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Constructing Lapse Stress Scenarios

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Section B4, Monday 11 November 2013

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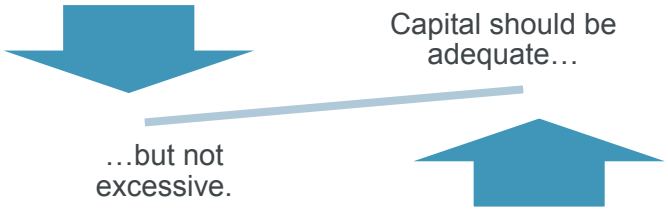
Lapse Risk Modelling

Setting the scene

What does the business need from it's model?

The lapse risk model is primarily used to set economic capital requirements, and is vital for many aspects of decision making



This is harder for demographic risks such as lapse risks for a number of reasons.

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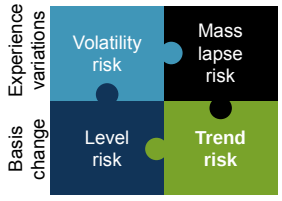
Lapse Risk Components

A one-year value-at-risk calculation involves a projection of profits over the coming year. The impact on profits due to persistency risk can be separated into two types:

- *Experience variation:* Experience during the year is higher or lower than expected
- *Basis change:* The technical provision at the end of the year is based on a future assumed basis that is higher or lower than the basis assumed at the start of the year

The following table lists four components commonly seen in lapse risk models:

Type	Component	Description – Risk arising from…
Experience variation	Volatility risk	Statistical fluctuations of experience around expected assumptions
	Mass lapse risk	One-off spike in experience due to an identifiable event
Basis change	Level risk	Re-evaluation of the level of future decrements in the valuation basis
	Trend risk	Re-evaluation of the time trends in the valuation basis



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The Data Challenges

Completeness	Adequacy	Appropriateness
• Did we record actual lapses, experience against expectation or both? • Has our experience monitoring approach remained consistent over time? • Did we record our experience at the level of granularity required to assess risk by the risk drivers that interest us?	• We may only have 10 years worth of experience • Is this really sufficient to set a 1 in 200 capital requirement? • How relevant is experience data from historical commercial and regulatory environments to today's world?	• Product designs and sales practice are constantly evolving. • Our experience today may be relevant to the products we sold 5 years ago, but what about the products we sell today? • We could get external or industry data, but how relevant is this to our own business?

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Solvency II Raises the Bar

Statistical Quality Standards

- These standards help to remove subjectivity from our models
- They also introduce a barrier to expert judgement
- And may encourage spurious accuracy

Mass Lapse

- The Standard Formula treats mass lapse events as a separate risk
- This sets a precedent for our internal models
- We must be aware of the potential double count.
- Q: what is our expected rate of "mass lapse"?

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Use of Scenarios

- Scenario analysis is a common approach to calibrating risk distributions using expert judgement, and is particularly useful in assessing tail risks where data is limited.
- A scenario is a hypothetical event, which can be described in sufficient detail to allow a robust estimate of the financial cost to be determined.
- To be useful, we must be able to also estimate the probability of this event (or one as least as severe) occurring. Often this is the weak link.

• Scenarios are commonly used to assess mass lapse risk
• However not always in a manner which is clearly consistent with other parts of the distribution.

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So what does this all mean?

- Many of these issues will be familiar to those concerned with modelling and understanding lapse risks.
- Many of these issues will already have been confronted by those responsible for calibrating and validating internal models
- However how much comfort do we really have that our models provide a realistic assessment of our risk exposure?

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Stress Tests derived from FSA Persistency Study

FSA Persistency Survey 2012

Single Premium

Anniversary Start year	0	1	2	3	4
1998	1000	987	966	933	906
1999	1000	989	966	938	906
2000	1000	987	965	932	894
2001	1000	987	964	929	870
2002	1000	983	953	892	836
2003	1000	975	950	909	865
2004	1000	981	946	908	856
2005	1000	976	949	901	843
2006	1000	971	937	895	841
2007	1000	976	940	896	855
2008	1000	972	939	901	
2009	1000	976	949		
2010	1000	980			

