Institute
and Faculty
of Actuaries

Measuring uncertainty beyond "Bootstrap"

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Beyond "Bootstrap"

Definition of "Bootstrap" - triangle techniques based on chain ladder, such as Mack or ODP bootstrap
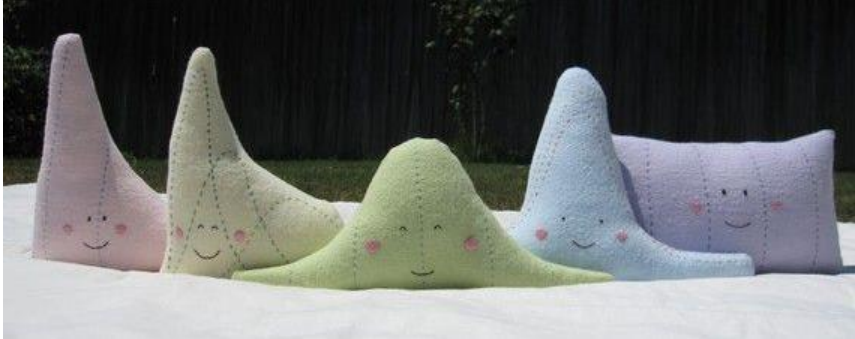
A limited measure

The past is not necessarily a good guide to the future

Beyond "Bootstrap"

Is it realistic to define a distribution of outcomes at all?

MUQ (Measuring Uncertainty Qualitatively)
Stage 1: Bring together work that has done before into one place

Framework

Alternative approaches

Measuring uncertainty beyond "Bootstrap"

Framework elements
- Data uncertainty
- Expert judgement
- Effectiveness of methods
- Reserve risk appetite

Alternative approaches
- Models for aggregate triangles
- Individual claims reserving
- Interaction with capital models

Data uncertainty – matrix

- Data problems we often hear…

  | We've had a big change in our claims handling process | We just have the bordereaux available for that class | We had a few missing case estimates at year-end | The only triangle we have is net paid |

- One example of data uncertainty matrix currently in use:

Data Uncertainty by reserving class (count)		Data quality					
		Poor	Below average	Average	Above average	Excellent	Total
By class (number)	Low (<£5m)	2		2	7		11
Materiality (Reserve £m)	Mid (£5m to £20m)	1			3	2	6
	High (£25m+)			3	12		15
	Total	3	0	5	22	2	32

- A more detailed measure? As the level of data quality can be an aggregate effect of many other factors: location, measurability, nature, quantity and judgements.

Data uncertainty – additional dimensions

- Locating potential data uncertainty as a first step towards a finer measurement, the table below should provide a clearer path.

Stages	Data uncertainty sources			
	Operation	System	Real world	Expert judgement
Target and obtain	Negligence in planning. Missing out certain classes	New classes falling outside system scope.	Little data with new business. Evolving risk changing target scope.	Not seeing the complete picture.
Store and share	Inconsistent formats with claims input. Loose definition and labelling.	Lack of storage capacity. Lack of security control on access.	Underlying risk evolving ignored.	Having to choose which data should be stored.
Use	Incorrect data used. Error linking to model.	Poor data output functionality.	Model or method change.	Assumptions replacing data. Selection of data and amount to use.
Maintain	No documentation on claims data manipulation.	Inflexible for data adjustments. Claims record loss during system upgrade.	Evolving risk/model triggers unplanned development pattern adjustments	Overlook certain data areas, misjudging proportionality.
Dispose	Disposing incorrect policy records.	Lack of recovery functions.	Evolving risk may shorten data lifetime, accelerate disposure.	Premature disposure of historical claims.

Data uncertainty – matrix new view

- The data uncertainty matrix below should help to generate a qualitative overview of where most important uncertainties are, and how these can be further measured in a number of uncertainty dimensions.

Data Uncertainty Matrix	Measurability of uncertainty (from determinism, through probability and possibility to ignorance)			Nature of Uncertainty		Qualification of knowledge base (backing)			Value-Ladenness of judgements		
	Statistical uncertainty	Scenario uncertainty	Recognised ignorance	Knowledge related	Variability related	Strong	Fair	Weak	Large	Medium	Small
Data issues by source											

Source: RIVM/MNP Guidance for uncertainty assessment and communication, October 2003

Framework
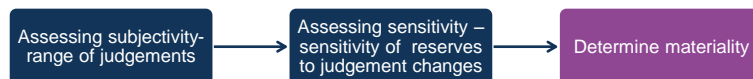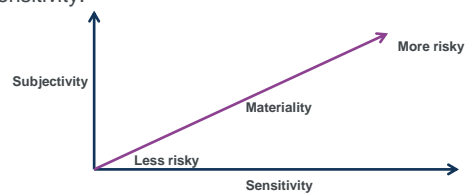- Data uncertainty
- Expert judgement
- Effectiveness of methods
- Reserve risk appetite

Expert judgement uncertainty – current practice

- Challenges associated with uncertain data necessitate the use of expert judgement.

