering  
Research  
Shaping the future  
Networking  
Professional support  
Enterprise and risk  
Learned society  
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### Claim inceptions experience, males, OC1

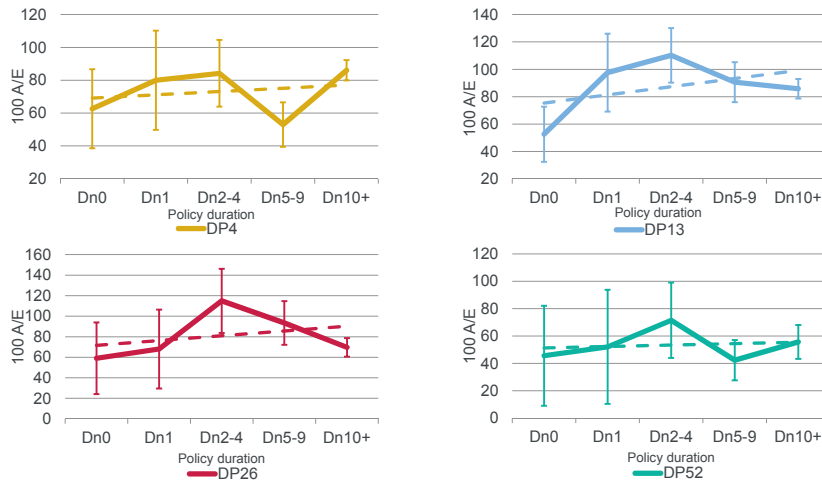


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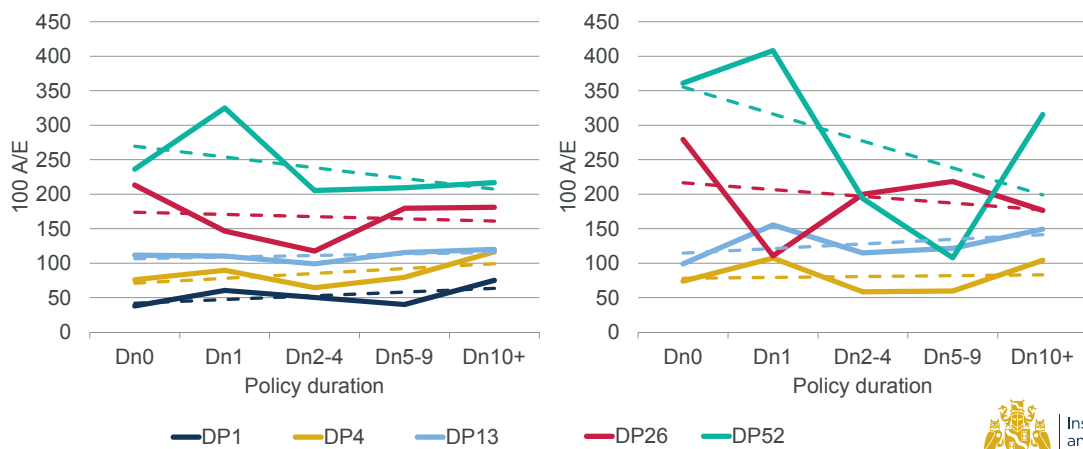
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## Claim inceptions experience, males, OCs2-4



## Claimant recovery experience, females, OC1 (left), OCs2-4 (right)



## Summary

Benefit amount	Policy duration
<b>Inceptions</b>	<b>Inceptions</b>
Males: lighter experience for larger amounts	Select effect ~50% OC1; less clear OCs2-4
Females: little impact	Effect lasts up to five years
<b>Recoveries</b>	<b>Recoveries</b>
Evidence of higher recovery rates for smaller amounts	Mixed/little impact

*Note: not all data subsets exhibit the above features*



## Graduation of experience, 2003-2010

Expertise  
Sponsorship  
Thought leadership  
Progress  
Community  
Sessional Meetings  
Education  
Working parties  
Volunteering  
Research  
Shaping the future  
Networking  
Professional support  
Enterprise and risk  
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Supporting

## Motivation

- IPM 1991-98 inception graduations released in July 2010 (WPs46-48)
  - Out of date
  - Covered males, OC1 only: limitation

- Inceptions experience has rapidly improved

e.g. 2007-2010 (males OC1):