RP – Tied Agent

Anniversary Start year	0	1	2	3	4
1998	1000	899	811	720	630
1999	1000	894	790	685	583
2000	1000	879	762	648	561
2001	1000	869	742	635	550
2002	1000	877	777	645	569
2003	1000	885	737	648	465
2004	1000	883	771	646	517
2005	1000	885	784	710	622
2006	1000	893	799	688	582
2007	1000	897	781	669	574
2008	1000	889	798	695	
2009	1000	903	829		
2010	1000	876			

RP – IFA

Anniversary Start year	0	1	2	3	4
1998	1000	918	829	744	663
1999	1000	915	811	715	638
2000	1000	879	758	666	567
2001	1000	866	765	638	548
2002	1000	881	742	640	554
2003	1000	860	748	640	551
2004	1000	849	720	605	530
2005	1000	856	733	620	518
2006	1000	863	737	607	523
2007	1000	865	711	612	518
2008	1000	830	715	590	
2009	1000	854	713		
2010	1000	856			

The study contains numerous other data sets, but there are concerns over accuracy (for example, negative lapse rates).

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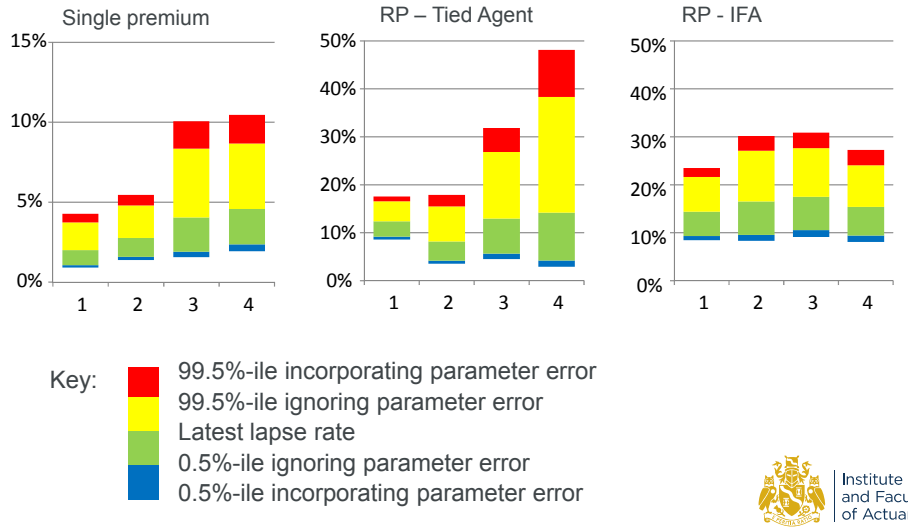
Stress Test Construction



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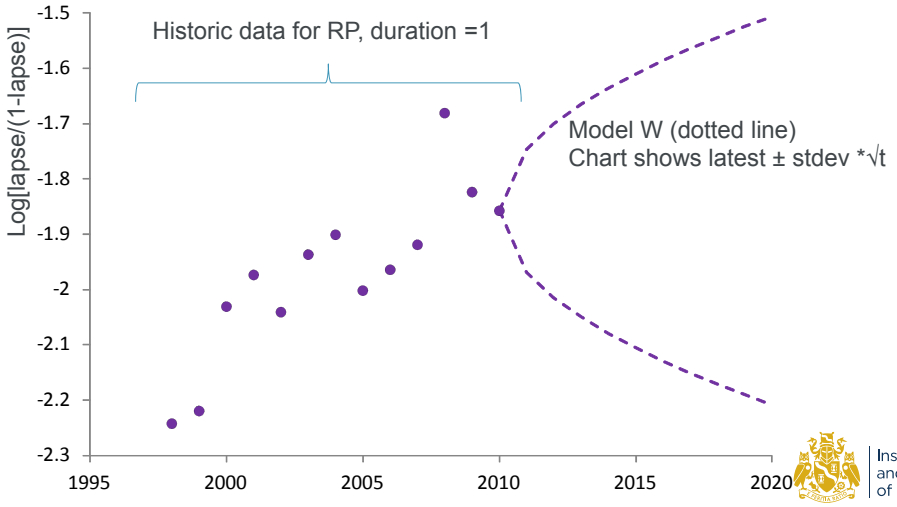
Forecasts based on Random Walk (Model W)



