Triangle Free Reserving

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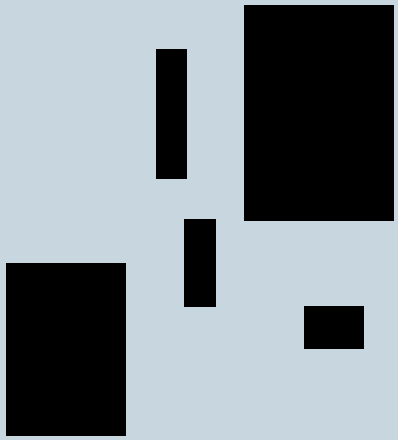
Agenda

- Introduction
  - Triangle Free Reserving – a framework, not a method
- Triangle Free Reserving
  - IBNER
  - IBNR Frequency
  - IBNR Severity
- Results

Introduction

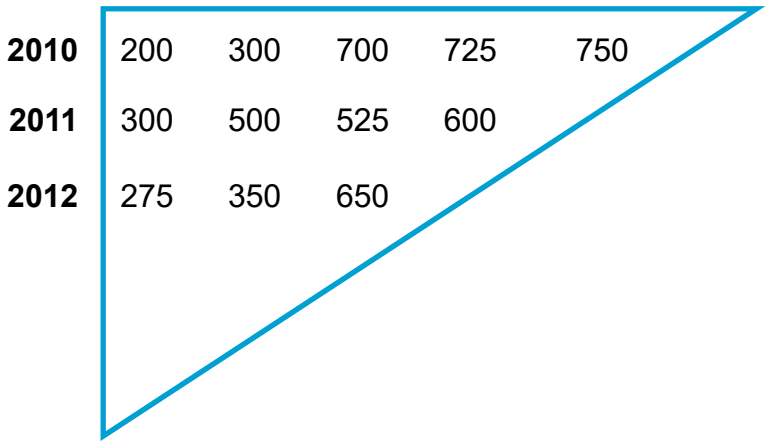


The “Triangle Trick”

- Most reserving techniques compact historical loss experience into a loss development triangle – a powerful tool that summarizes the complex process of insured’s reporting claims and insurers settling them
  - Successful and simple
- Once data is summarized into a triangle, a large amount of information is lost
  - Regardless of the number of claims, a ten year period is summarized into only 55 data points
- Like image compression, a triangle obscures the original, information rich image. Triangle Free Reserving relies on the original detailed data and is an alternative to traditional techniques

- Method presented today based on paper by Pietro Parodi – “Triangle-free reserving: a non-traditional framework for estimating reserves and reserve uncertainly”

Triangle Based Methods



2010	200	300	700	725	750
2011	300	500	525	600	
2012	275	350	650		

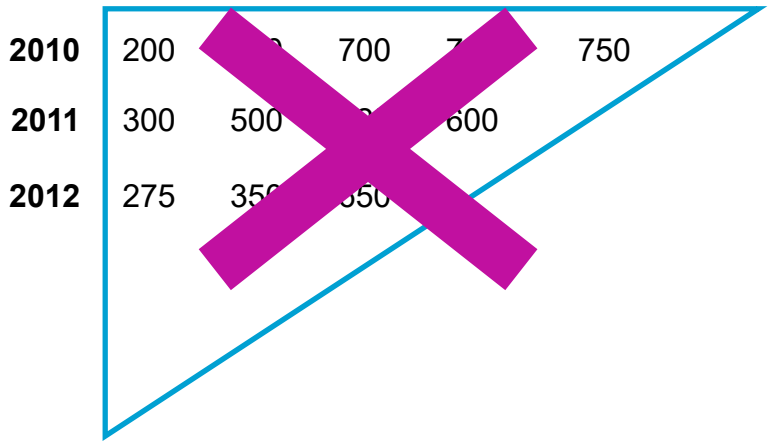
- Traditional actuarial techniques focus on highly aggregated data
- In order to get as much information out a triangle as possible, we employ a variety of techniques:
  - Development Factors, Bornheutter-Ferguson, Cape Cod, etc.
- To measure variability, we either select judgmental ranges, or add additional methods on top of triangles such as bootstrapping residuals

Non-trivial Assumptions Underlie Triangle-Based Projections

2010	200	300	700	725	750
2011	300	500	525	600	
2012	275	350	650		

- Paid Projections:
  - Payments will occur at the same rate as in the past
  - Payments will have similar costs in the future as they did in the past
- Reported Projections:
  - Same assumptions as paid
  - Case reserving occurs at the same rate as in the past
  - Appropriate case reserve amount is similar to case reserves in the past

Triangle Free Methods



If we didn't know triangles existed today, how would we estimate reserves?

Triangle Free Reserving isn't a specific method – it's a framework: To develop claims using individual claims data, what would you need?

