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# Peril-based reserving – an update

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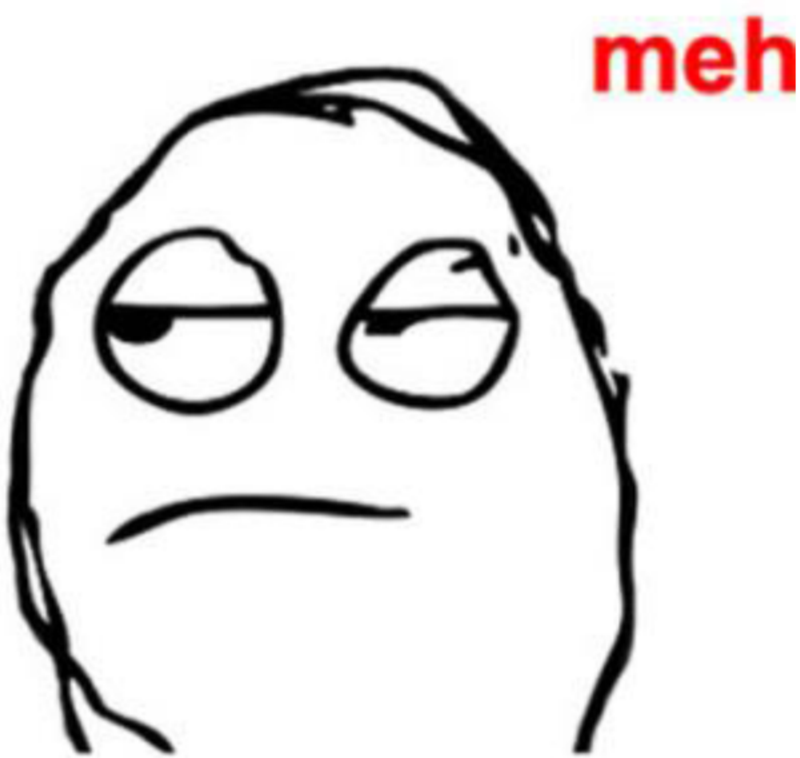
GIRO Conference 2016
Workshop D6
Thursday 22 September 2016, 15:45 – 16:45

# Reserving – Who cares?

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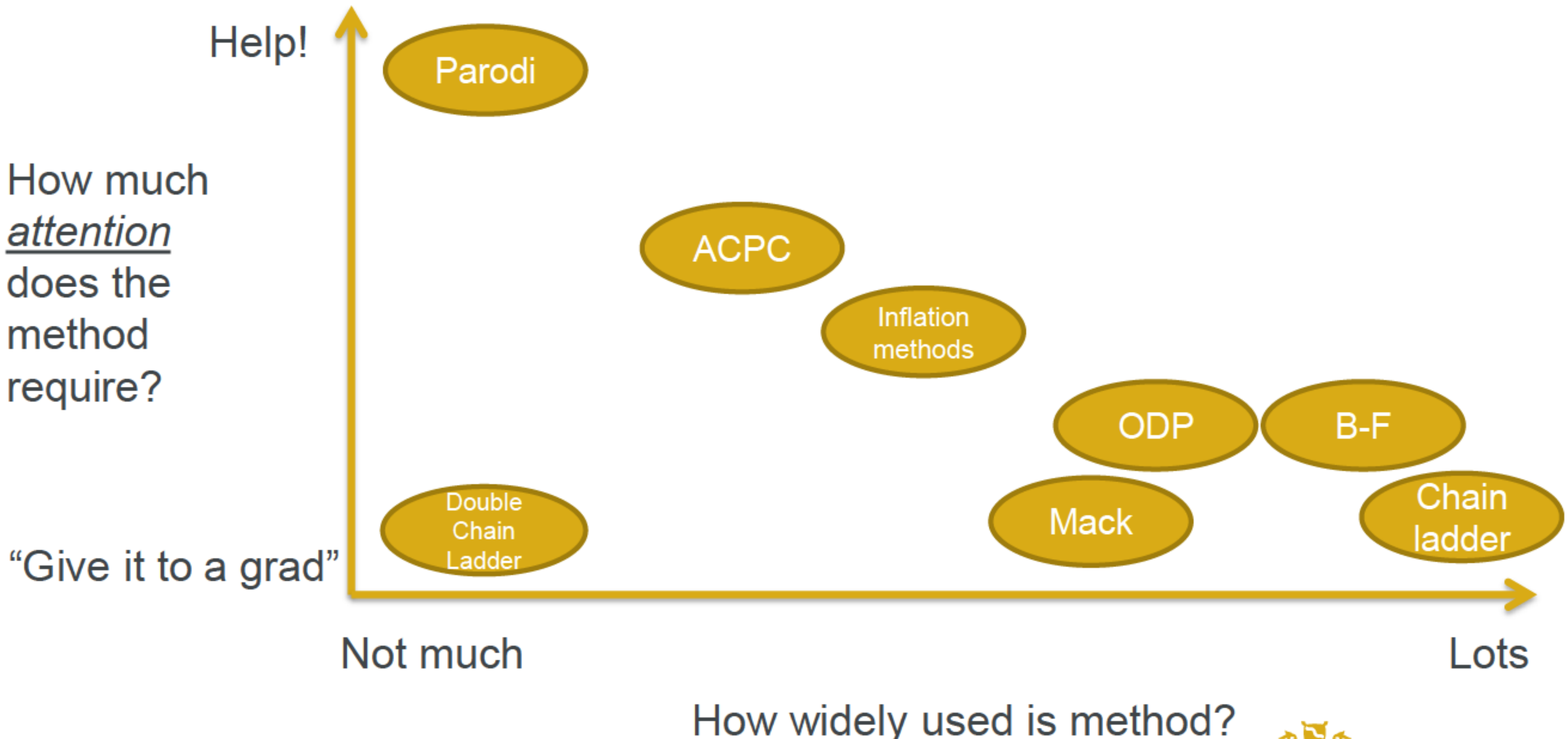
# What makes you use a method?

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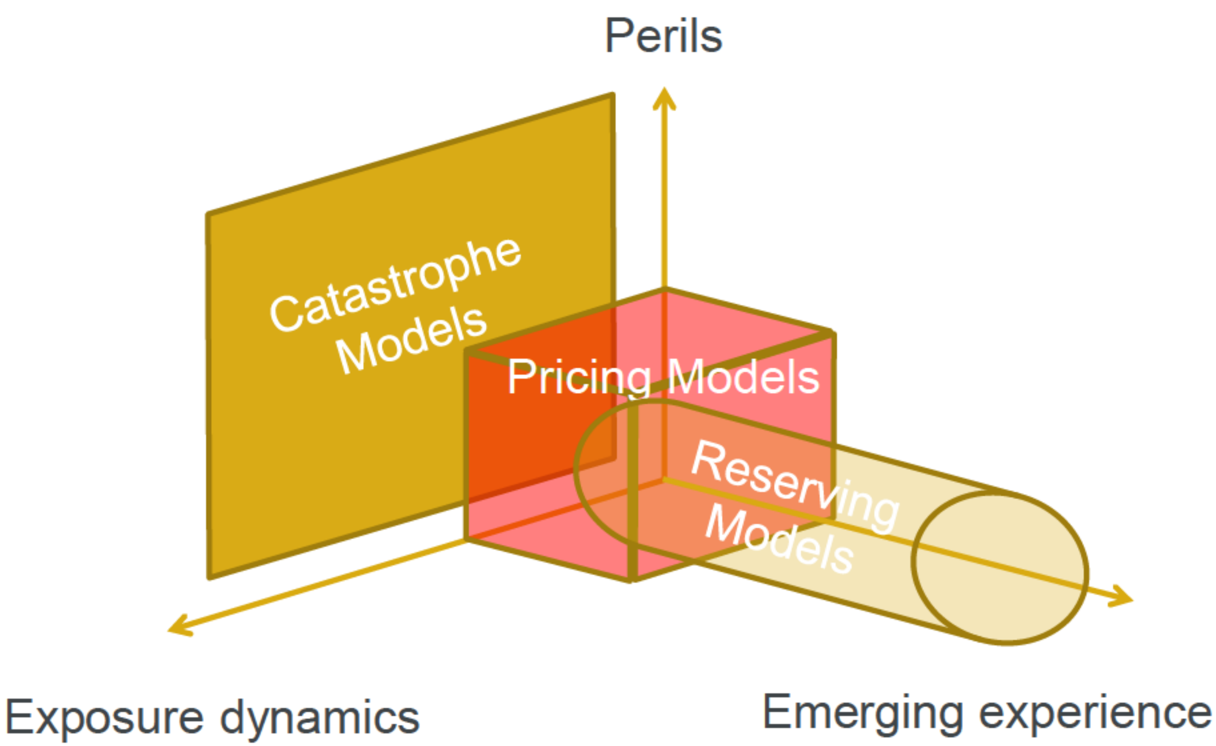
# Thinking in three dimensions