DP1	DP4	DP13	DP26	DP52
66%	53%	52%	55%	54%

- Recoveries experience less different (esp. short DPs) so less pressing

e.g. 2007-2010 (males OC1):

DP1	DP4	DP13	DP26	DP52
103%	101%	107%	127%	172%



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## Data

	Exposure	Claim inceptions
<b>Males</b>	<b>2,468,059</b>	<b>11,195</b>
OC1	1,152,391	6,653
OC2	267,789	785
OC3	188,355	893
OC4	129,682	653
OC5	729,842	2,211
<b>Females</b>	<b>976,002</b>	<b>3,307</b>
OC1	487,205	2,000
OC2	106,194	363
OC3	49,652	108
OC4	10,236	25
OC5	322,716	811
<b>Total</b>	<b>3,444,062</b>	<b>14,502</b>

- Eight years' data improves credibility

- 48% of exposure from OC1

- 72% of exposure from males

But:

- In 1991-98 this was more like 60%/85%

- Users require rates for both genders and all occupation classes



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## Sickness rates or claim rates?

### Sickness rates

- Traditional CMI approach (used in IPM 1991-98)
- Combined with termination rates to derive claim rates

### Claim rates

- Used by practitioners
- Do not require termination rates

We have chosen to graduate **claim rates**:

- Minor modification to exposure methodology, no longer allowing for sicknesses that do not become claims
- Age still defined at date of sickness



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## Methodology

- Graduating claim inception rates similar to graduating mortality rates
- Used CMI Graduation Software (WP77)
  - Gompertz, G(s) / Gompertz-Makeham, GM(r,s) / Co-graduation, Co(a,b) / GLM
- Generalised linear models (GLM) 'borrow strength'
  - Enabled us to graduate data for females and smaller occupation classes

$$\log(\mu_g) = \sum_{i=1}^s a_i \cdot D_i(g)$$

- Graduate all data together – but with DPs split – so that, e.g.
  - Male and female data combined used to determine effect of occupation classes
  - Occupation class data combined used to determine effect of being male/female



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## Challenges

- Calendar year – improvement throughout period but no more recent data
  - Chose not to reflect in main graduations but working paper will demonstrate impact
- DP52 – rates did not conform to natural order of occupation classes
  - But OC was not a statistically significant factor for this DP so chose to drop
- OC5 (unknown) – mixture of other OCs; mix changes over time
  - Rates shouldn't be needed by users in practice
  - Chose not to graduate data from this class
- Female OC4 (in particular) – very little data
  - GLM allows us to produce reasonable rates



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## Model selection

Step-wise approach for each deferred period separately:

1. Consider model incorporating “intercept” and each first-order factor in turn
  - e.g.  $\text{Rate} \sim \text{Intercept}$  or  $\text{Rate} \sim \text{Age}$  or  $\text{Rate} \sim \text{Sex}$  or  $\text{Rate} \sim \text{OC}$
2. Select whichever gives the best fit
  - Primary test statistic = AIC (others = BIC, Deviance, K-S, Signs test, Runs test)
3. Test model with an additional factor
  - e.g.  $\text{Rate} \sim \text{Intercept} + \text{Age}$  or  $\text{Rate} \sim \text{Intercept} + \text{Sex}$  or  $\text{Rate} \sim \text{Intercept} + \text{OC}$
4. Repeat iteratively, continue until the test statistics no longer improve
  - i.e. the improved fit does not outweigh the ‘cost’ of an extra parameter



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## Model selection

Note, we allow:

- Polynomials in continuous factors (age), e.g.  $\text{Rate} \sim \text{Age} + \text{Age}^2 + \text{Age}^3$
- Interactions between factors, e.g.  $\text{Rate} \sim \text{Age} + \text{Sex} + \text{Age} * \text{Sex}$   
(representing a different rate of change by age for each sex)

### 5. Chosen models visually inspected to ensure undesirable features avoided

- Rates should increase with age
- Rates should go through 'gates' at majority of ages
- Rates provide sensible extrapolations to age 70

### 6. Checked fit reasonable for each 'unit' (Sex/DP/OC combination)



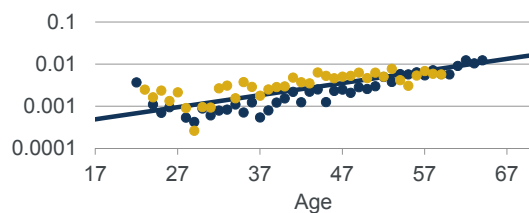
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## Example – DP13