The alternative – return to original data

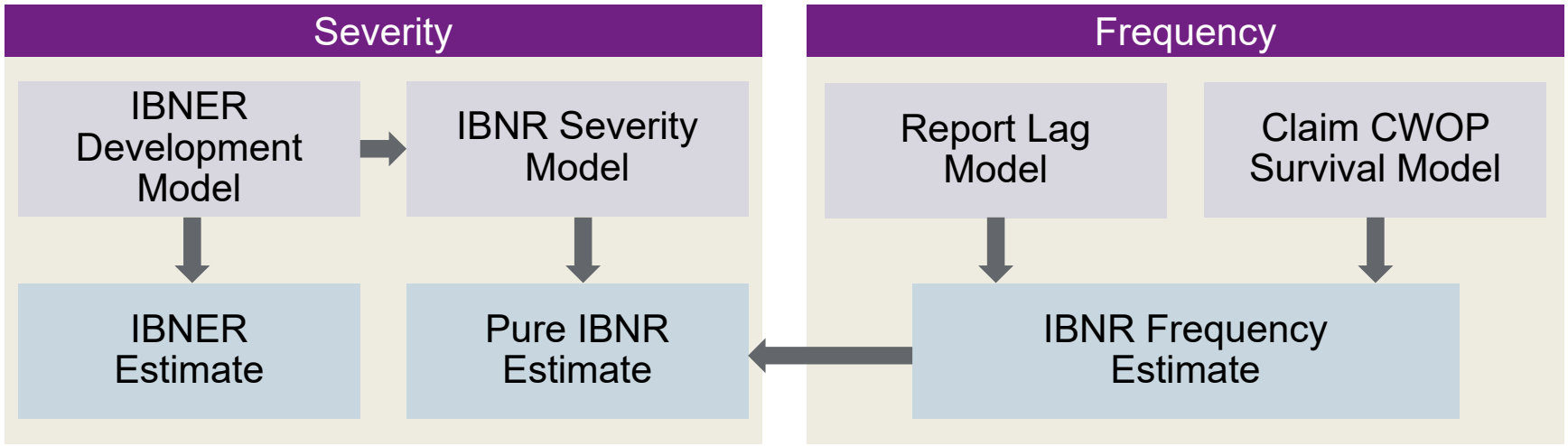
Claim	Loss Date	Reported Date	Evaluation Date	Open	Attorney	Medical Only	Reported Loss
00001	5/30/2017	7/15/2017	12/31/2018	Y	Y	N	50,000
00002	6/15/2017	6/15/2017	12/31/2018	N	N	Y	500
00003	2/10/2018	2/15/2018	12/31/2018	Y	N	Y	6,000
00005	11/5/2018	11/9/2018	12/31/2018	Y	N	Y	1,000
00001	5/30/2017	7/15/2017	12/31/2019	N	Y	N	60,000
00002	6/15/2017	6/15/2017	12/31/2019	N	N	Y	500
00003	2/10/2018	2/15/2018	12/31/2019	N	Y	N	20,000
00005	11/5/2018	11/9/2018	12/31/2019	Y	N	Y	2,000

Claims level data is information rich – and can be used to study claims processes in more detail:

- Report lag by claim – and how it varies by claim characteristics
- Separately identify development on known claims (IBNER) versus development from newly reported claims
- Analyze how known claims develop (what claims characteristics are impactful to development?) or the probability that a claim is likely to develop above a certain threshold

Triangle Free Reserving – a Framework

(Not a specific method)



For each model:

Simple:

- Curve Fitting
- Empirical Distributions

Complex:

- GLMs
- Machine Learning

- Complexity of each can model can vary as needed
- Form of each model doesn't depend on the others

Triangle Free Reserving – Advantages

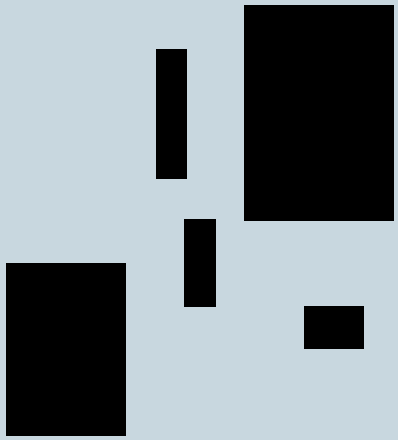
- Split IBNER vs. IBNR
- Single Framework for Point and Range Estimates
- Easy to incorporate new information
- Flexibility

Triangle Free Reserving – Caveats

- Requires detailed information:
  - At minimum by claim: Loss Date, Report Date, history of loss amounts by evaluation period
  - To incorporate information such as the presence of an attorney – it's not enough to know that a claim is litigated – also need to know when the insurer first knew this
- Computationally intensive
  - With large datasets, the empirical distributions these methods create can be large. Pulling random samples from these distributions to generate ranges can be time consuming

Triangle Free Reserving

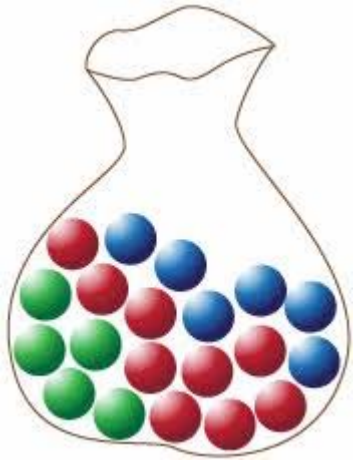
The Framework



Triangle Free Reserving – Overview

Each model can be developed in a variety of ways – or even in some cases lifted from existing processes (such as case reserving models for IBNER).

For our application, we focused on empirical distributions for all models.



Draw:
2 red
4 blue
4 green

Bag of Marbles PDF	
Color	Probability
Red	20%
Blue	40%
Green	40%

Benefit of this approach: Can evaluate how the framework performs on different datasets objectively. However in reality there would likely be more judgement involved at each step.