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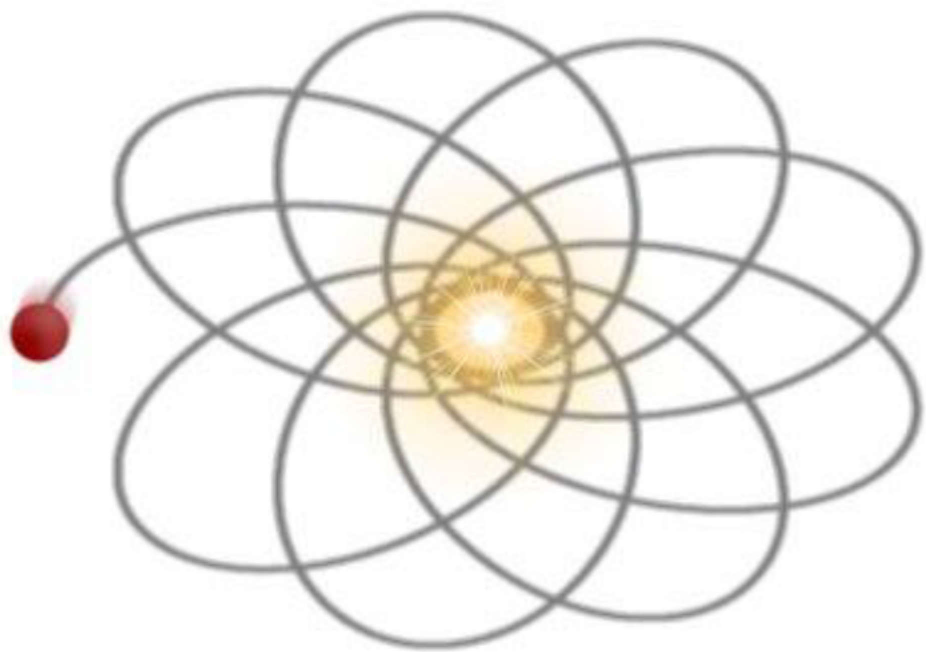
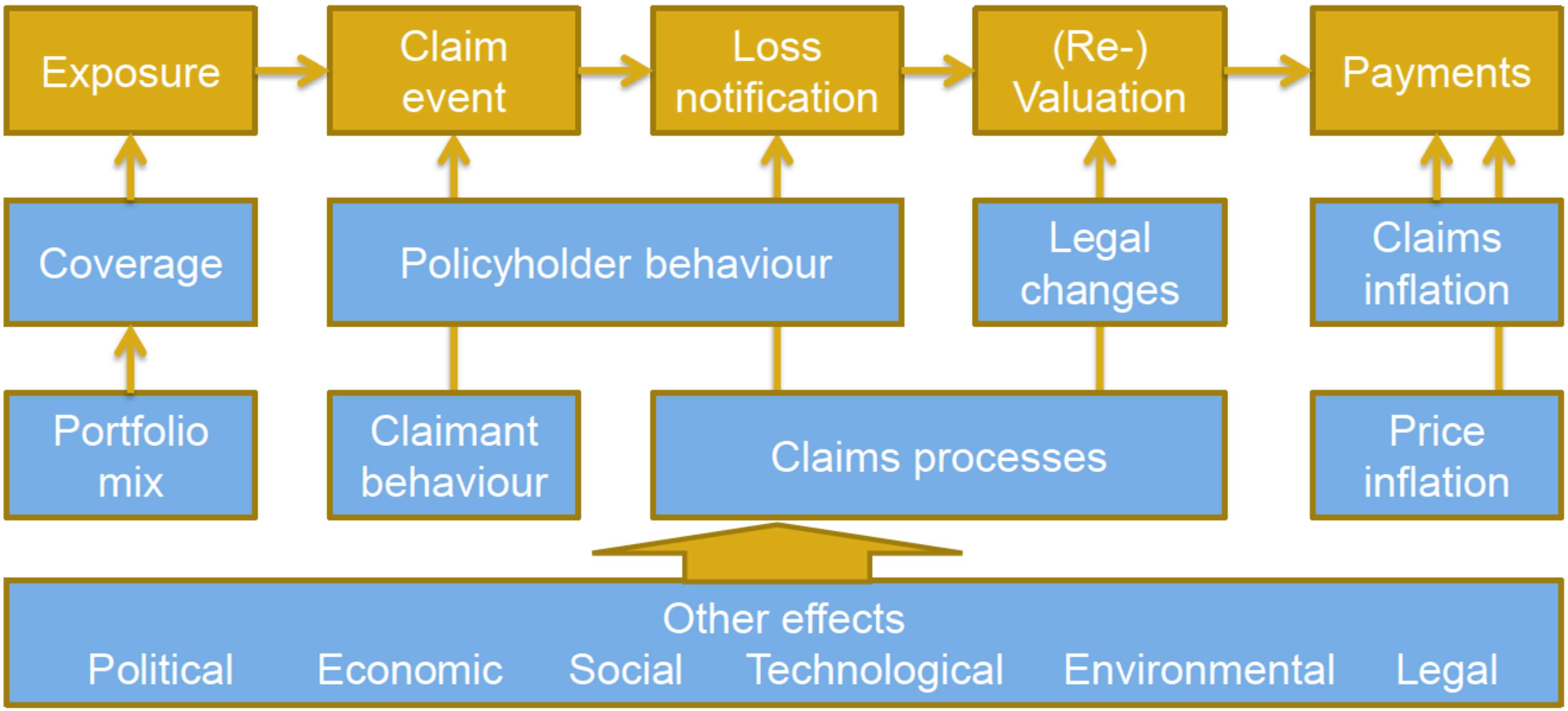
# What makes a good model?



# Breaking down the claims process

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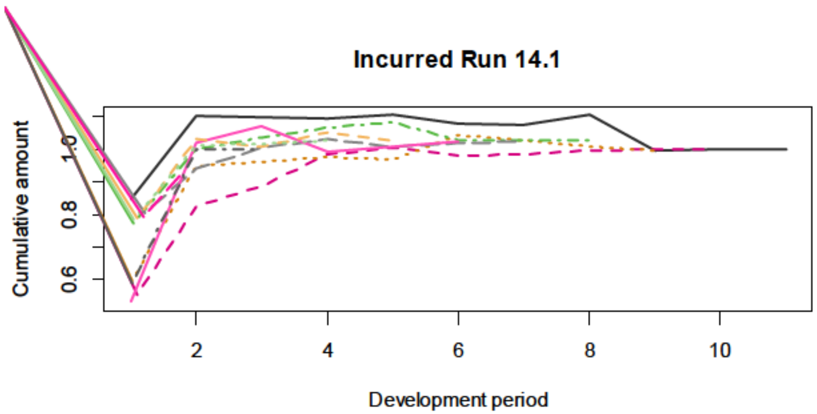
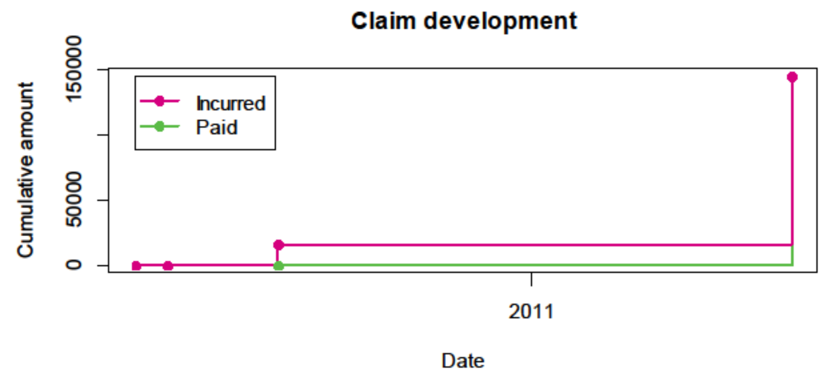
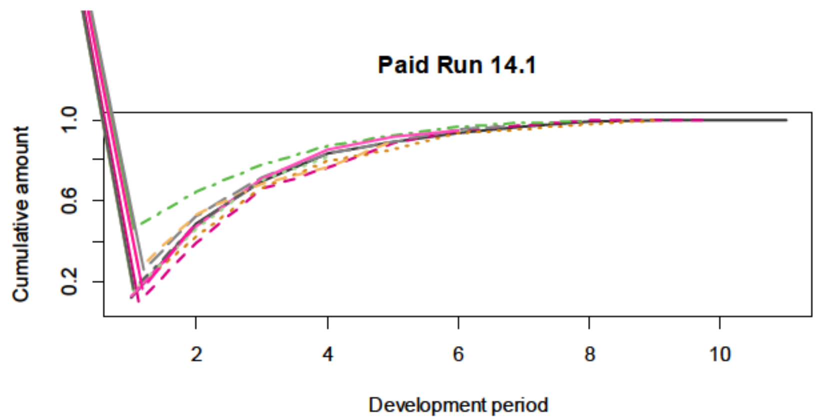
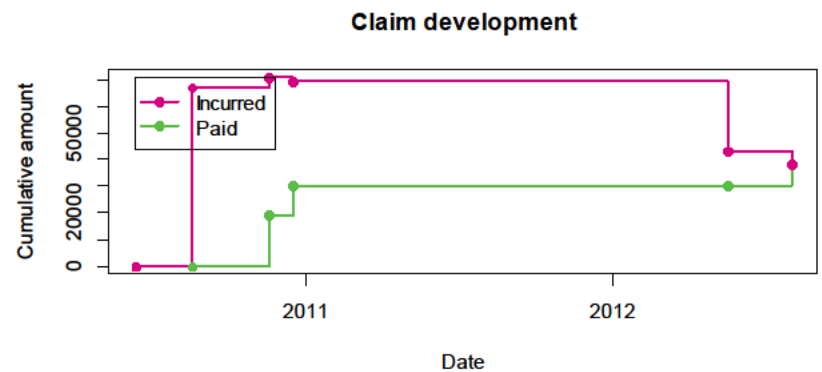
# Loss simulation – what not to do

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# Loss simulation – what not to do

- Complexity
- Explicit chain ladder assumptions
- Implicit assumptions

# Claims simulation redux

- How simple can we make our process and still get something realistic?

- Let's try stripping the process down to the following:
  - A certain number of claims happens at various points in time during the accident year
  - After a delay they are reported and we put a reserve on it
  - After a further delay each claim is settled and the file is closed