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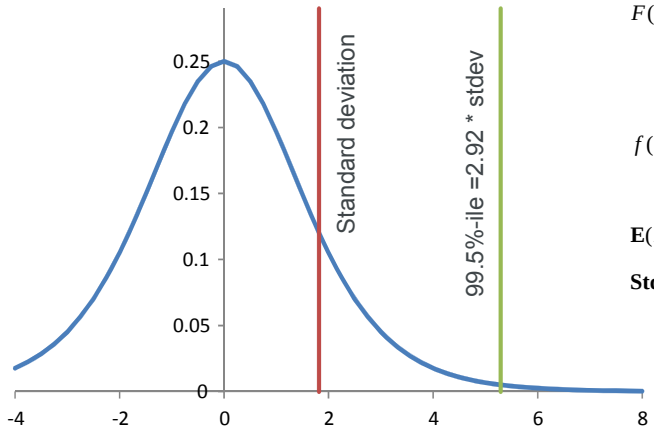
Assume Logistic Distribution for Increments



$$F(x) = \frac{1}{1+\exp\left(-\frac{x}{\beta}\right)}$$

$$f(x) = \frac{\exp\left(\frac{x}{\beta}\right)}{\beta\left\{1+\exp\left(\frac{x}{\beta}\right)\right\}^2}$$

$$\mathbf{E}(X) = 0$$

$$\mathbf{Stdev}(X) = \frac{\pi\beta}{\sqrt{3}}$$

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Some Unrealistic Assumptions

Assumption	Response
Log[lapse rate / (1-lapse rate)] performs a random walk	???
Increments have a logistic distribution	???
Sample standard deviation is a good way to measure dispersion of a logistic distribution.	???
We know the standard deviation of the increments	???
The same model applies to the future as to the past	???

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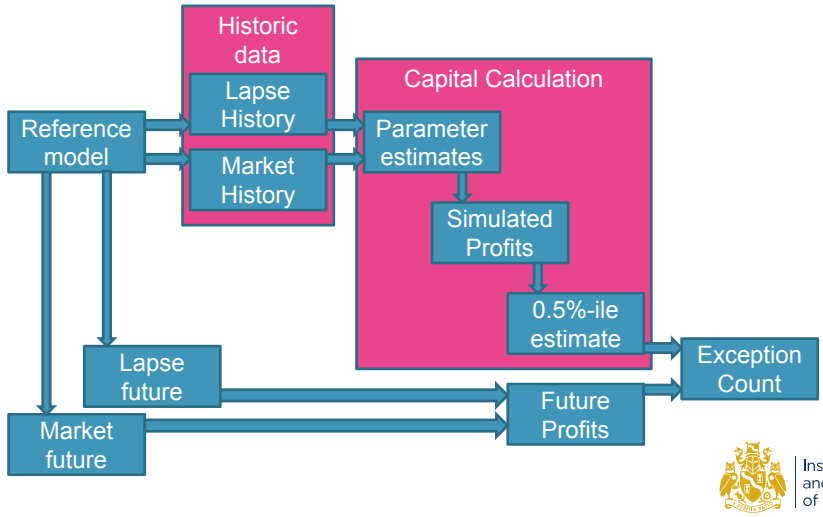
Allowing for Parameter and Model Error

The Prediction Test



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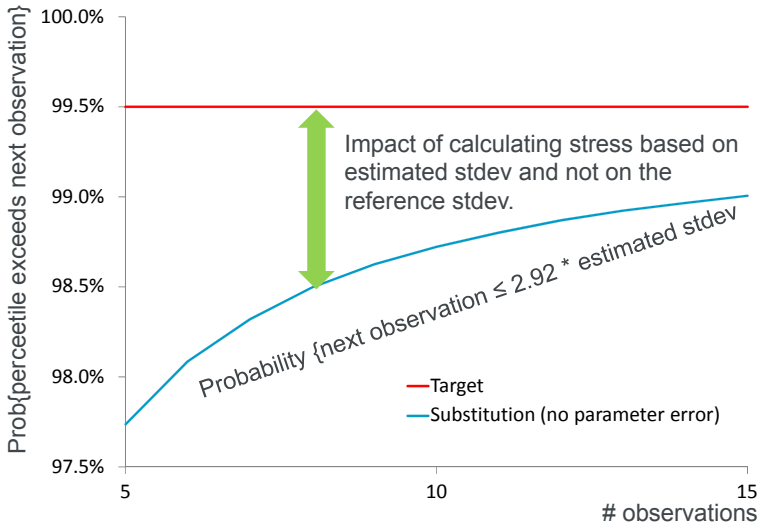
Prediction Test Results: Substitution Method