- A recognised method of measuring expert uncertainty is to look at its subjectivity against sensitivity.

Assessing subjectivity- range of judgements → Assessing sensitivity – sensitivity of reserves to judgement changes → Determine materiality

- Any other factors that would also impact the level of expert judgement uncertainty?

Expert judgement uncertainty – other factors
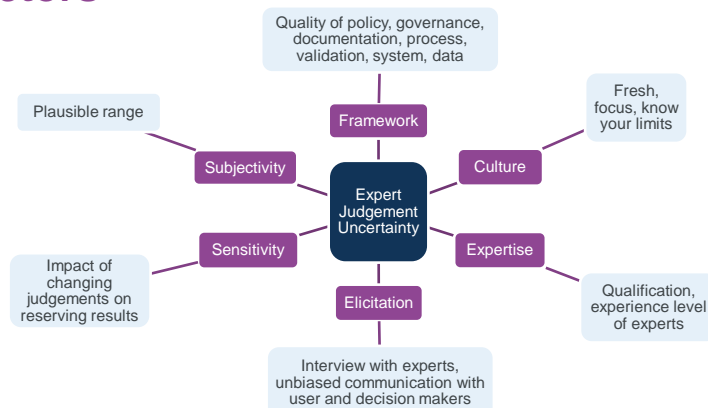
Sources: Sitting in judgement – The Actuary, Nov 2013. Getting better judgment – Getting better judgement working party. Expert judgement – Solvency and capital management working party

- Additional uncertainty which should not outweigh its benefit.

- A point based approach? Similar to safety rating used for cars and airlines.

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Communication - Language

- GI ROC paper "Quantification and Reporting of Uncertainty for GI Reserving" 2007 suggested standard vocabulary for communicating reserve uncertainty

Indicative percentile	75%	90 %	95 %	99%
Wording 'below' percentile	Fairly likely that the outcome will lie below this estimate	Likely that the outcome will lie below this estimate	Very likely that the outcome will lie below this estimate	Extremely likely that the outcome will lie below this estimate
Wording 'above' percentile	Reasonable chance that the outcome could lie above this estimate	Possible but unlikely that the outcome will lie above this estimate	Possible but very unlikely that the outcome will lie above this estimate	There is a possibility, albeit remote, that the outcome will lie above this estimate

- Weather scientists also use a similar approach - The Intergovernmental Panel on Climate Change

- What's the percentages for "fairly likely", "likely" and "very likely" in your own interpretation?

- Why do you think it is not used more?

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Framework

- Data uncertainty
- Expert judgement
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- Reserve risk appetite

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Effectiveness of Methods

- In selecting a best estimate for reserving it should recognised that a range of methods are available to achieve this
- Looking at the outputs of a range of methods can help measure the model uncertainty (the risk that your chosen model is wrong)
- The Effectiveness of Methods Working Party (2008/2009) listed the following methods and tested them for effectiveness

| Possible Reserving Methods |
| --- |
| Chain ladder (PCL, ICL) |
| Bornheutter-Ferguson (PBF, IBF) |
| ACPC-based methods (APC, AIC, PPCI, PPCF) |
| Case estimate-based methods (PCE) |
| Operational time (OpTime) |
| Probabilistic trend family (eg ICRFS) |
| Other (user-selected) methods… |
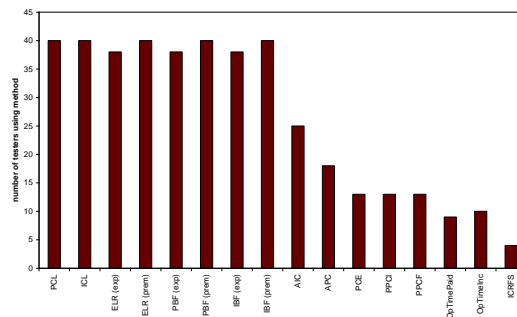
Range of Methods