IBNER Model – Traditional Development

Claim	Incurred Amount Age 12	Incurred Amount Age 24	12-24 Factor
00001	4500	5000	
00002	500	0	
00003	250	500	
00005	0	300	
00006	0	125	
Sum	5250	5925	1.129

Typical Triangle Method – sum incurred amounts by age and take the ratio.

- This captures IBNER development on known claims, but also development on claims that may not have been known about at earlier ages.

IBNER Model – IBNER Specific Development

Claim	Incurred Amount Age 12	Incurred Amount Age 24	12-24 Factor
00001	4500	5000	
00002	500	0	
00003	250	500	
~~00005~~	~~0~~	~~300~~	
~~00006~~	~~0~~	~~125~~	
Sum	5250	5500	1.048

To capture IBNER exclusively, we focus on only open claims at a given age for each ATA factor.

- So for our current Age 12 accident period, we would develop incurred amounts by only 4.8% (rather than 12.9% from the previous slide).

IBNER Model – Why are IBNER specific LDFs better?

Claim	Incurred Amount Age 12	Incurred Amount Age 24	12-24 Factor
00001	4500	5000	1.111
00002	500	0	0.000
00003	250	500	2.000
~~00005~~	~~0~~	~~300~~	
~~00006~~	~~0~~	~~125~~	
Sum	5250	5500	1.048

By focusing on IBNER specific LDFs:

- We generate factors that can be used to develop individual claims to ultimate. Once done, this can be used as an input to our IBNR Severity model.
- We can analyze the distribution of IBNER factors by age (required for ranges, also useful insight).

IBNER Factors - Age 12-24	
Factor	Probability
0.000	20%
0.100	10%
1.000	50%
1.500	10%
2.000	10%

IBNER Model

IBNER Factors - Age 12-24	
Factor	Probability
0.000	20%
0.100	10%
1.000	50%
1.500	10%
2.000	10%

A starting point:

- Can split into different distributions by claim type
  - Litigated vs. not; Medical vs. Indemnity, etc.
- GLM fit to IBNER factors possible:
  - Can use age, size of incurred amount, ratio of outstanding to incurred, many other variables
- Many companies have already implemented case reserving models
  - If that's the case – you already have an IBNER model.

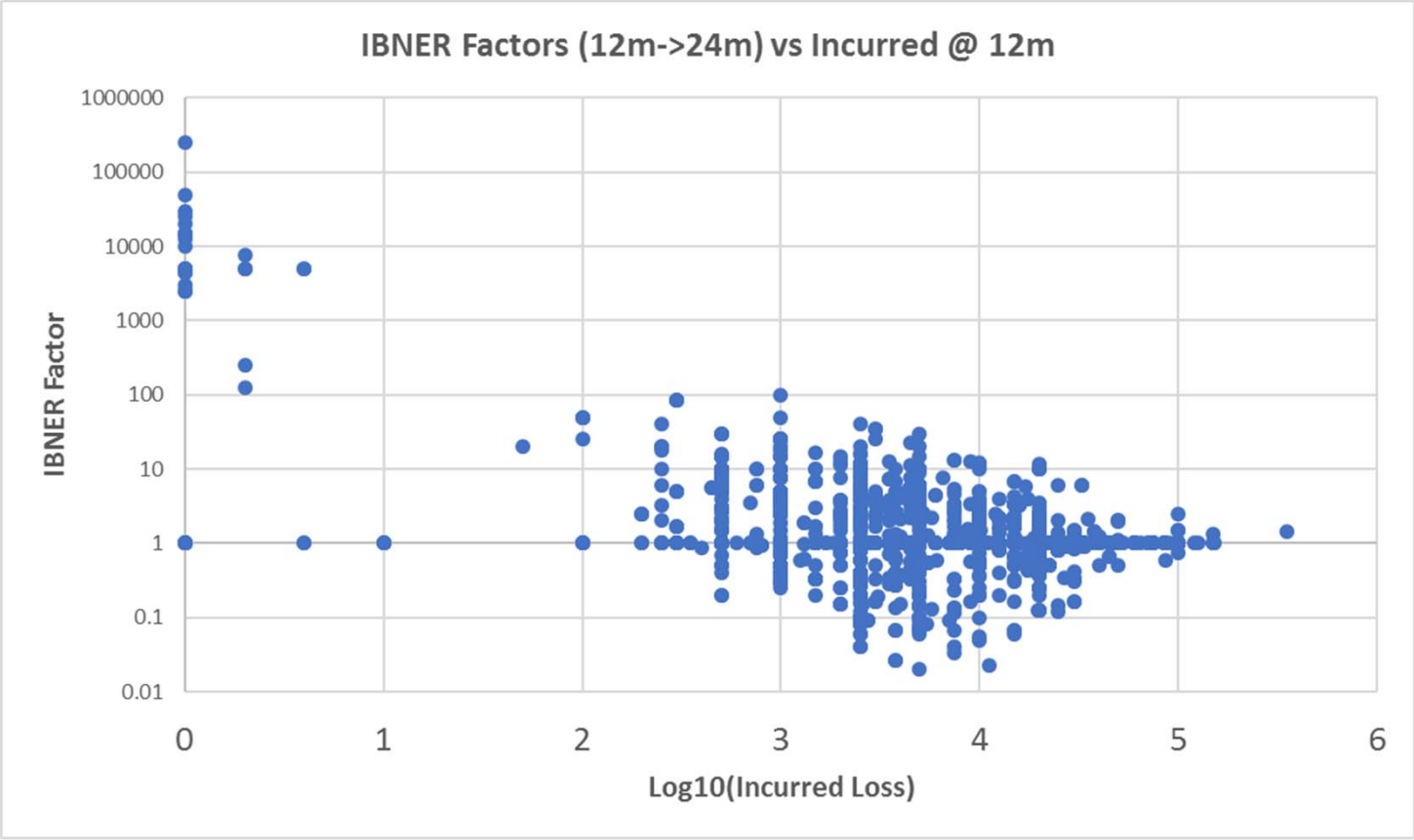
IBNER Model – Sampling to generate distribution