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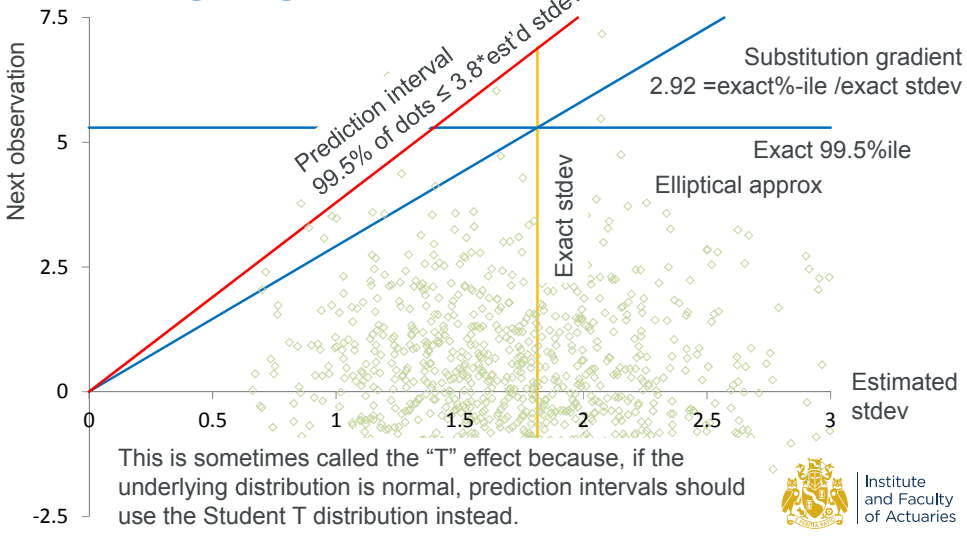
What is going on?



This is sometimes called the "T" effect because, if the underlying distribution is normal, prediction intervals should use the Student T distribution instead.

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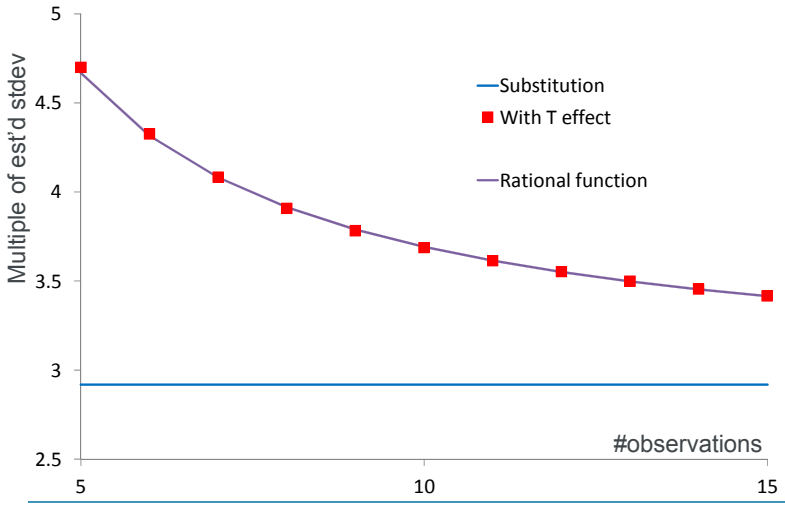
The T effect Disappears for Large Samples



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Elliptical Approximation to the "T Effect"

Allowance for estimation error and bias:

$$\text{Prediction interval} \approx \frac{1}{\sqrt{(1+\beta)^2-(\gamma+\beta)^2}} \cdot \frac{\text{Exact percentile}}{\text{Exact stdev}}$$

Where:
Expected estimated stdev = (1+β) * exact stdev
0.5%-ile estimated stdev = (1-γ) * exact stdev