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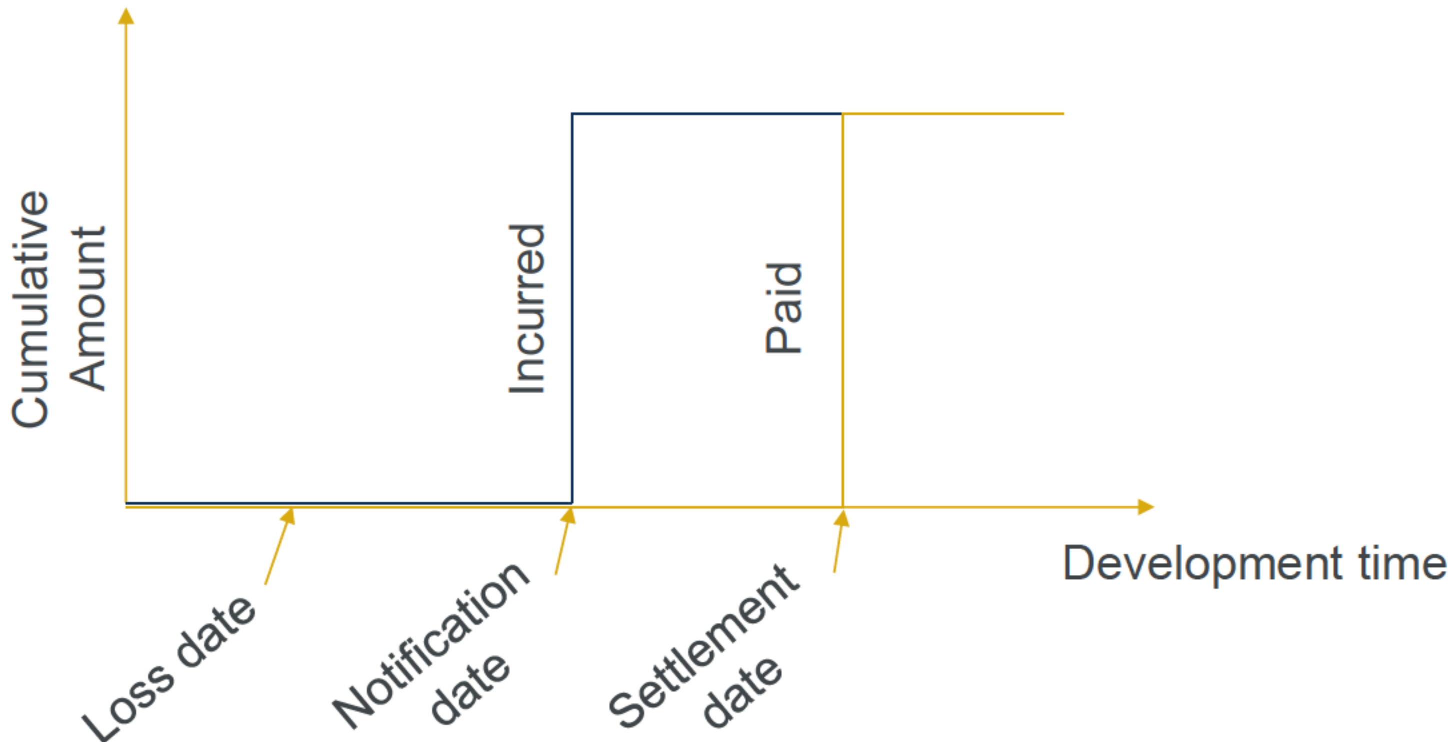
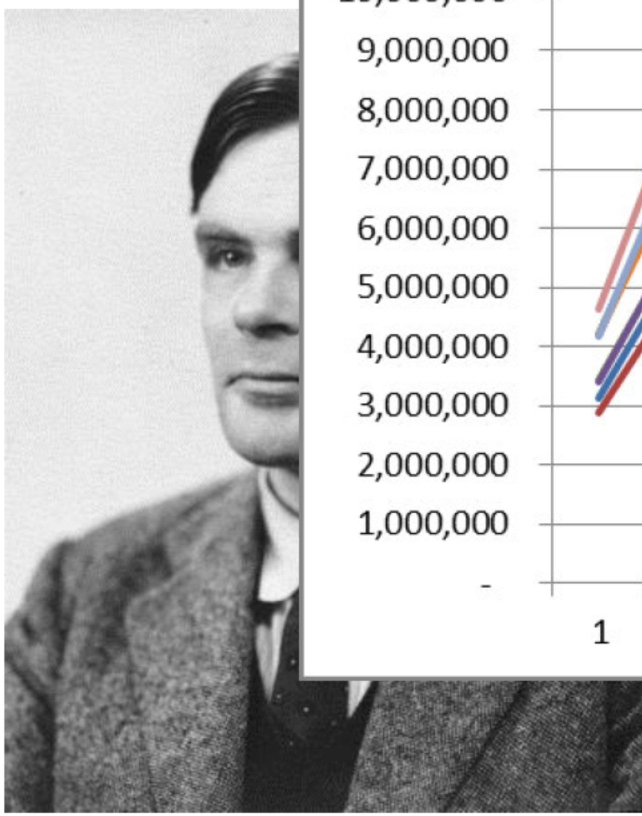
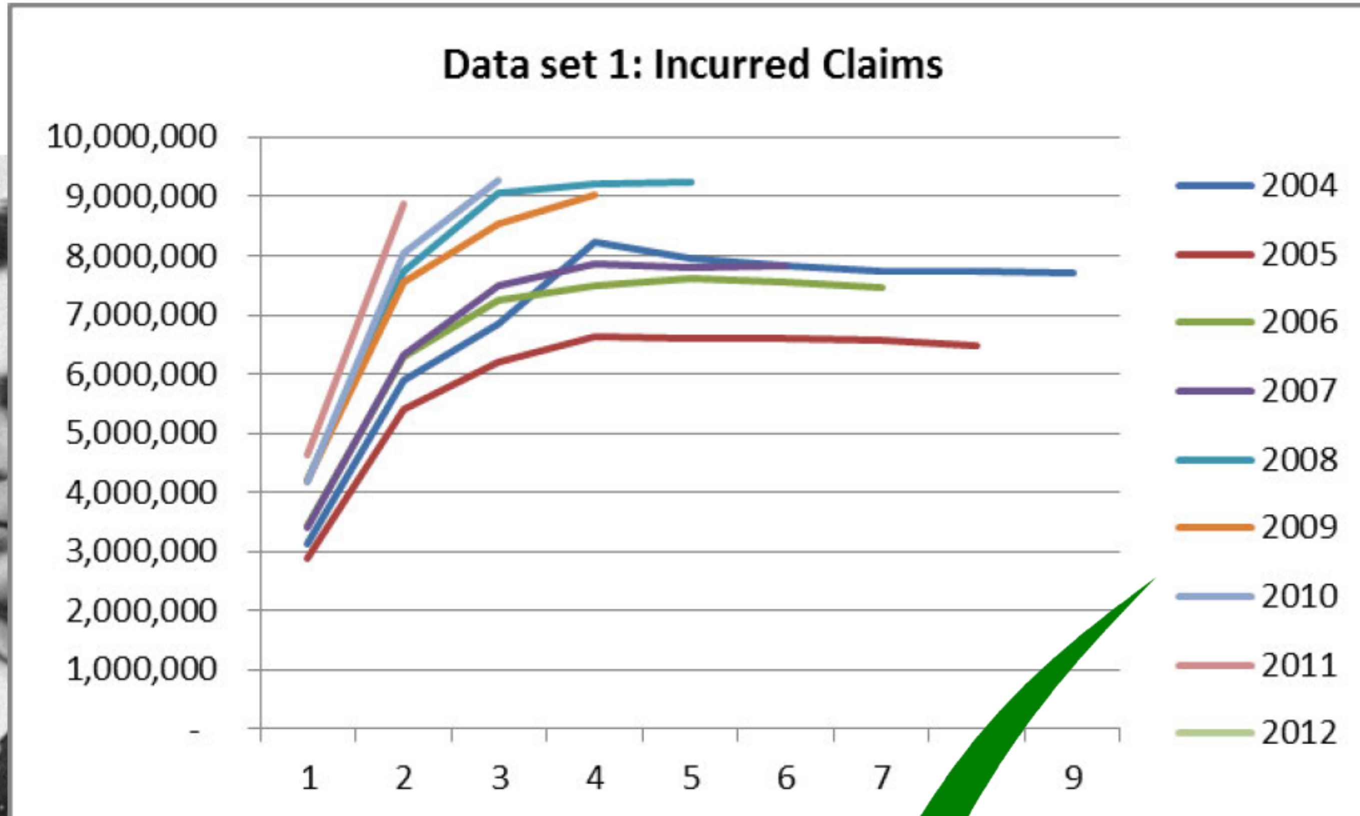
# A very simple claims process…



# Would it pass his test?



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# Henrietta Lacks and the HeLa cell line

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# Data lines: a taxonomy - 1

- Data set: a published instance of transactional loss data

| | Acc_Yr | Dev_Yr | Cal_Yr | Claim.no | policytype | claimtype | Acc_Date | Transaction.date | Open_Cla | Closed_Cl | Incurred | Paid |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 1 | 2006 | 1 | 2006 | 1 | 1 | 1 | 28/07/2006 | 04/08/2006 | 1 | 0 | 4434.653 | 0 |
| 2 | 2006 | 2 | 2007 | 1 | 1 | 1 | 28/07/2006 | 23/02/2007 | 0 | 0 | 1168.6 | 2869.797 |
| 3 | 2006 | 2 | 2007 | 1 | 1 | 1 | 28/07/2006 | 28/07/2007 | 0 | 1 | 211.6391 | 2945.096 |
| 4 | 2006 | 1 | 2006 | 2 | 1 | 1 | 06/04/2006 | 13/04/2006 | 1 | 0 | 1435.956 | 0 |
| 5 | 2006 | 1 | 2006 | 2 | 1 | 1 | 06/04/2006 | 31/08/2006 | 0 | 0 | 2362.533 | 1584.567 |
| 6 | 2006 | 1 | 2006 | 2 | 1 | 1 | 06/04/2006 | 23/10/2006 | 0 | 1 | 492.2458 | 2706.167 |
| 7 | 2006 | 1 | 2006 | 3 | 1 | 1 | 25/12/2006 | 29/12/2006 | 1 | 0 | 2729.804 | 0 |
| 8 | 2006 | 2 | 2007 | 3 | 1 | 1 | 25/12/2006 | 30/08/2007 | 0 | 0 | 670.7003 | 0 |
| 9 | 2006 | 3 | 2008 | 3 | 1 | 1 | 25/12/2006 | 25/07/2008 | 0 | 1 | 1393.593 | 4794.098 |
| 10 | 2006 | 1 | 2006 | 4 | 1 | 1 | 03/09/2006 | 07/09/2006 | 1 | 0 | 3397.113 | 0 |
| 11 | 2006 | 1 | 2006 | 4 | 1 | 1 | 03/09/2006 | 21/10/2006 | 0 | 0 | 905.2508 | 0 |
| 12 | 2006 | 2 | 2007 | 4 | 1 | 1 | 03/09/2006 | 02/08/2007 | 0 | 1 | 247.1809 | 4549.545 |

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# Data lines: a taxonomy - 2

- Data line: a collection of data sets generated using the same generation engine and input parameters
- Accompanied by:
  - A description of its profile / charactaristics
  - A parameter input file
  - Output validation
- Typically 1,000 or 10,000 data sets in a data line

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# Data lines: a taxonomy - 3

- Data generations: all data lines created using a common generation engine

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# Some definitions

| | |
|---|---|
| $\wp$ | A particular claims generation process and parameter set. |
| P | A particular instance of $\wp$ that we observe in life. Here we are able to generate thousands of Ps. |
| ${R^o}_P$ | Perfect reserve for instance P, refer to this as " $R^o$ " |
| $E_{\wp}[R^o]$ | Expected reserve across all P $\in \wp$ |
| $SD_{\wp}[R^o]$ | Inherent variability in perfect reserve, the variability that arises as a result of the process |
| $\mathcal{E}$ | Our loss reserve estimation process, eg chain-ladder |
| $\widehat{R_{\mathcal{E}}}$ | Our reserve estimate using $\mathcal{E}$ |

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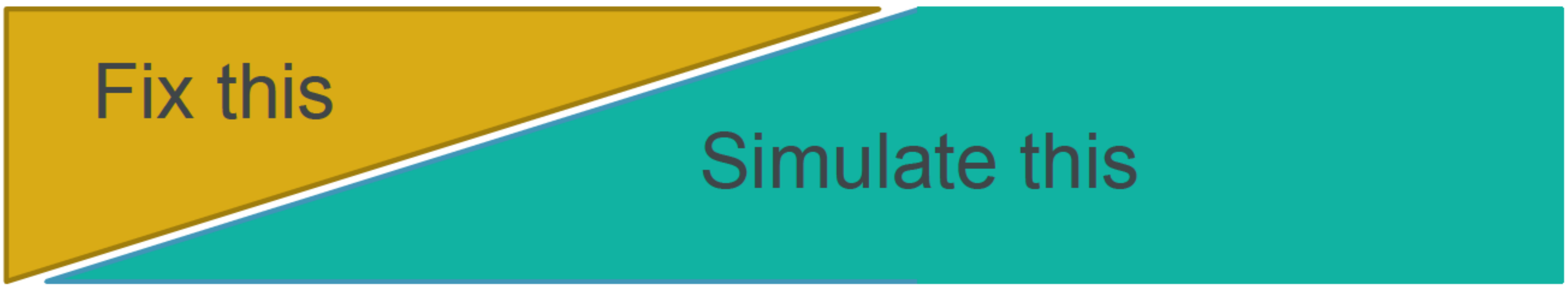
# What this means in practice

Most reserve approaches model like this:




This approach requires us to model like this:


*Fixing the triangle collapses the process*

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# What we observe

$$\frac{E_{\wp}\left[R^{o} - \widehat{R_{\mathcal{E}}}\right]}{E_{\wp}[R^{o}]}$$

Expected error in reserve estimate using estimator $\mathcal{E}$ under generation process $\wp$

"Model bias"

$$\frac{SD_{\wp}\left[R^{o} - \widehat{R_{\mathcal{E}}}\right]}{E_{\wp}[R^{o}]}$$

Variability of reserve estimate using estimator $\mathcal{E}$ under generation process $\wp$

"Projection error"

$$\frac{SD_{\wp}\left[R^{o} - \widehat{R_{\mathcal{E}}}\right]}{E_{\wp}\left[R^{o} - \widehat{R_{\mathcal{E}}}\right]}$$

"Coefficient of Variation" measure

Helpful to look at percentiles too

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# Recap:
# What is peril-based reserving about?