- Intercept + Age  $\text{AIC} = 549.0568$



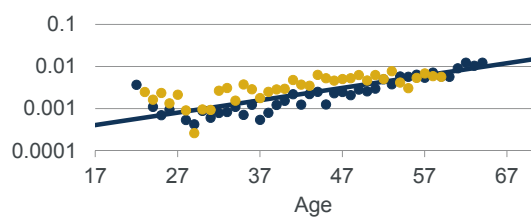
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## Example – DP13

- Intercept + Age      AIC = 549.0568
- Intercept + Age + OC      AIC = 475.3109



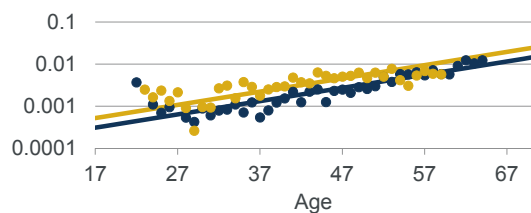
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## Example – DP13

- Intercept + Age      AIC = 549.0568
- Intercept + Age + OC      AIC = 475.3109
- Intercept + Age + OC + Sex      AIC = 387.3644



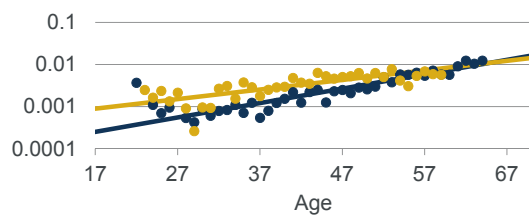
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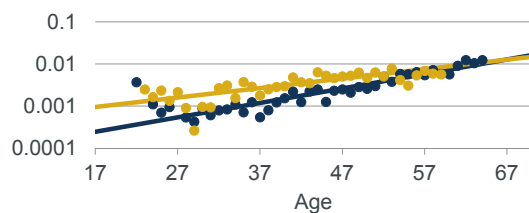
## Example – DP13

- Intercept + Age       $AIC = 549.0568$
- Intercept + Age + OC       $AIC = 475.3109$
- Intercept + Age + OC + Sex       $AIC = 387.3644$
- Intercept + Age + OC + Sex + Age\*Sex       $AIC = 366.5855$

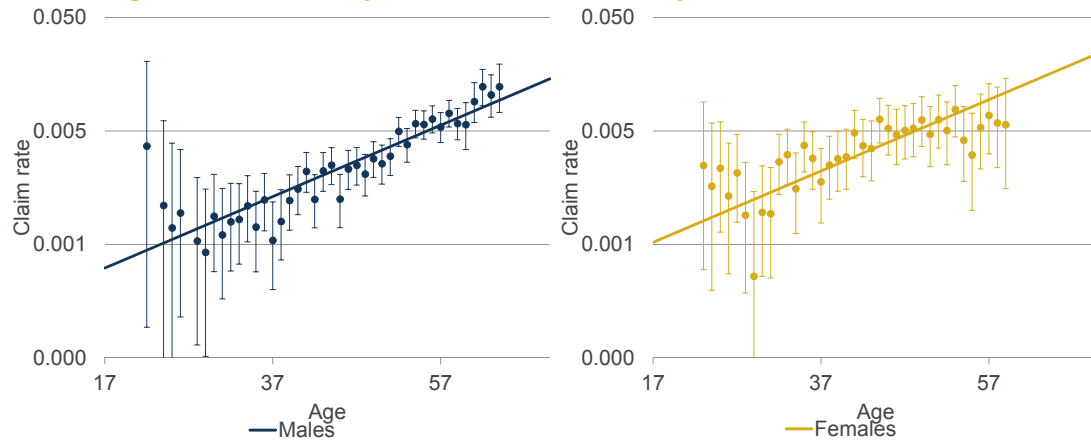


## Example – DP13

- Intercept + Age       $AIC = 549.0568$
- Intercept + Age + OC       $AIC = 475.3109$
- Intercept + Age + OC + Sex       $AIC = 387.3644$
- Intercept + Age + OC + Sex + Age\*Sex       $AIC = 366.5855$
- Intercept + Age + OC + Sex + Age\*Sex + OC\*Sex       $AIC = 362.6045$