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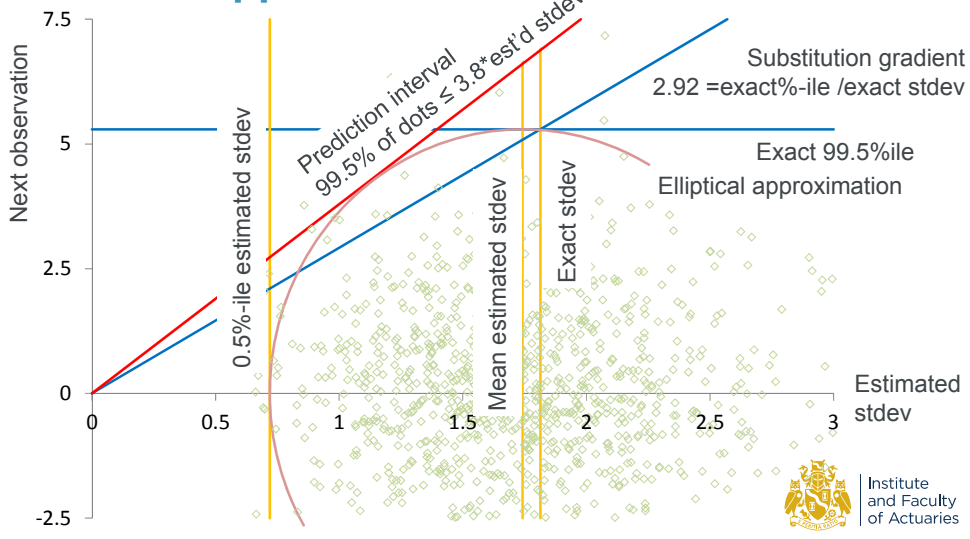
How the Approximation Works



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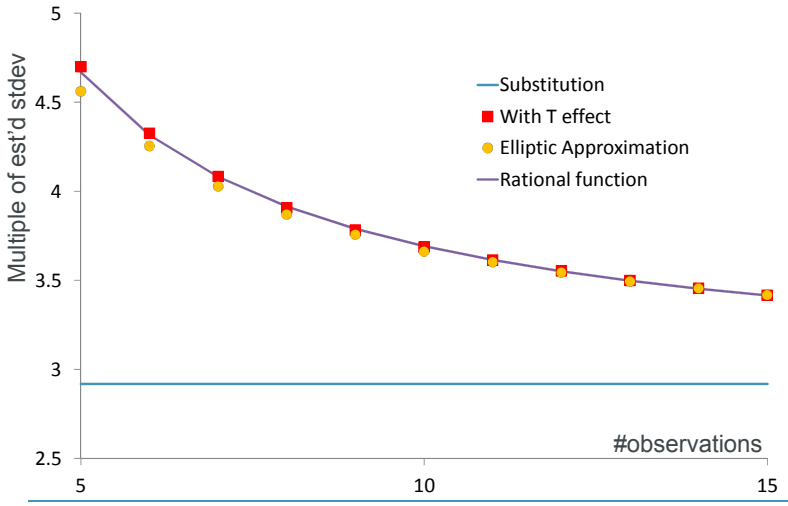
How Good is the Approximation?



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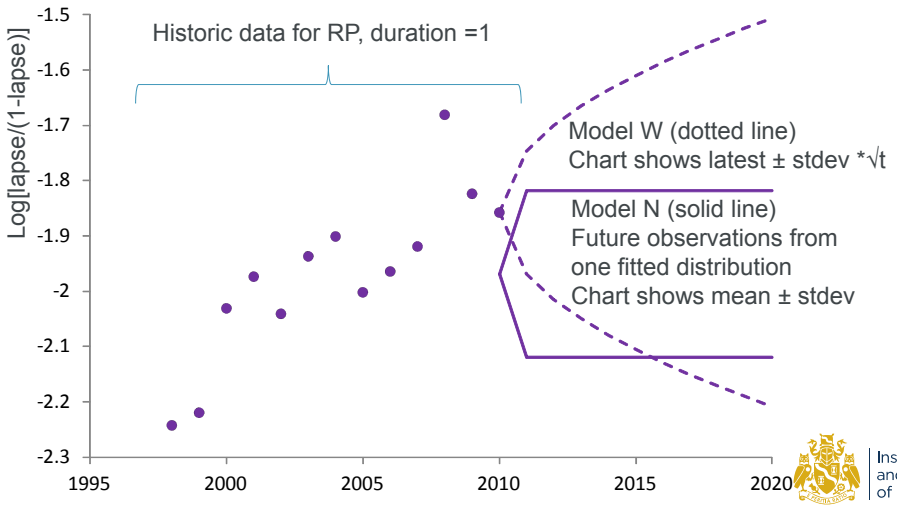
Alternative Models: Noise & Walk