- Use of an "overview grid" of results can help the Actuary understand the variation in the result based on choosing different methods

All data in £'000s

Class 1	Data				Ultimates								Outputs			
Accident Year	EP	Paid	OS	Incurred	PCL (8)	PCL (12)	ICL (8)	ICL (12)	AVCC (inc Nil)	AVCC (ex Nil)	PBF	IBF	Selected Ult	IBNR	Reserve	ULR
2005	5,836	3,901	34	3,936	3,550	3,706	3,979	3,901	3,511	4,019	3,550	3,901	3,901	-34	-	66.8%
2006	6,128	5,339	143	5,482	4,945	5,162	5,542	5,434	4,890	5,597	4,945	5,434	5,434	-49	95	88.7%
2007	6,434	4,909	216	5,125	4,895	5,110	5,486	5,379	4,841	5,540	4,895	5,379	5,379	254	470	83.6%
2008	6,756	4,588	659	5,248	4,821	5,033	5,404	5,298	4,768	5,457	4,821	5,298	5,298	50	710	78.4%
2009	7,094	3,873	1,024	4,897	4,421	4,615	4,955	4,858	4,372	5,004	4,421	4,858	4,858	-39	985	68.5%
2010	7,449	3,692	1,384	5,075	4,651	4,856	5,213	5,111	4,600	5,265	4,651	5,111	5,111	36	1,419	68.6%
2011	7,821	3,483	2,056	5,539	5,151	5,378	5,774	5,661	5,095	5,831	5,409	5,491	5,831	291	2,347	74.5%
2012	8,212	2,864	3,832	6,697	6,174	6,446	6,920	6,785	6,106	6,988	6,483	6,581	6,988	291	4,124	85.1%
2013	9,033	1,363	4,127	5,491	5,134	5,360	5,755	5,642	5,078	5,812	5,391	5,473	5,812	321	4,448	64.3%
2014	9,937	344	3,923	4,267	4,523	4,721	5,069	4,970	4,473	5,119	4,749	4,821	5,119	852	4,775	51.5%
Total	74,702	34,358	17,399	51,757	48,265	50,387	54,100	53,039	47,735	54,630	49,315	52,347	53,731	1,973	19,373	71.9%

- Where wildly different results are being obtained this can indicate your choice of model is important and there may be model risk which should be discussed
- Model risk could also extend to choice of development factor exclusions and selection of tail factors
- Outputs can also be shown as graphs in order to aid communication

Range of Methods
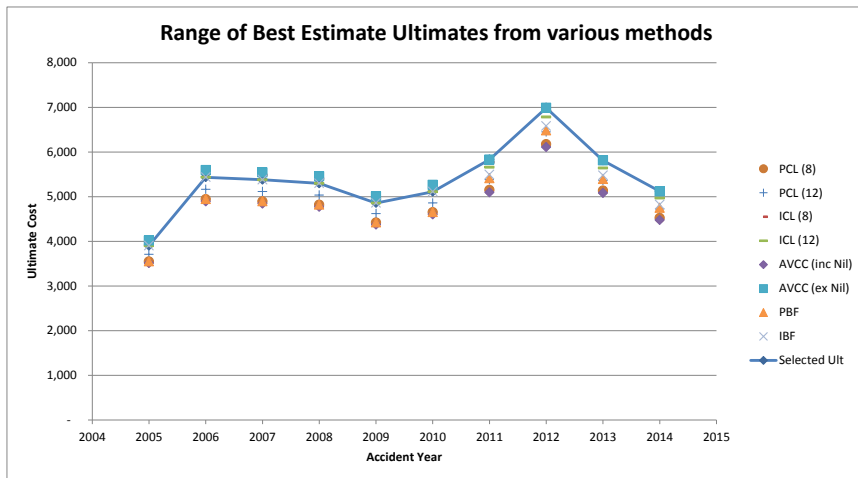
Framework

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Reserve Risk and ERM – qualitative aspects

- Rating Agencies assess risks qualitatively as well as quantitatively

- Benchmark reserve risk qualitatively?