## Example – DP13 (no interactions)



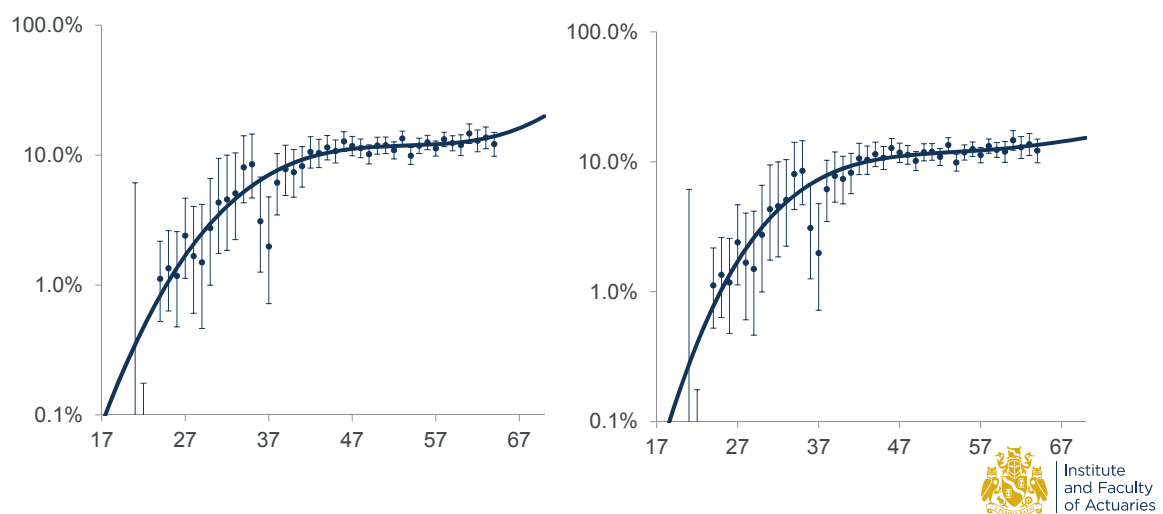
## Example – DP13 (no interactions)

Males, CMI Occupation Class 1					
Summary of experience by Deferred Period					
Deferred Period	DP 1	DP 4	DP 13	DP 26	DP 52
$100 \times A/E$					
All ages	100	100	98	100	101
By age group:					
17 - 19	-	↓	↓	↓	↓
20 - 24	94	148	↓	↓	↓
25 - 29	101	82	83	96	↓
30 - 34	116	113	91	96	98
35 - 39	76	85	68	94	81
40 - 44	103	94	102	82	84
45 - 49	102	87	80	105	95
50 - 54	99	109	102	115	119
55 - 59	100	111	109	107	110
60 - 64	100	87	120	74	64

## Example – DP13 (with Age\*Sex interaction)

Males, CMI Occupation Class 1					
Summary of experience by Deferred Period					
Deferred Period	DP 1	DP 4	DP 13	DP 26	DP 52
$100 \times A/E$					
All ages	100	100	98	100	101
By age group:					
17 - 19	-	↓	↓	↓	↓
20 - 24	94	148	↓	↓	↓
25 - 29	101	82	95	96	↓
30 - 34	116	113	102	96	98
35 - 39	76	85	74	94	81
40 - 44	103	94	107	82	84
45 - 49	102	87	82	105	95
50 - 54	99	109	100	115	119
55 - 59	100	111	104	107	110
60 - 64	100	87	111	74	64

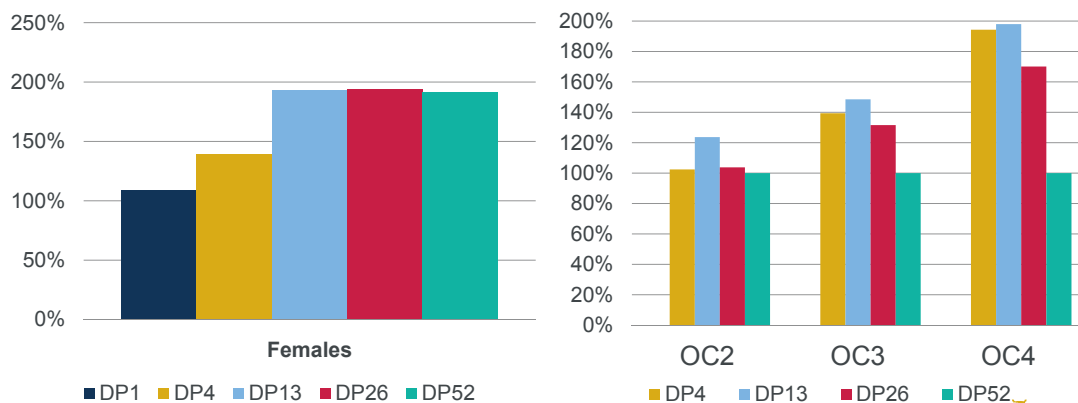
## Example – DP1: cubic (left) vs quartic (right) (males)