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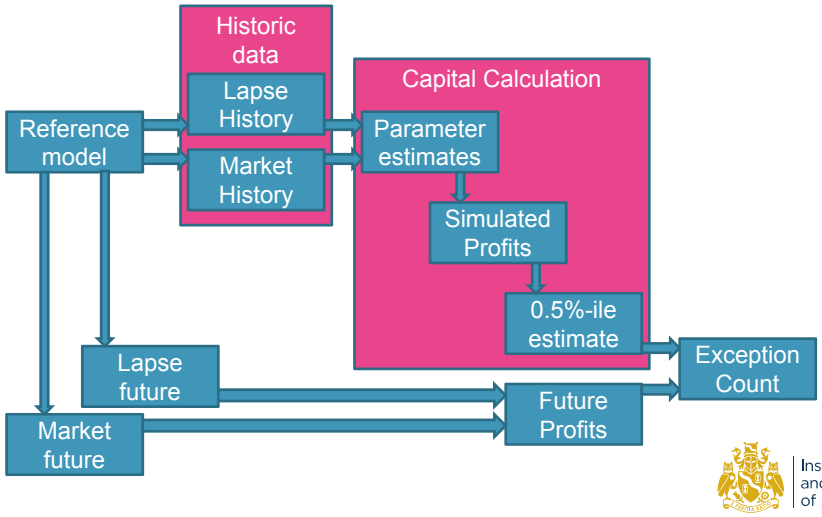
Testing Alternative Models



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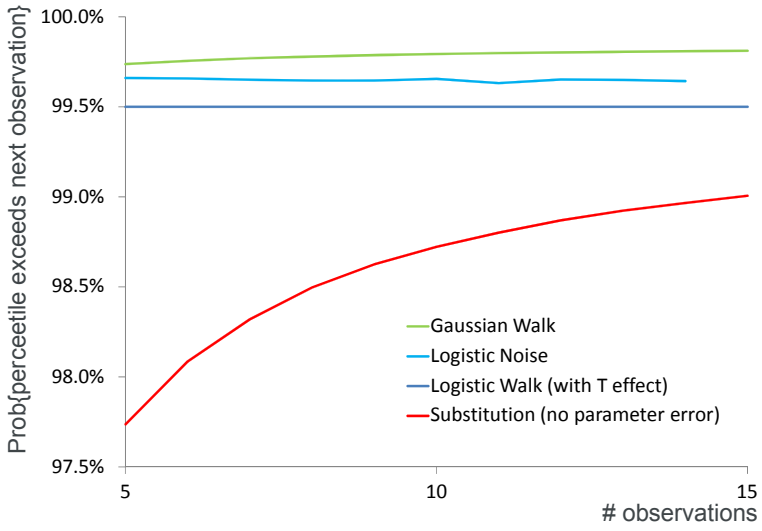
Robustness Impact of Mis-specified Models



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Unrealistic Assumptions Revisited

Assumption	Response
Log[lapse rate / (1-lapse rate)] performs a random walk	Prediction interval is cautious if the lapse rates are independent.
Increments have a logistic distribution	Prediction interval is cautious if we assume normal distributions instead,
Sample standard deviation is a good way to measure dispersion of a logistic distribution.	The prediction test is evidence that the method works; how we derived the estimates is irrelevant.
We know the standard deviation of the increments	Use a larger multiple of estimated standard deviation
The same model applies to the future as to the past	You cannot get rid of all limitations and exclusions with clever statistics.