- Thinking about the underlying claims process rather than an aggregate claims triangle.
- Formalising thinking in three dimensions:
  - Exposure
  - Risks
  - Time
- Testing our ideas we need some data to work with.

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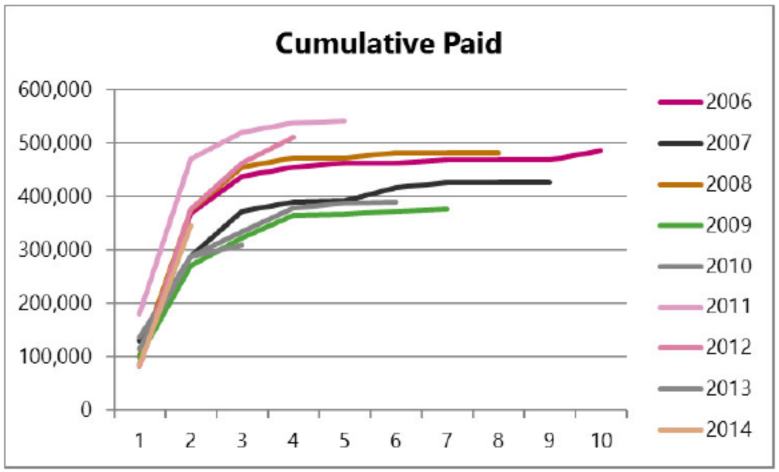
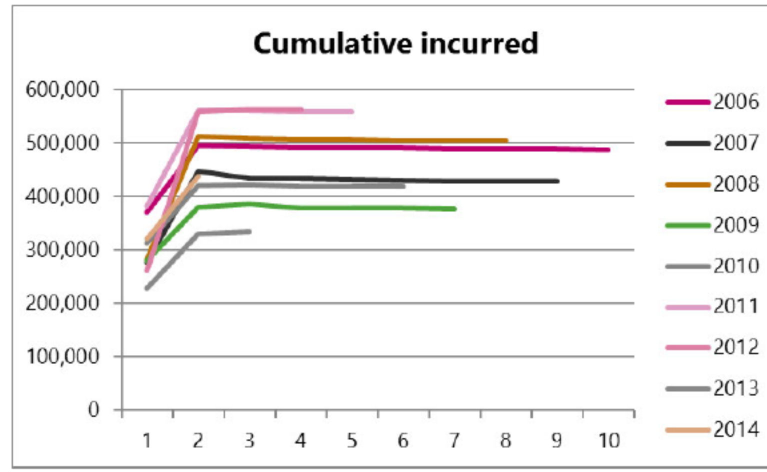
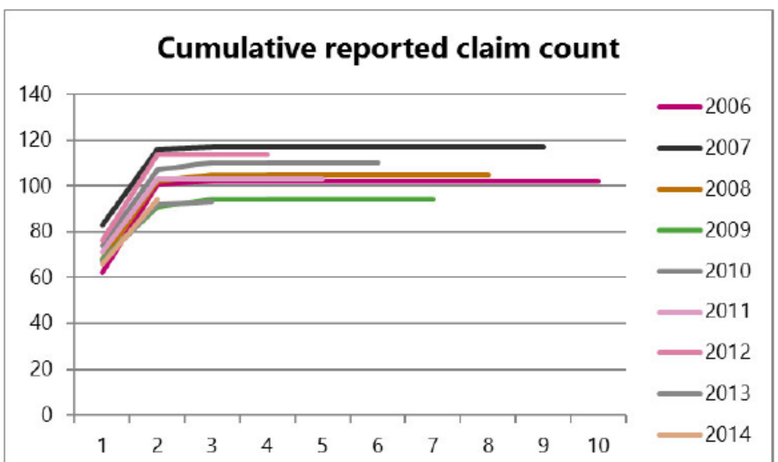
# Some results

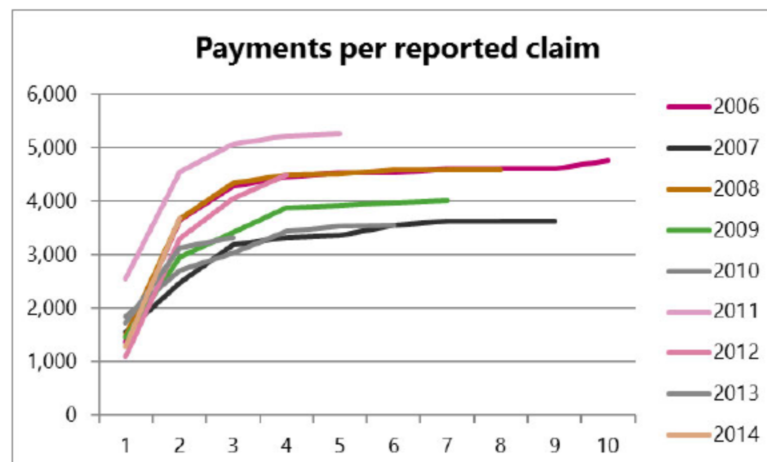
Adopting this approach enables us to quantify the performance of models