- Reserve Risk is also often considered as part of a risk appetite within an ERM framework

Reserve Risk

Insurance Risk

Enterprise Risk

Risk Control Indicators

Reserve & Claims Management Control from rating agency perspective

• Track record of consistent reserve releases • Independent centralised reserving function with effective feedback loops • Assumptions robustly set and justified • Information fed into economic capital models • Robust review process, including both internal and third party actuarial reviews • Well-defined and extensive claims management framework	• Experienced chronic adverse development • Lack of adequate understanding and modelling of the risk of adverse loss development. • Reserving is fragmented in business units without centralized coordination or supervision • Reserving is disconnected from claims and might be pressured from underwriting • The review process is unsatisfactory and has failed to reveal chronic issues • There are no claims management authority levels or they're not applied in practice.

Inspired by "S & P Insurance Enterprise Risk Management Criteria May 2013"

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True or false?

"A well defined claims management framework should lead to less reserve uncertainty than a poorly defined claims management framework, as the risk of adverse deviation in reserves and/or claims payments for operational reasons should be reduced"

"A disjointed actuarial function spread across many territories with no central oversight is more likely to lead to an out-turn that deviates from best estimate than an integrated actuarial function with central oversight"

"A reserving team that does not perform stress and scenario testing is less able to understand its reserve risks than a team which does and his hence more likely to assess reserve uncertainty incorrectly"

"A reserving function that obtains third-party review of its work is more likely to understand its reserves and risks and hence less likely to assess reserve uncertainty incorrectly"

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Reserve Risk within Risk Appetite

- Deterioration of reserves is not to exceed b% in any one quarter

- 1-in-200 deviation not to exceed c% of gross income

- "We have no appetite for significant deviations in earnings driven by reserving deficits"

- Reserves/premiums ratios…. be greater than x%

- Reserving Risk Capital Charge not be greater than x% of….

- Capital at risk from potential claims reserving losses (based on the VaR for the whole reserve portfolio) should not exceed x% (e.g. 20%) of own funds according to SII calculation

Analysis of Company Reports to understand treatment of Reserve Risk

Measuring uncertainty beyond "Bootstrap"
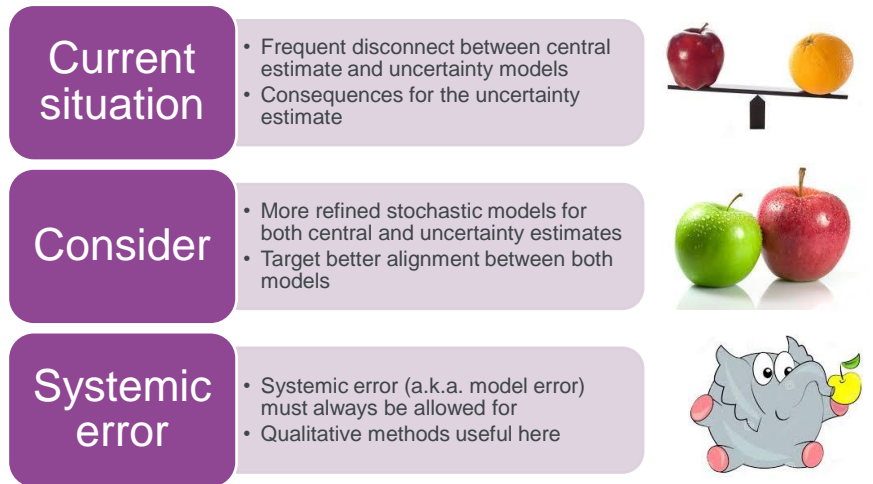
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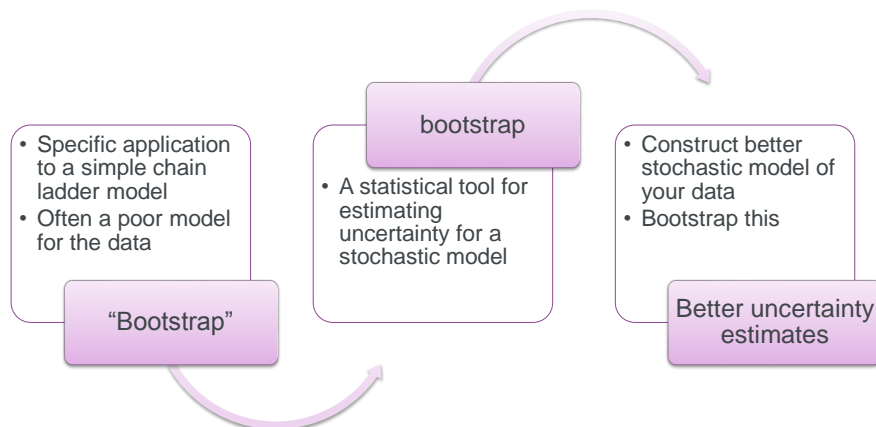- Interaction with capital models