Incurred Amount		Sample 1	Sample 2	Sample 3
Claim	12	12-24 Factor	12-24 Factor	12-24 Factor
00001	4500	0.100	1.000	0.000
00002	500	1.000	0.000	1.000
00003	250	1.000	1.500	0.100

Once you've created an empirical distribution of IBNER factors, you can use it to run simulations of IBNER development:

- For each simulation:
  - Sample from the appropriate IBNER distribution by age to develop each claim to ultimate.

IBNER Model – Diagnostics



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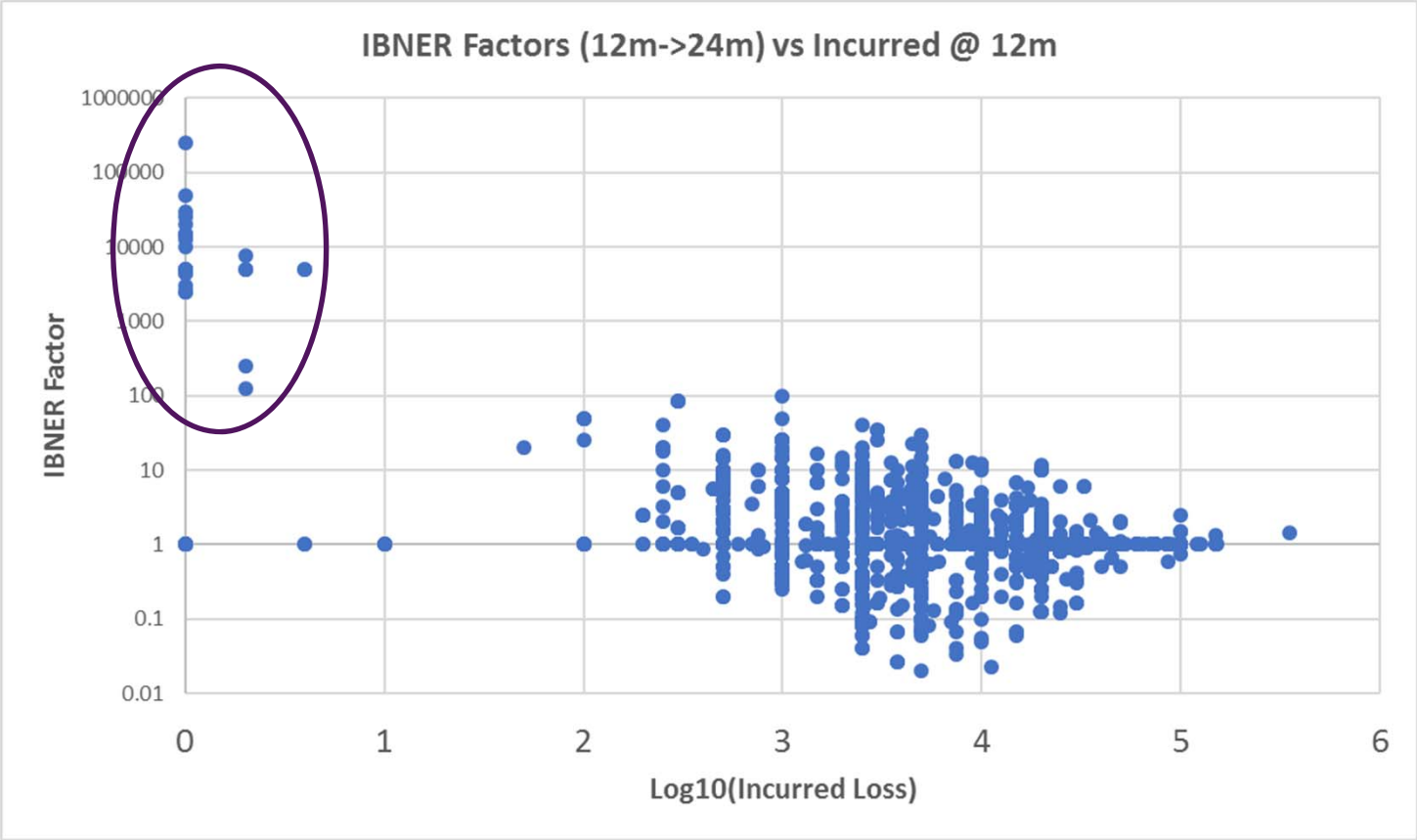