# Results 1
# Example summary claims triangles

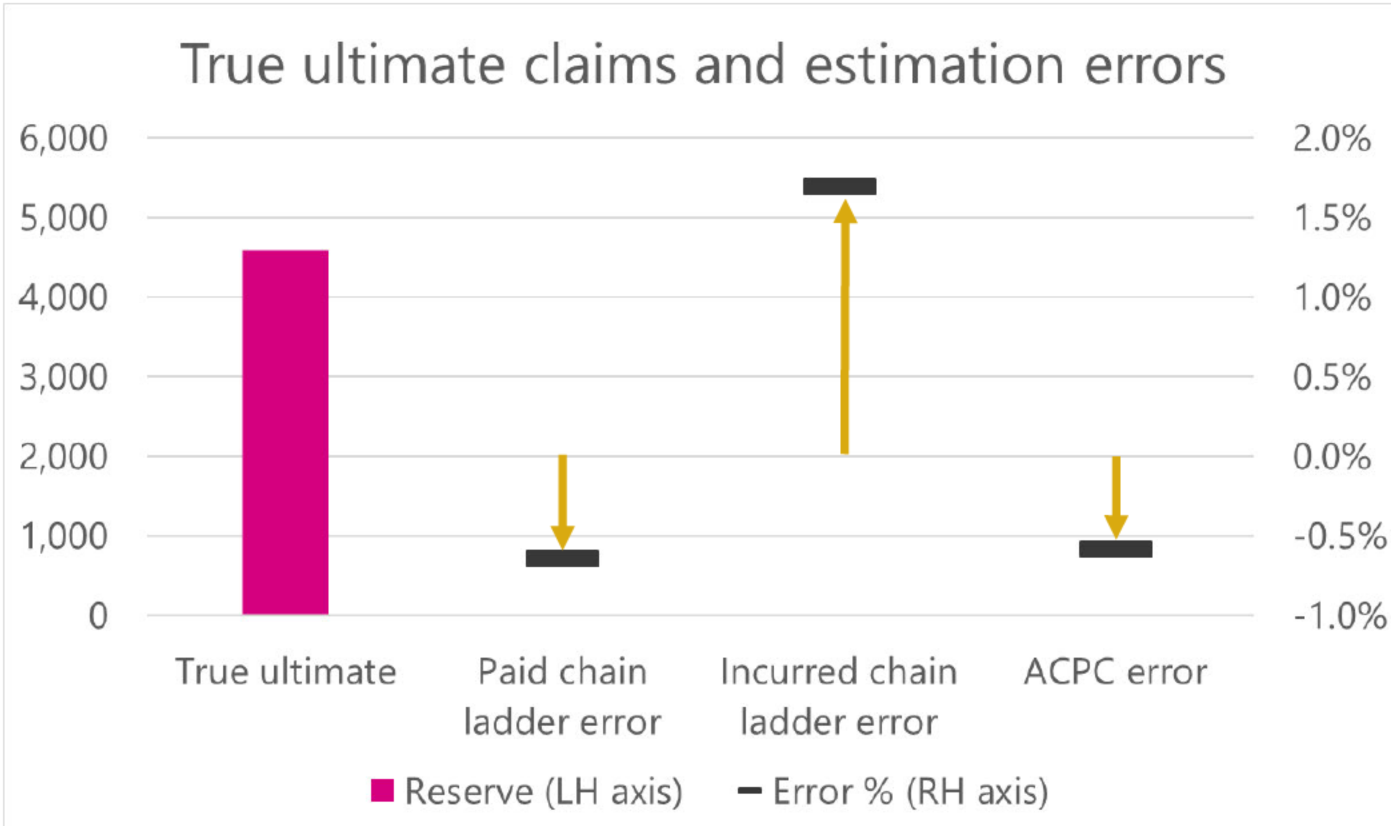


# Results 2
# Example claims projection results




## And repeat many times…

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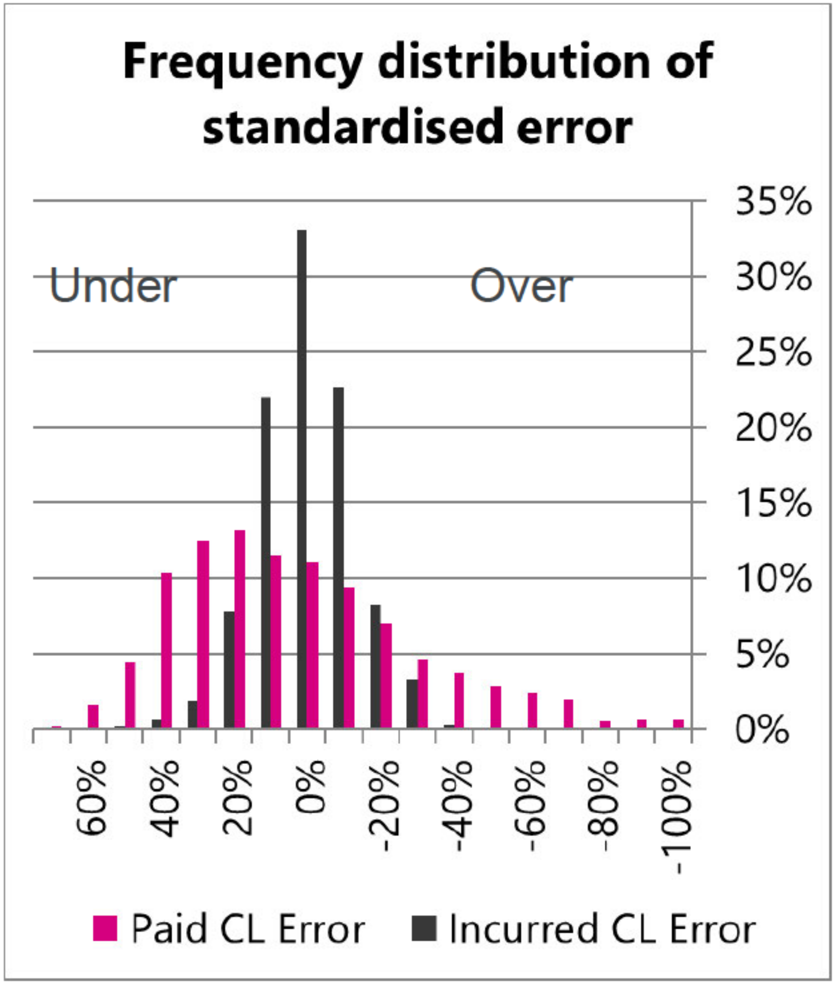
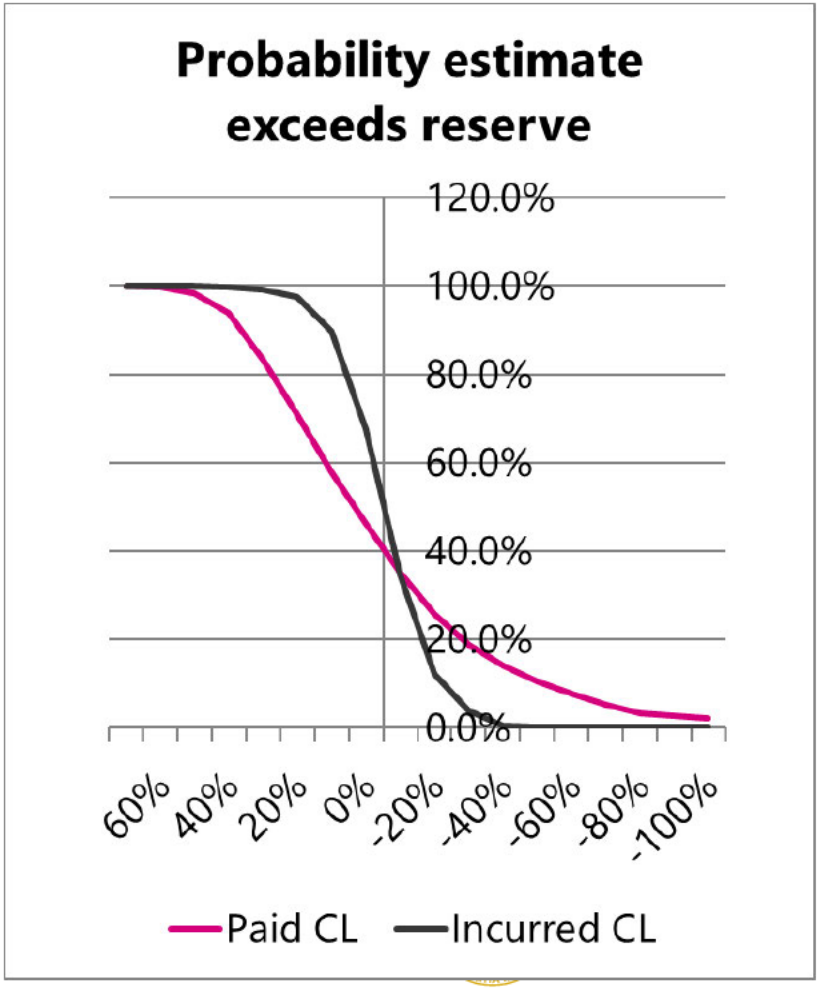
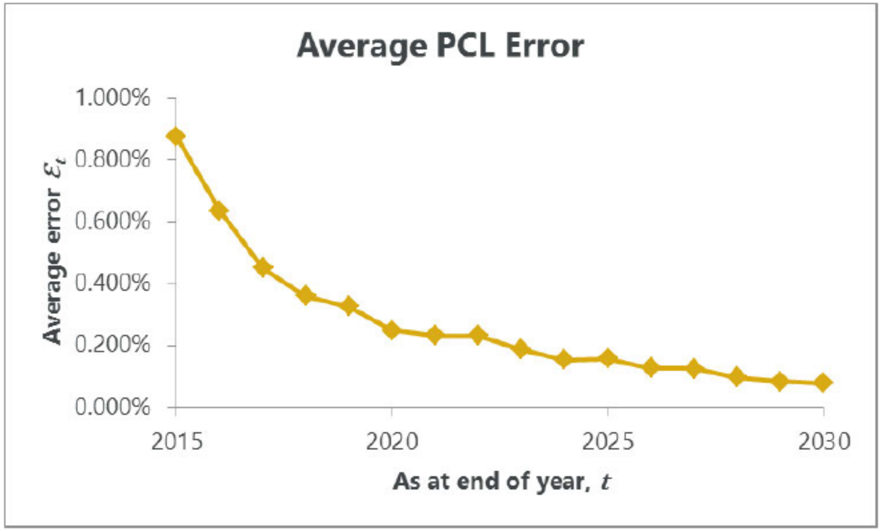
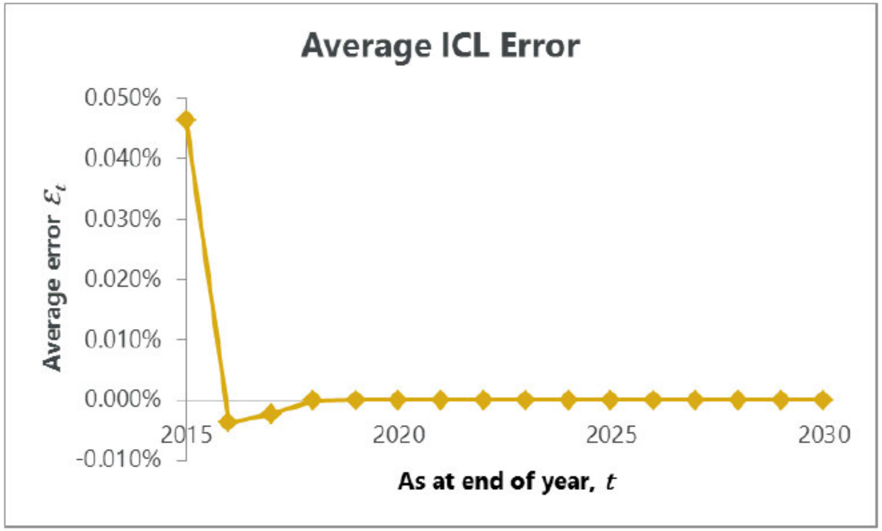
# Results 3
# Distribution of estimates under process



# Results 4
# Measure speed of convergence

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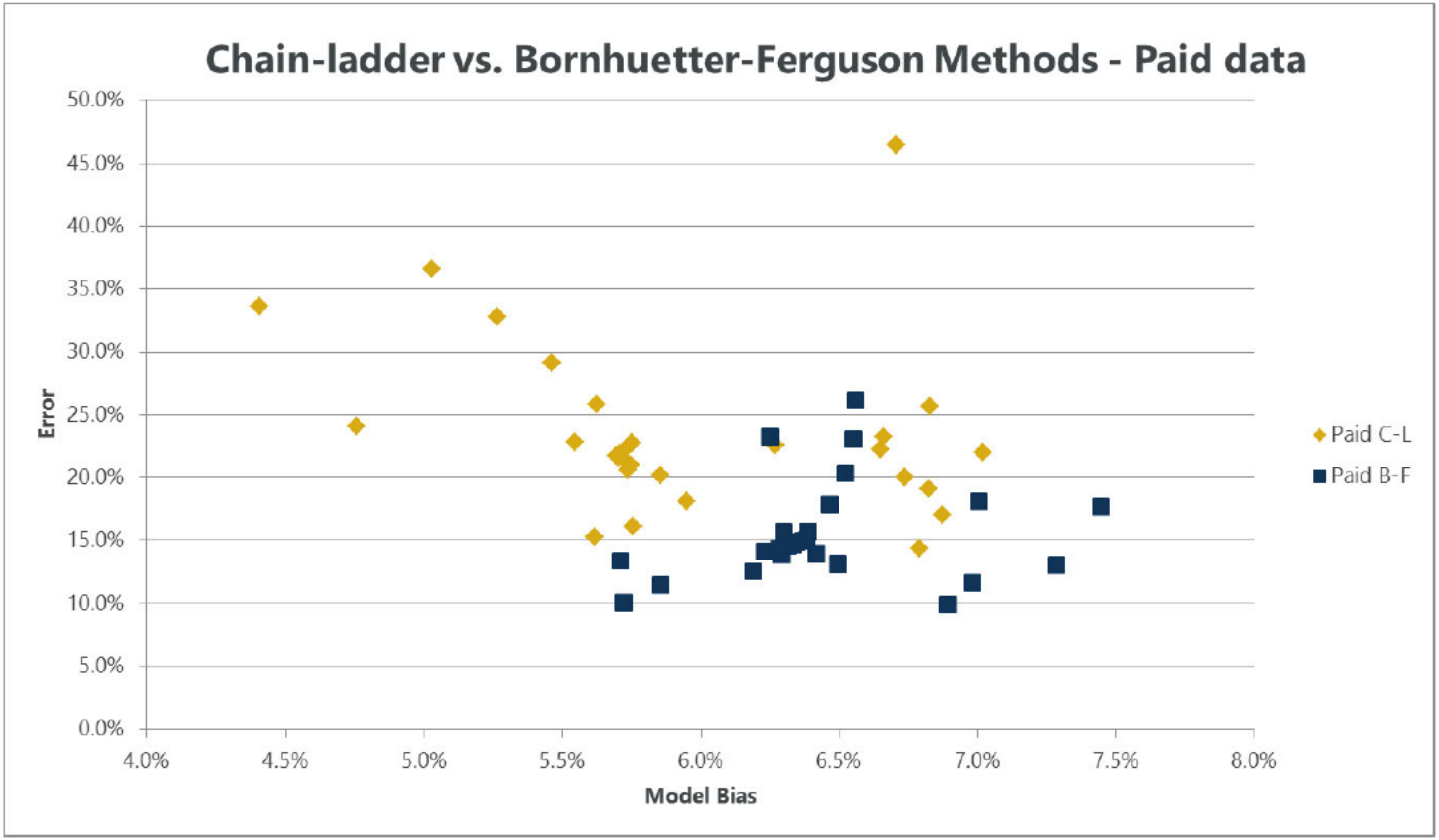
# Results 5 – Chain-ladder and BF models