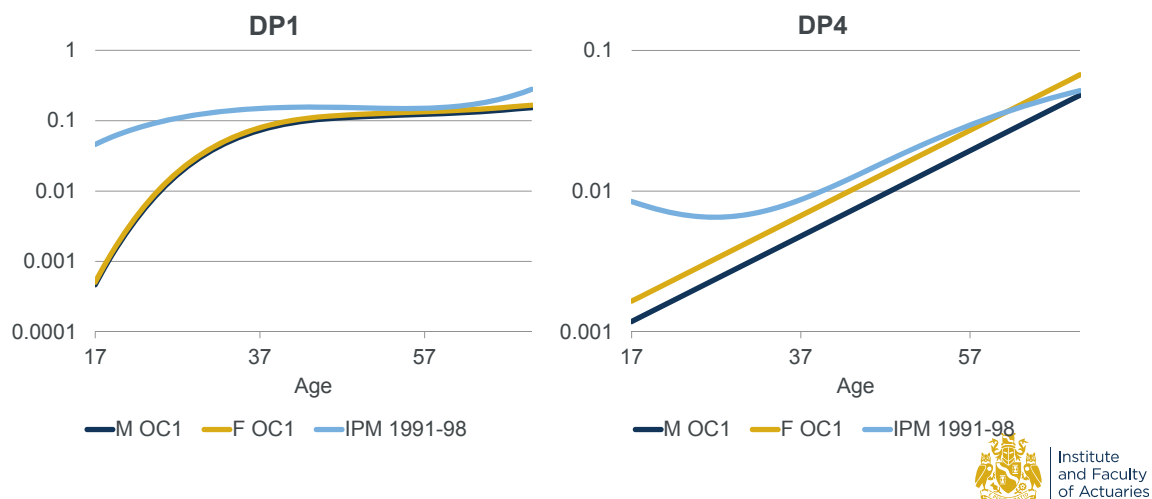
## Chosen models – summary

Deferred period	Model
DP1	Intercept + Age (quartic) + Sex
DP4	Intercept + Age (linear) + Sex + OC
DP13	Intercept + Age (linear) + Sex + OC + Age*Sex
DP26	Intercept + Age (linear) + Sex + OC
DP52	Intercept + Age (quadratic) + Sex

## Fitted rates – multiplicative factors (vs males/OC1)



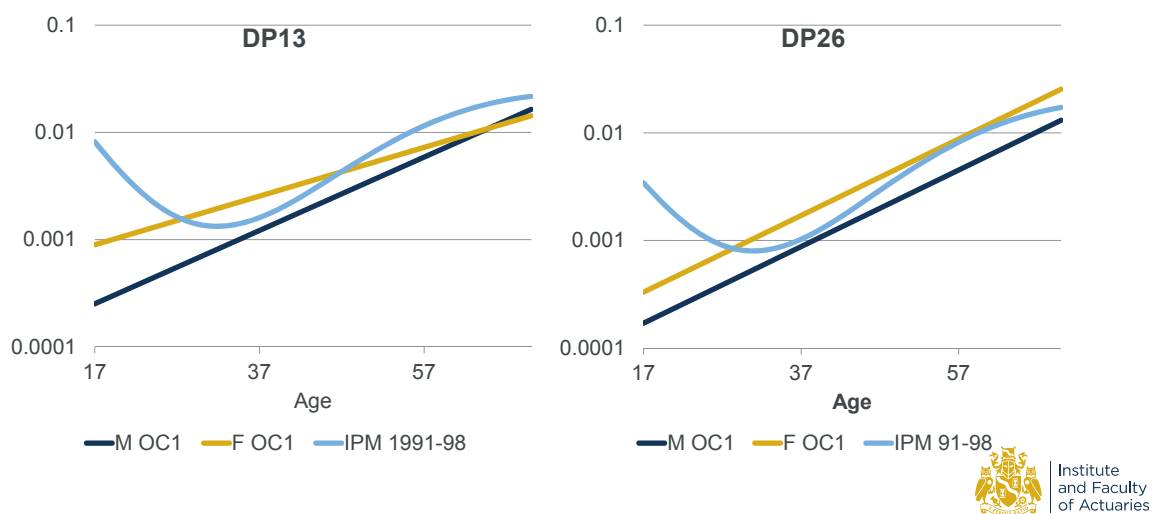
## Draft graduations – comparison with IPM 1991-98