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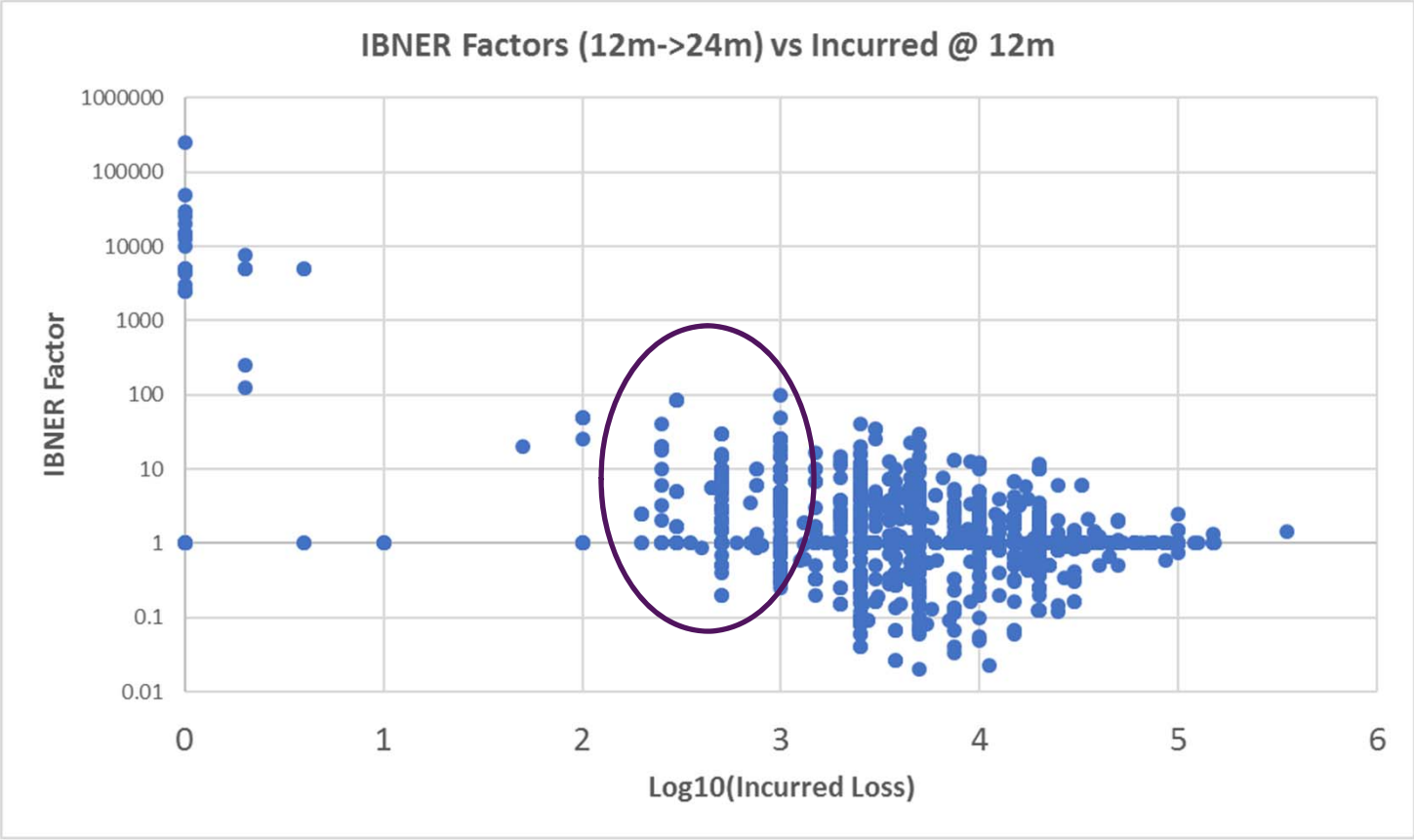
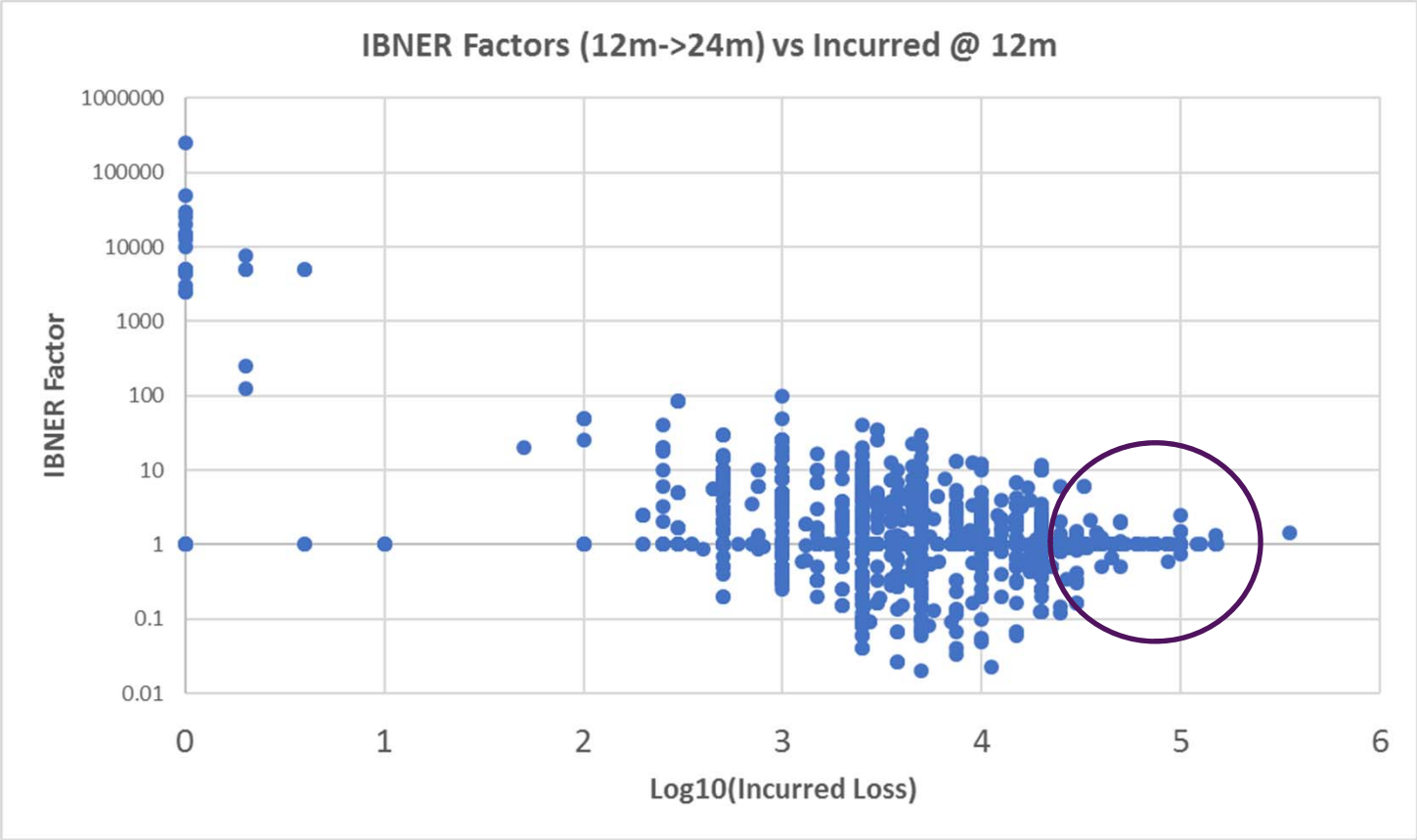