Alternative modelling approaches

Current situation	• Frequent disconnect between central estimate and uncertainty models • Consequences for the uncertainty estimate
Consider	• More refined stochastic models for both central and uncertainty estimates • Target better alignment between both models
Systemic error	• Systemic error (a.k.a. model error) must always be allowed for • Qualitative methods useful here

From the "Bootstrap" to the bootstrap

- Specific application to a simple chain ladder model
- Often a poor model for the data

"Bootstrap"

bootstrap

- A statistical tool for estimating uncertainty for a stochastic model

- Construct better stochastic model of your data
- Bootstrap this

Better uncertainty estimates

Extensions to aggregate models

- More refined modelling of triangles
  - E.g. GLMs, log incremental reserving
  - Model effects by accident, development, calendar periods
  - Some specific actuarial packages to do these (e.g. ICRFS but can be done in stats packages like R [free!])
- Frequency/severity modelling
  - E.g. for claims that settle as lump sums
    - Reported claims
    - Settlement rates
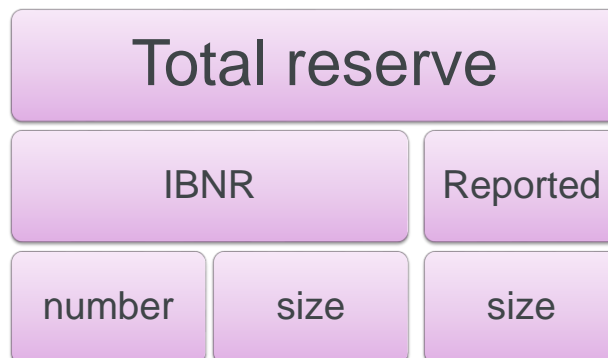   - Average payments per settled claim
- Consider granularity level
  - Month/quarter/half-year/annual
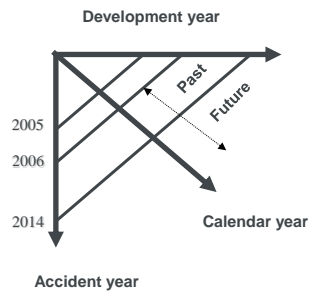
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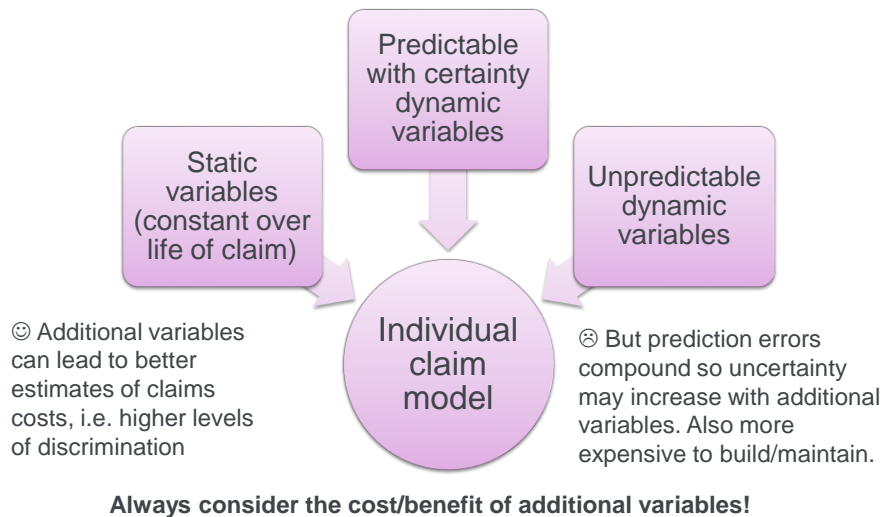
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Individual claim reserving

- Starting point is claims header and transactional data
- Framework something like this (see Parodi and others)

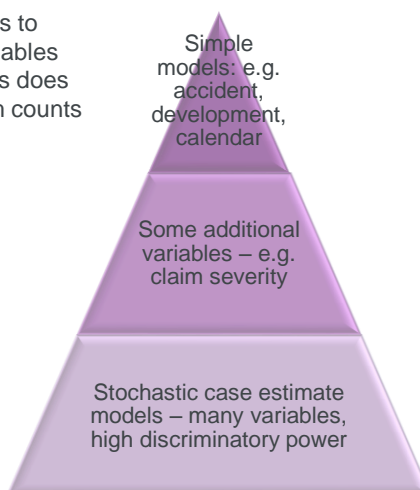13 November 2015

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Specifying individual models

Predictable with certainty dynamic variables

Static variables (constant over life of claim)

Unpredictable dynamic variables

Individual claim model

☺ Additional variables can lead to better estimates of claims costs, i.e. higher levels of discrimination

☹ But prediction errors compound so uncertainty may increase with additional variables. Also more expensive to build/maintain.