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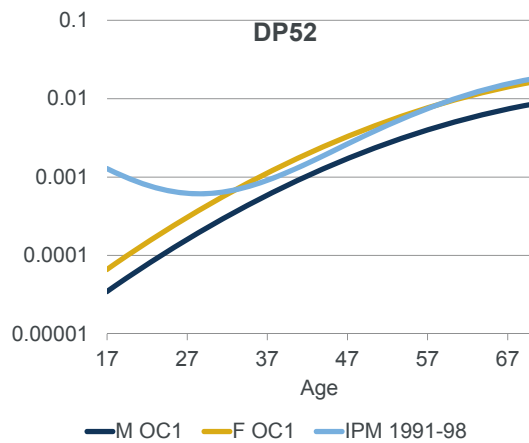
## Draft graduations – comparison with IPM 1991-98



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## Draft graduations – comparison with IPM 1991-98



## Future work

- Complete inception graduations, release consultation working paper
- Terminations graduations – need to develop methodology
- 2011-16 “all-offices” experience report
- Continuing to review analysis methodology
  - Reflect revised definitions of exposure and claim events in our systems
  - Further refinements, e.g. to duplicates
  - Incorporate additional data fields



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## Elsewhere in the CMI

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## CMI Assurances Committee activity

Date	Activity
December 2014	Experience report for 2007-2010 (WP75)
May 2016	Proposed "08" Series accelerated critical illness tables released for consultation (WP89)
October 2016	Proposed "08" Series term assurance mortality tables released for consultation (WP92)
January 2017	Final "08" Series accelerated critical illness and term mortality tables released (WP94)
October 2017 – April 2018	Processing data submissions for 2011-2016
May 2018	Experience report for 2011-2015 and survey on future data collection / analyses
July 2018	"Guidance" on using the CMI Model for term assurances
30 Sept 2018	Target date for data submissions to 2017
Feb 2019	Experience report for 2011-2017

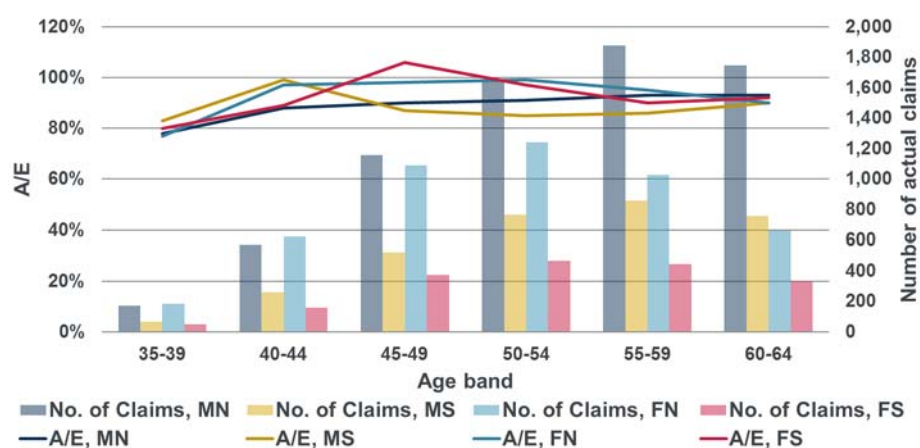


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## Mortality term assurances – draft experience 2011-2015



Durations 5+ only

Expected calculated using TMNL08/TFNL08 without improvements



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**Questions**

**Comments**

The views expressed in this presentation are those of the presenter.

Please send any questions, views or feedback to

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