IBNER Model – Diagnostics



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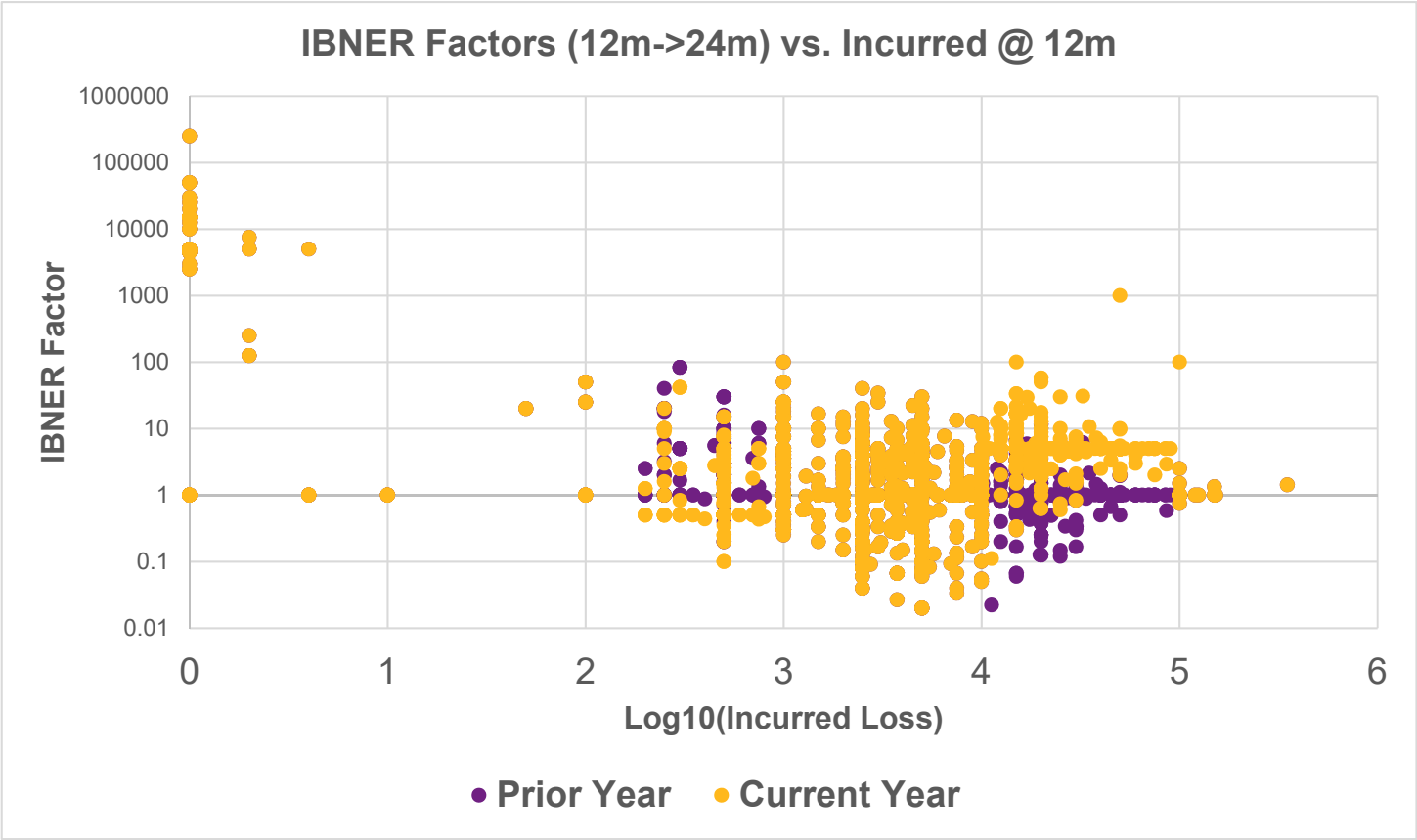