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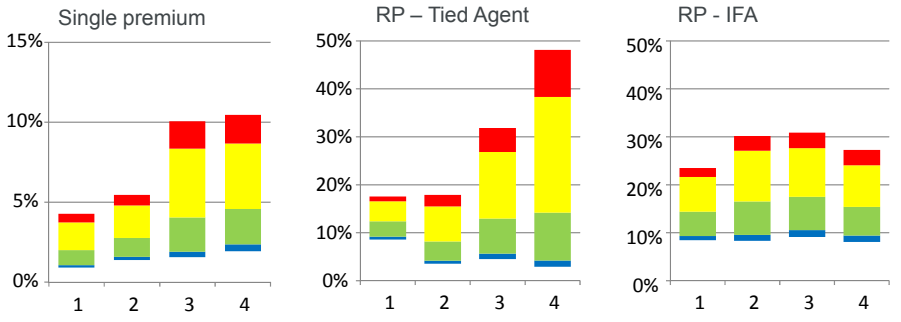
And Here are the Answers!



Key:

- 99.5%-ile incorporating parameter error
- 99.5%-ile ignoring parameter error
- Latest lapse rate
- 0.5%-ile ignoring parameter error
- 0.5%-ile incorporating parameter error

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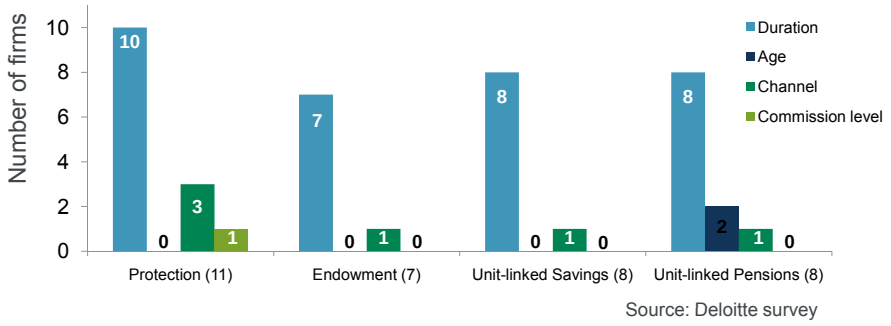
Choice of Product Level of Detail

Detail of Best Estimate Assumptions



Source: Deloitte survey

Question: At what level of detail (how many risk drivers) should lapse stresses be modelled?

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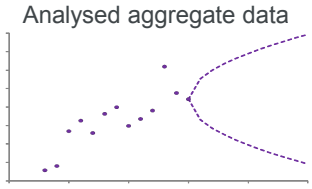
Aggregating Historic Data

Raw lapse rates

- Lapse count
- In-force count

Need to eliminate spurious trends due to changing business mix



Possible weights for lapse analysis

- Current basis — P/L based on outcome vs basis. So best to weight by basis at year start
- Constant basis — Avoid data jumps from basis change. So weight using a single basis.
- Unit impact — Apply greater weight to products and duration with greatest £ impact.

Product × duration × distribution

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Risk of a Level Shift in the Basis

The level risk driver represents the basis change over a one year time horizon.

A natural starting point is to estimating future basis changes based on past basis changes.

- Best estimate changes may not be an appropriate starting point for modelling basis changes when historic basis changes do not reflect changes in best estimates, e.g. there may be some prudence built into assumptions especially in a new market where there is little experience for analysis.

Possible Approach

- Estimate future basis changes based on theoretical constructed future bases. These reconstructed basis should be designed to behave more closely to the logical behaviour of best estimates. This approach aims at replicating how an actuary may set the basis given one year's worth of new experience.
- Model: Use fitted model of volatility risk and take a proportion through as basis change, e.g.

  Basis(t+1) = 1/3 of actual(t) + 2/3 of basis(t)

- The basis(t) is known and does not add variability. The only new information is the actual(t) which could alter the view on the best estimate in a year's time.

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Conclusions

Conclusions

- Solvency II raises the bar in terms of data quality for lapse risk analysis.
- Many firms derive stress tests based on statistical analysis of their own lapse experience.
- Model and parameter error are material – and can be as large as the modelled stochastic error, especially when few data points are available.
- Is mass lapse capturing the same risk as a model / parameter error shock?
- Take care when translating one-year experience outcomes into basis changes to ensure all risks are captured.

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