## A. Paid claims




Bornhuetter Ferguson models reduce error but increase bias

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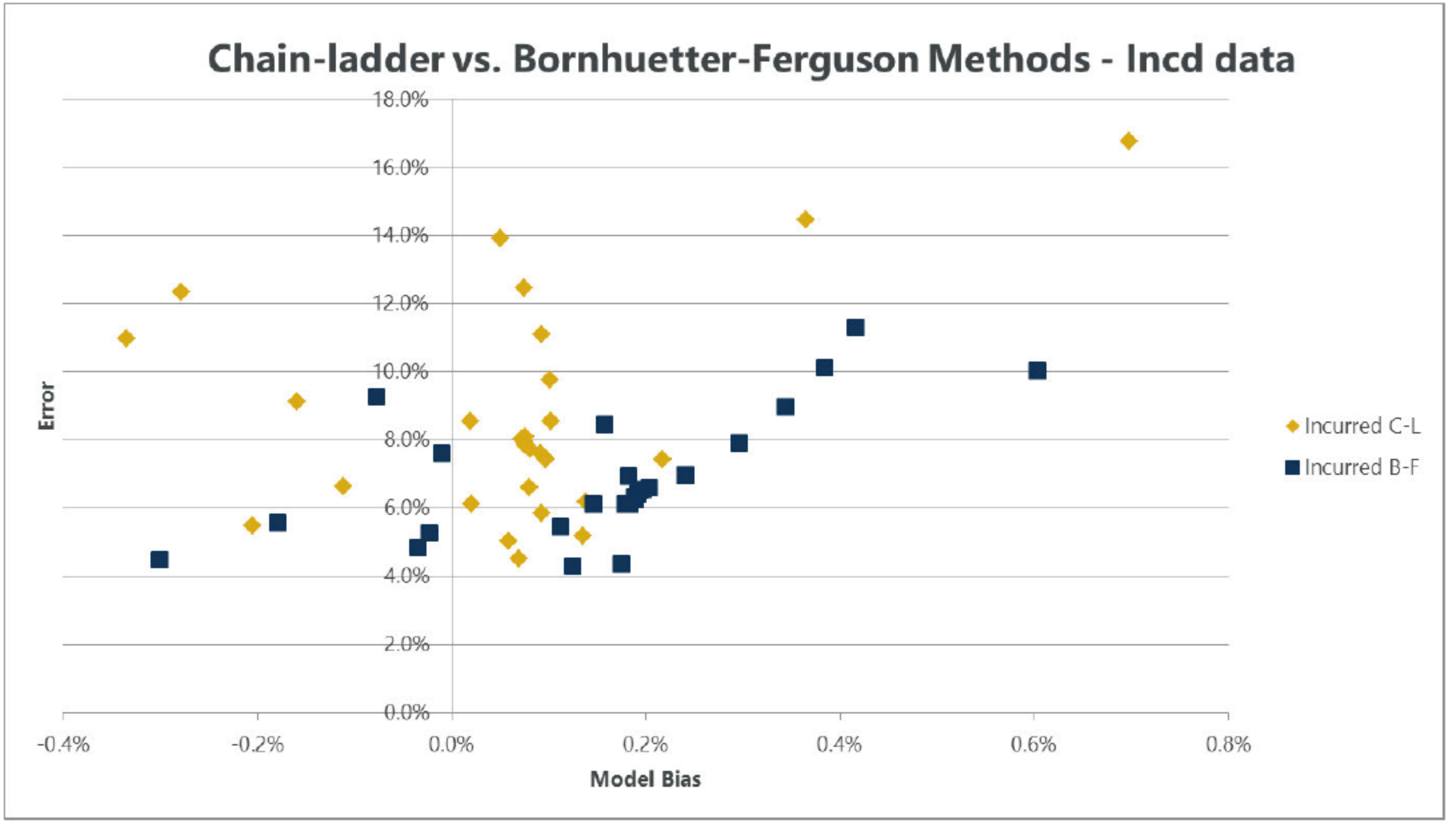
# Results 5 – Chain-ladder and BF models
## B. Incurred claims




Bornhuetter Ferguson models reduce error but increase bias

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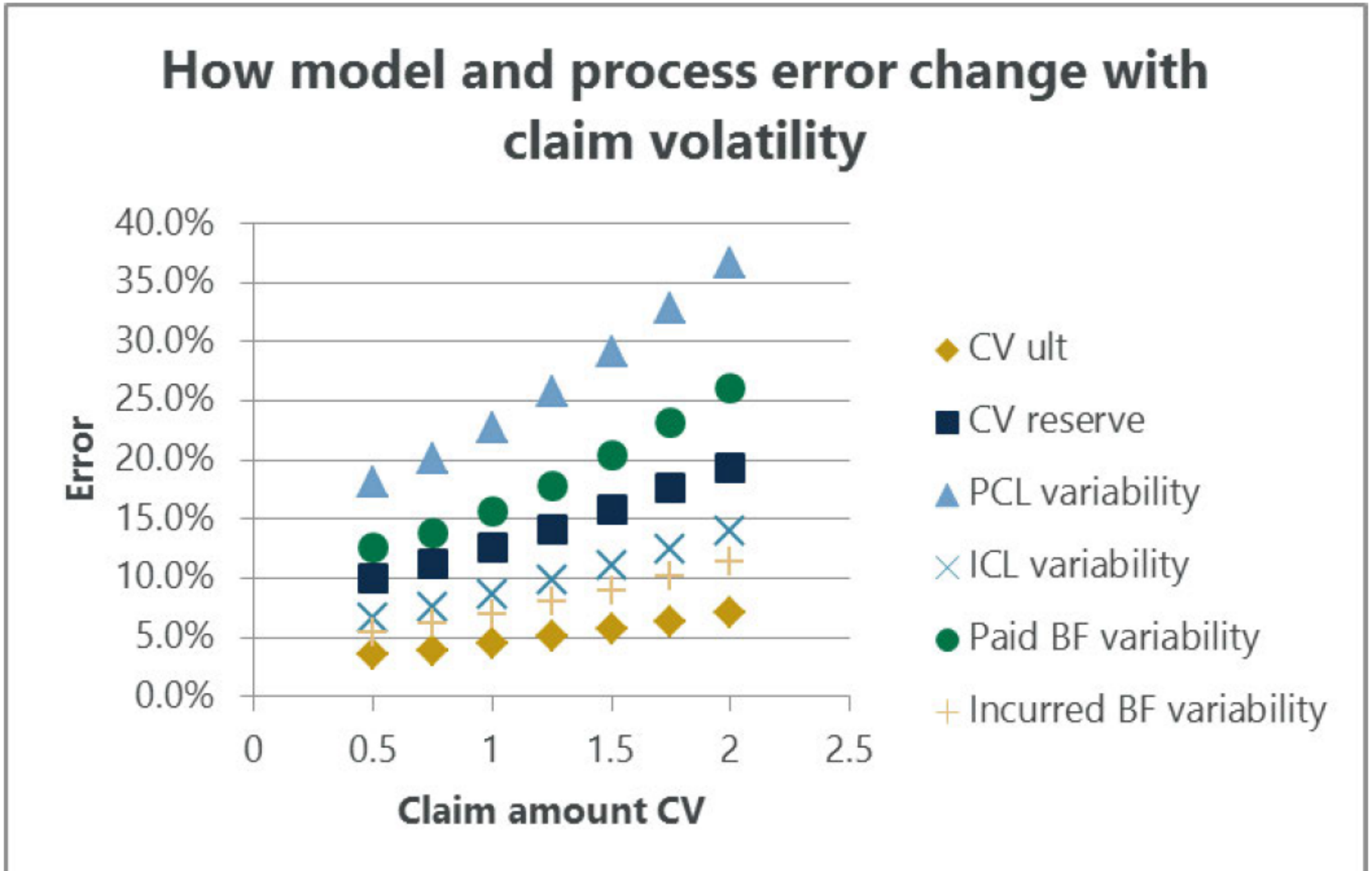
# Results 6 – Sensitivity tests
## A. Claim severity