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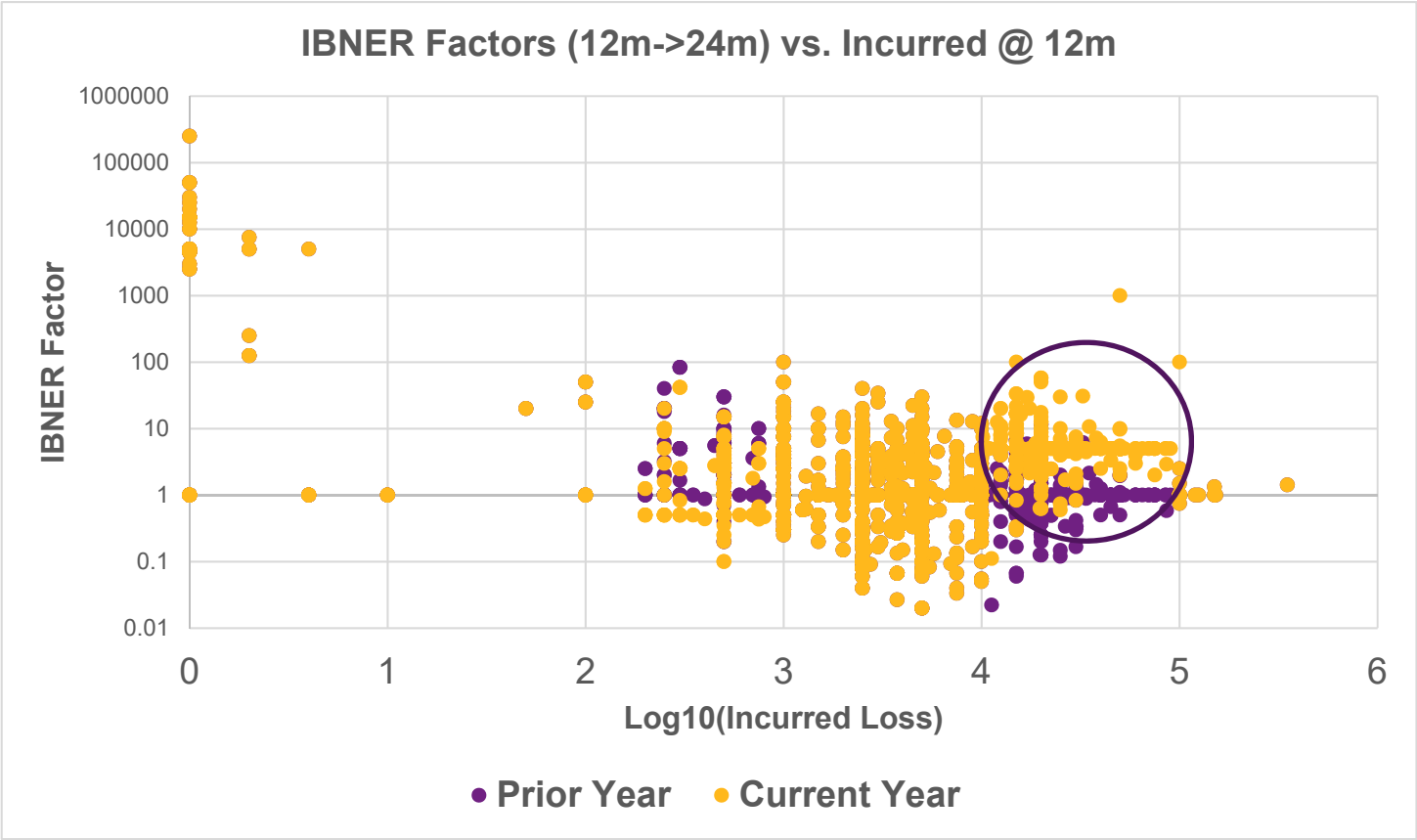


IBNR Severity

Multiple options – but your IBNER model is a starting point.

Claim	Status	Age	Incurred Amount	Wtd Avg IBNER Factor	Ultimate Incurred Amount
00001	Closed	N/A	4,500	-	4,500
00002	Closed	N/A	500	-	500
00003	Open	3	250	1.20	300
00005	Closed	N/A	5,000	-	5,000
00006	Open	2	750	1.30	975

Once you've developed individual claims to ultimate – those ultimate severities can be sampled from to generate an IBNR Severity distribution.

- Need to trend claims to current accident year level.

IBNR Frequency – Reporting Lag

Claim	Loss Date	Reported Date	Days Lag
00001	10/17/2014	10/23/2014	6
00002	12/14/2014	12/18/2014	4
00003	12/24/2014	12/26/2014	2