Always consider the cost/benefit of additional variables!

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Implications for uncertainty measurement

Simple models have similar variables to aggregate models but granularity enables better identification of data trends, as does separate modelling of size and claim counts

Augment simple models by a small number of key predictors to improve reserve forecasts
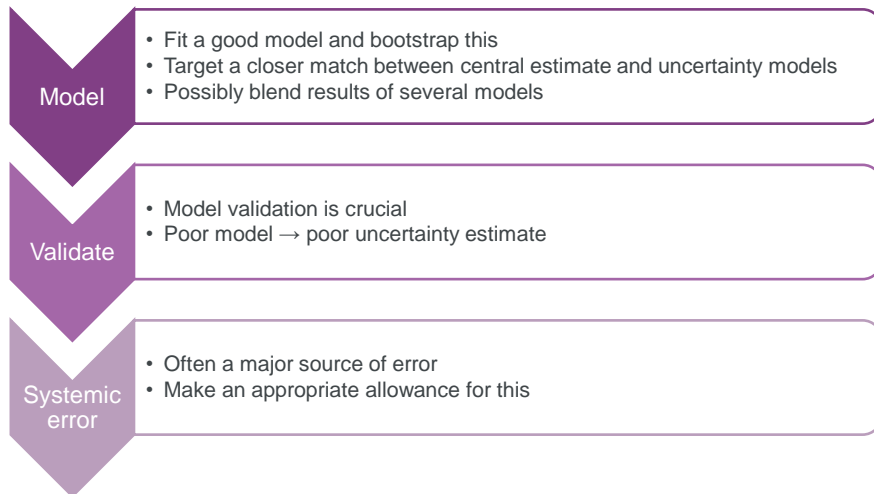
Alternative to manual case estimation. Use in reserving limited as prediction errors compound. Also expensive to build/maintain

Simple models: e.g. accident, development, calendar

Some additional variables – e.g. claim severity

Stochastic case estimate models – many variables, high discriminatory power

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Practical suggestions (not exhaustive!)

Model
- Fit a good model and bootstrap this
- Target a closer match between central estimate and uncertainty models
- Possibly blend results of several models

Validate
- Model validation is crucial
- Poor model → poor uncertainty estimate

Systemic error
- Often a major source of error
- Make an appropriate allowance for this

Alternative approaches
- Models for aggregate triangles
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Making more use of capital models?

Capital models ⟷ Reserve uncertainty

Not just the 1 In 200

Apples and pears?

Chicken or egg?

1 Year vs ultimate view
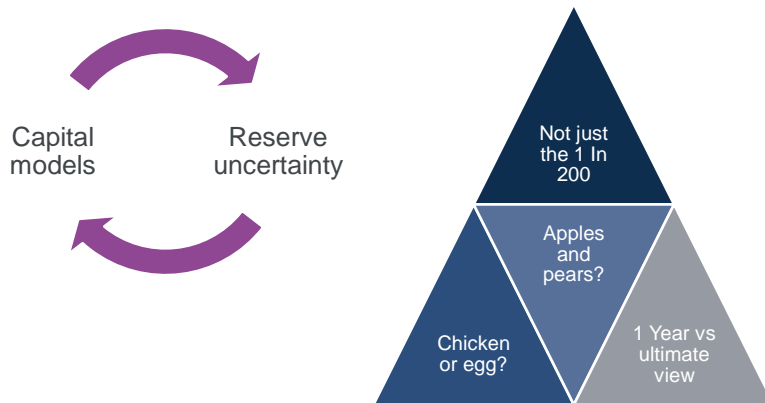
Measuring uncertainty
What next?

MUQ Stage 2

DO SOMETHING ABOUT IT!

- Join the working party
- Feedback your views
- Have a chat with a colleague
- See our website
  (find the GIROC page and follow your nose)

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Questions Comments