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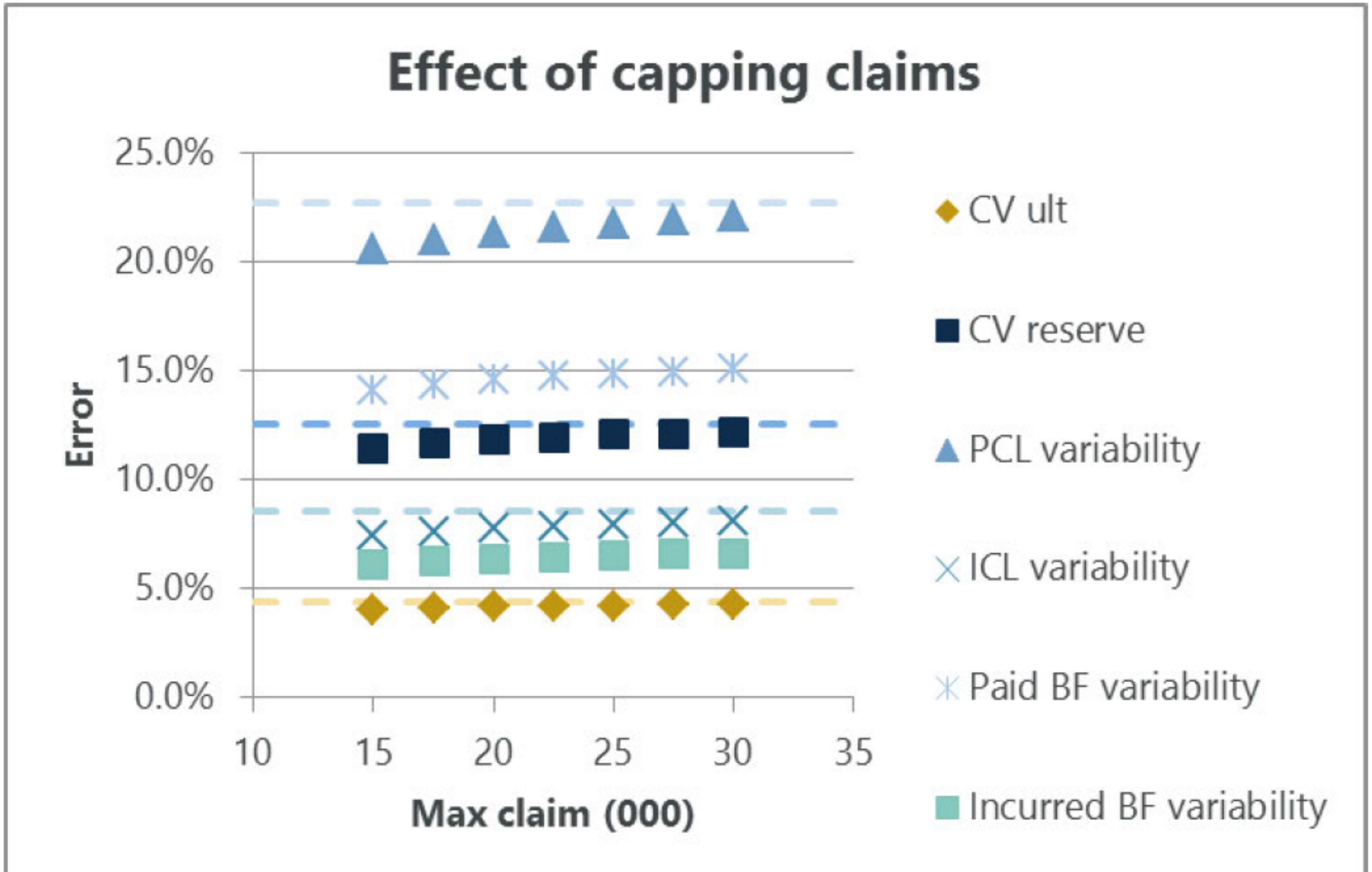
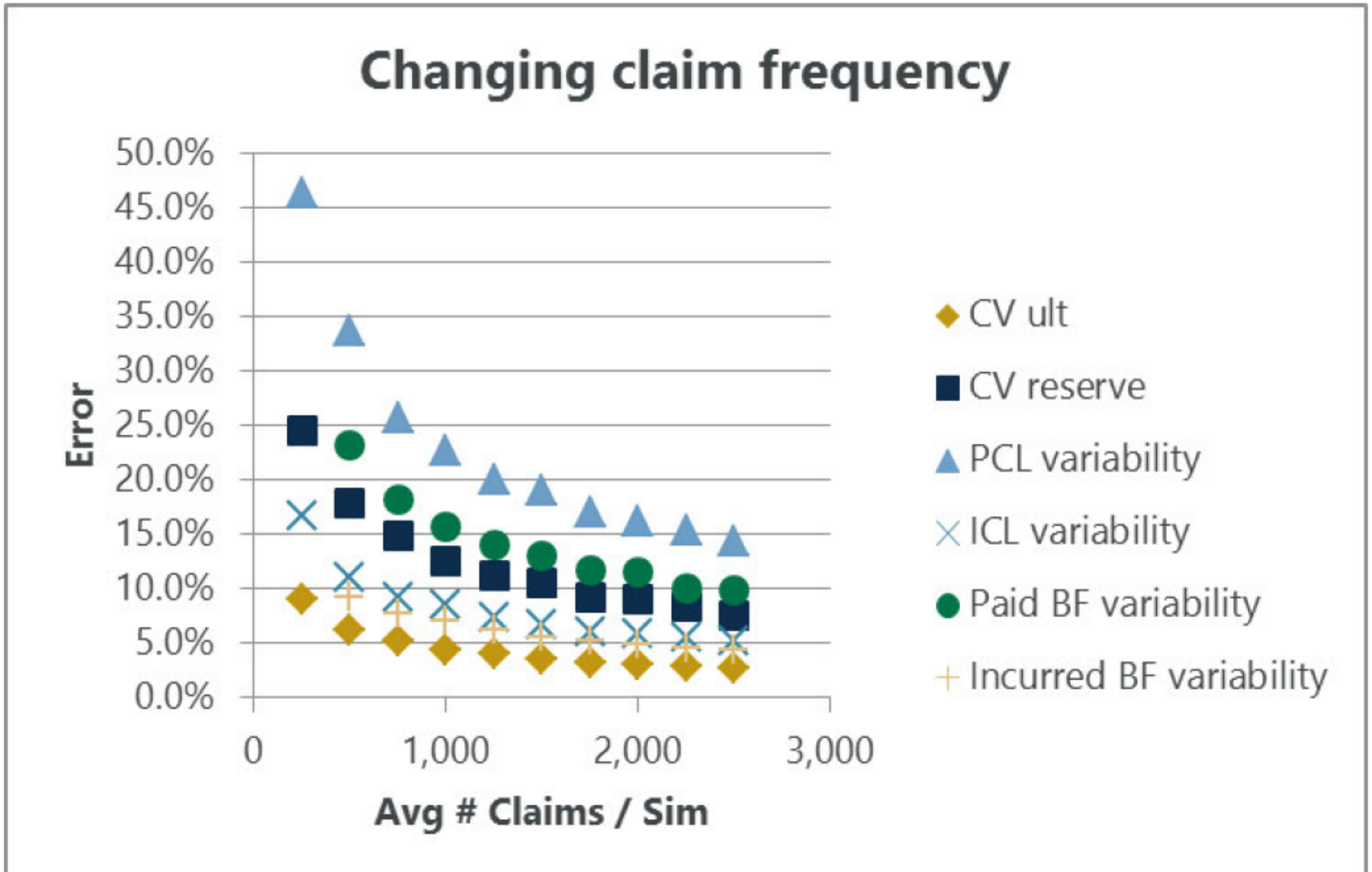
# Results 6 – Sensitivity tests
## B. Claim capping



# Results 6 – Sensitivity tests
## C. Claim frequency

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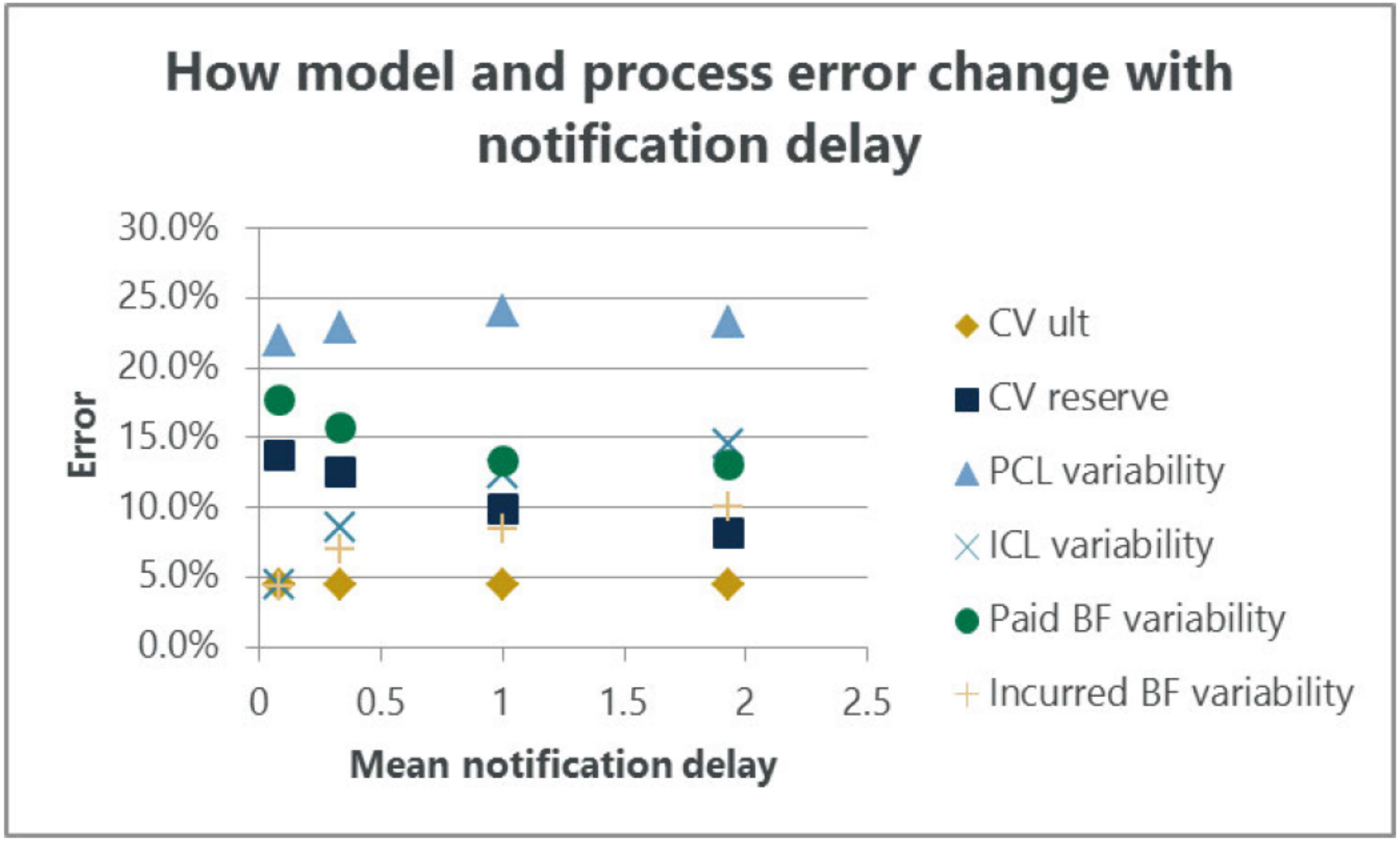
# Results 6 – Sensitivity tests
## D. Notification delay

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# Results 7 – Model robustness

Using our simulated loss data, we can evaluate how each of our methods performs under a range of conditions:

*Stable features*

- Initial under-reserving
- Assuming some claims settle for nil ("win factor")
- Both under-reserving and win factor

*Unstable feature*

- Weakening claims reserves over time

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# Results 7 – Model robustness
# Summary results

| Additional feature | Model bias | Projection error |
|---|---|---|
| Base model | 0% | 13% |
| Initial under-reserving | 0% | 14% |
| Under-reserving and win factor | -1% | 15% |
| Weakening case estimates over time | 16% | 11% |

No impact

Big impact

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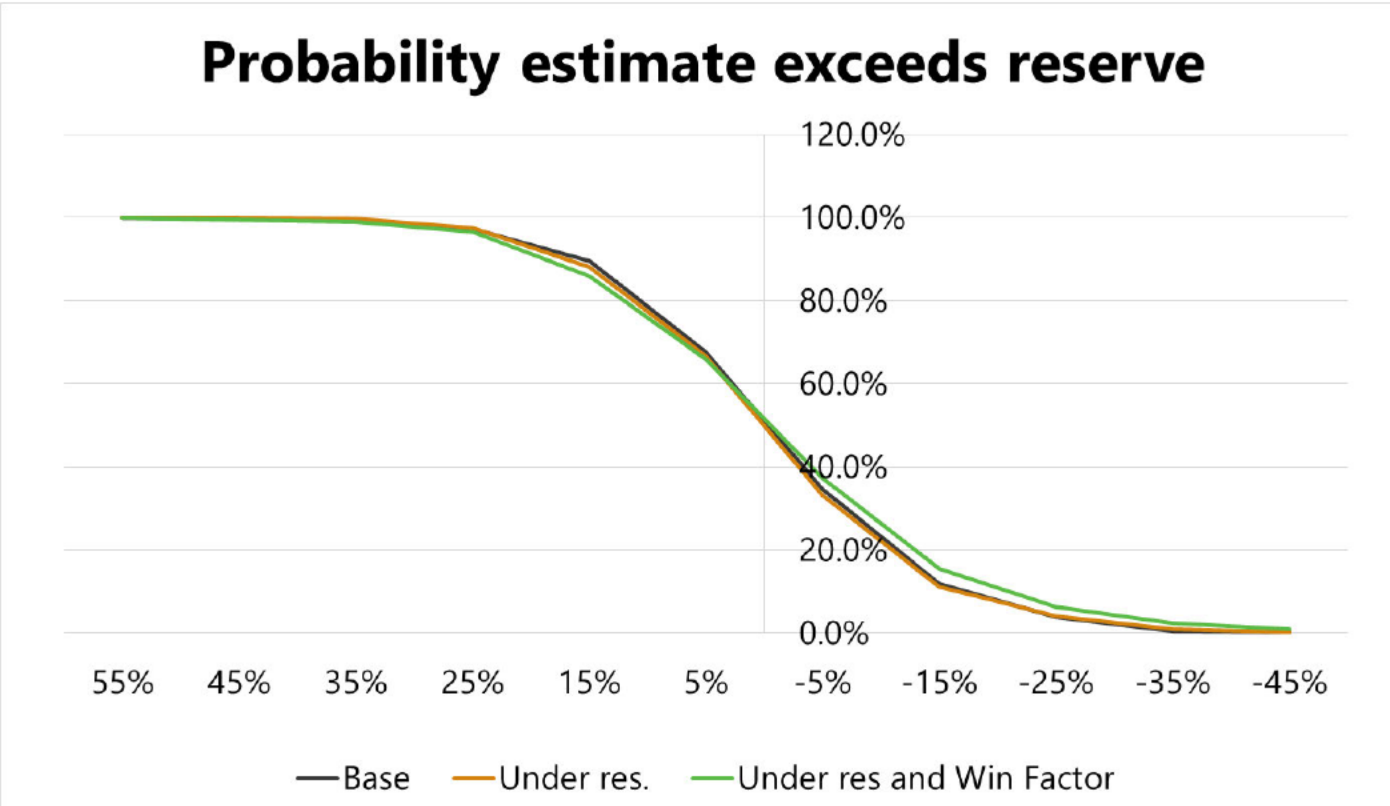
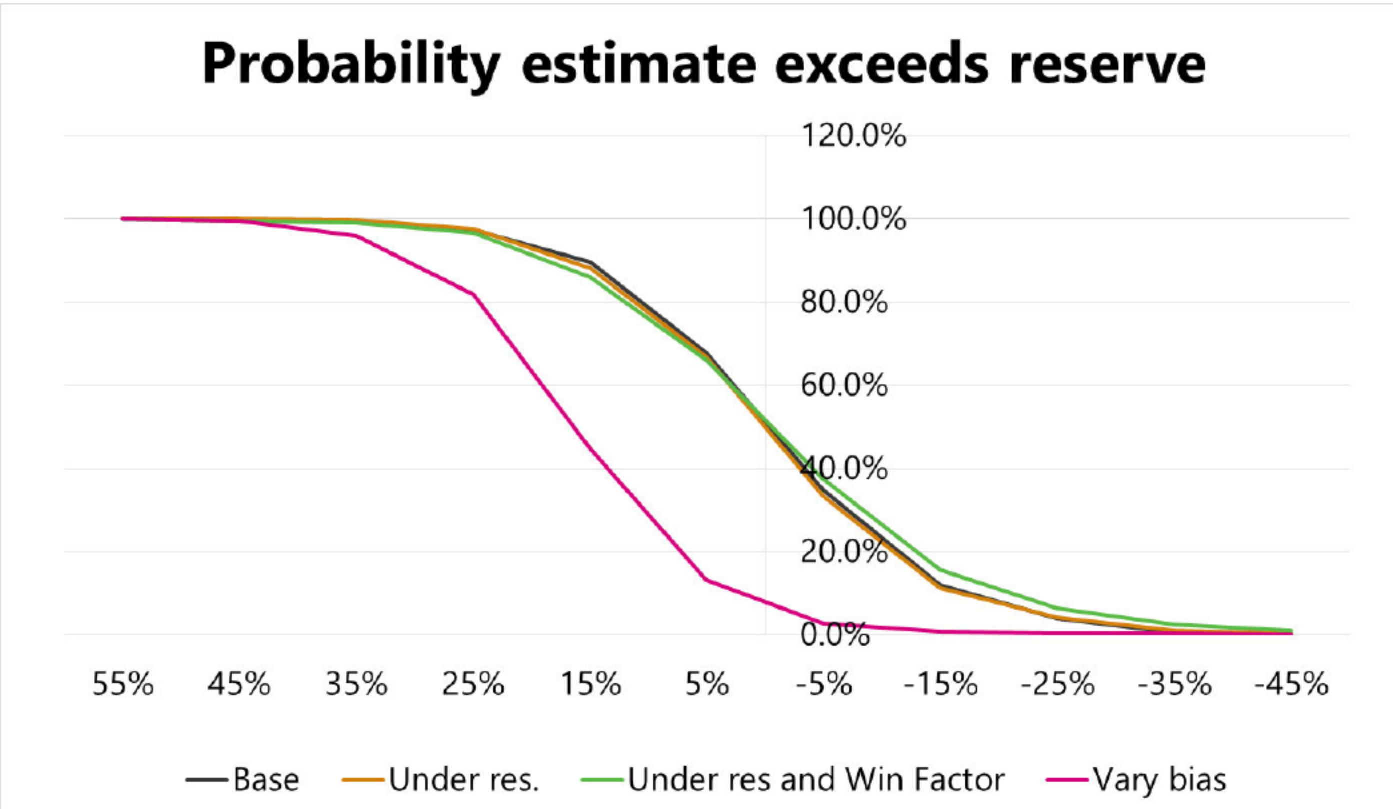
# Results 7 – Model robustness
# Stable features cause no problems



# Results 7 – Model robustness
# Model fails with non-stable process

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# Learning points

- Simple approach to simulating loss data behaves as we expected
- Behaviour aligns with expectations under a range of scenarios.
- Approach provides a means of evaluating new and existing reserving and reserve variability model techniques.
- And rules of thumb for practical applications.

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# Where next?

- Establish a set of base-line results
- Widen availability of data sets
- Refine our methodology for production and analysis of data sets
- Report on key measures and rules of thumb
- Recruiting for members of a steering group to oversee and challenge next phase of research

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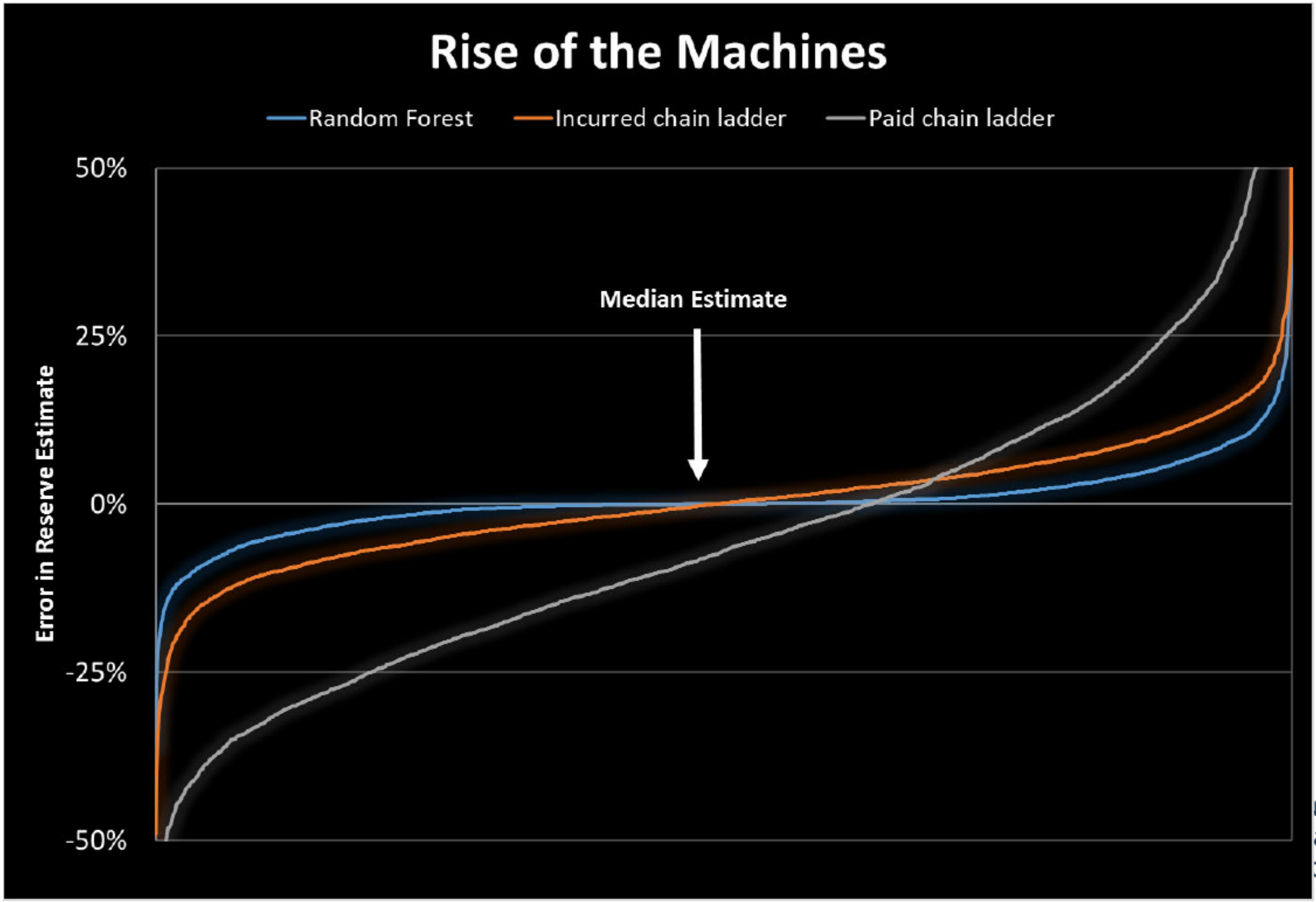
# And the future?



# Final thoughts…

- Can a machine learning approach be used to give a better estimate than an actuary?
- Certainly it will be faster…
- How soon until human actuaries are replaced?

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# Questions

# Comments

Expressions of individual views by members of the Institute and Faculty of Actuaries and its staff are encouraged.

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

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