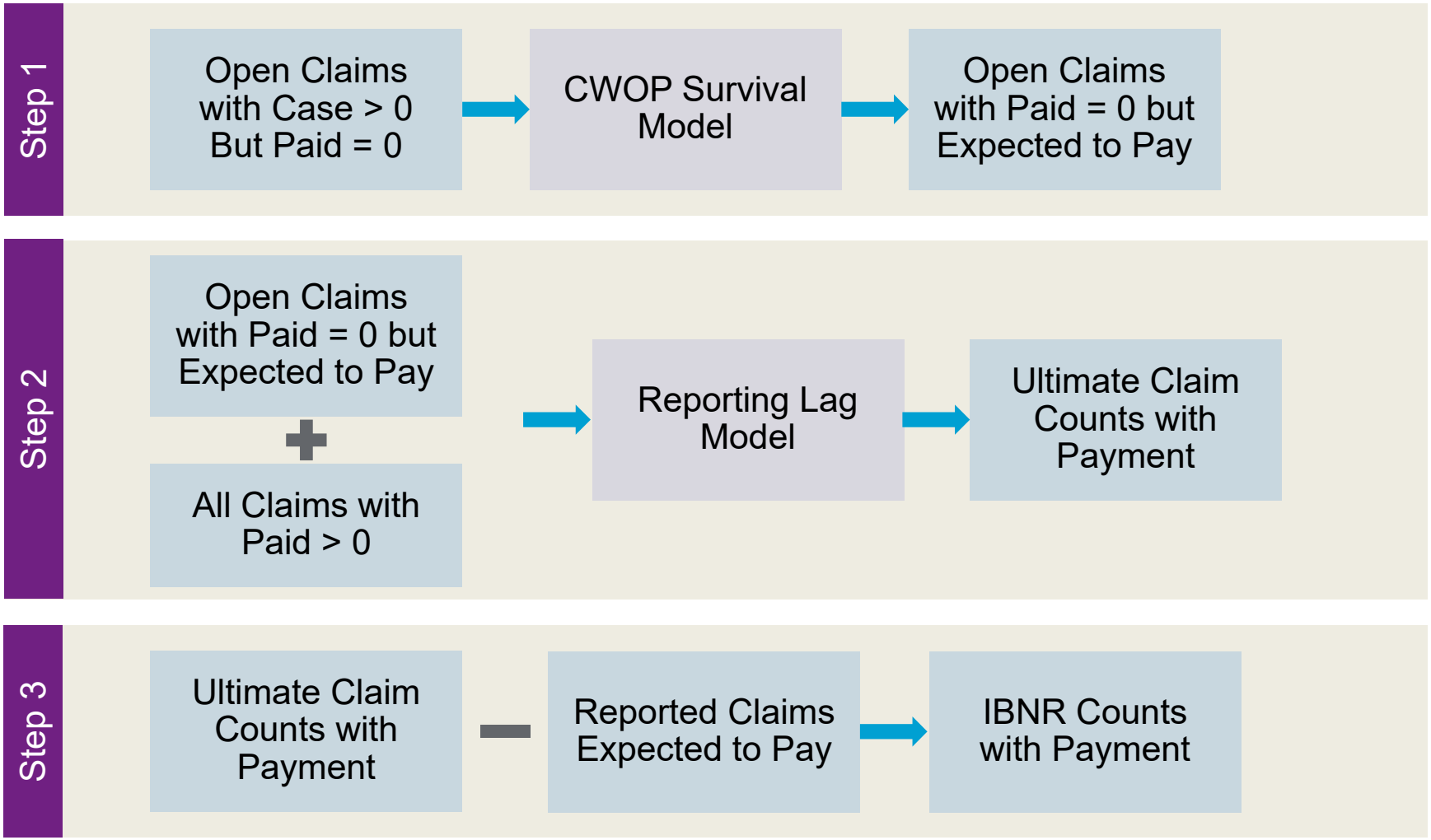
Days Lag	% Of Claims
0	15.00%
1	12.00%
2	10.00%
3	5.00%
4	3.00%

IBNR Frequency – CWOP Survival Distribution

Age in Years	# of Claims with Incurred > 0	# of Claims with Incurred > 0 in Current Period, But Dropped to Zero Next Period	Year on Year Probability a Claim Drops to 0	Year on Year Probability a Claim Doesn't Drop to 0	Cumulative Survival Probability
4	425	0	0%	100%	100%
3	450	25	6%	94%	94%
2	500	50	10%	90%	85%
1	600	100	17%	83%	71%

Reporting lag allows us to estimate number of claims not yet reported – but need to reduce estimate to only claims that will actually have a payment.

IBNR Frequency



IBNR – Sampling to Generate a Distribution

At this point we have:

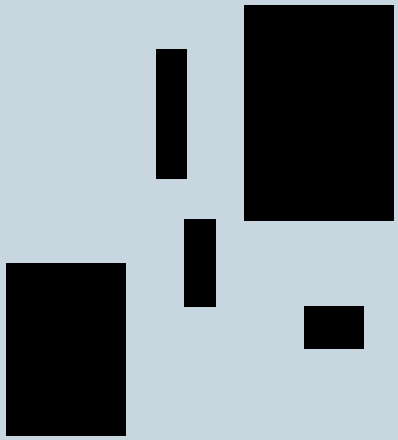
- An estimate of IBNR claims that are expected to have payments.
- A distribution of IBNR Severity.

From here we generate a distribution of pure IBNR:

- For counts, we can assume counts are Poisson and draw random samples (our IBNR claim estimate as the mean).
- For each sample of counts, we draw from our IBNR Severity distribution.

Note that a separate analysis on the variance of claim counts can be used to verify that Poisson is appropriate – otherwise negative binomial can be used to explicitly control the variance of claim counts.

Results



The Data

Fit the separate components on California Personal Auto Bodily Injury data.

- Quarterly basis
- Let empirical distributions flow through without adjustment, as a test.
- In practice we would analyze the distributions by AY or CY to ensure that no trends emerge.

Data is masked to hide the identity of the client.

Bulk of work in Python.

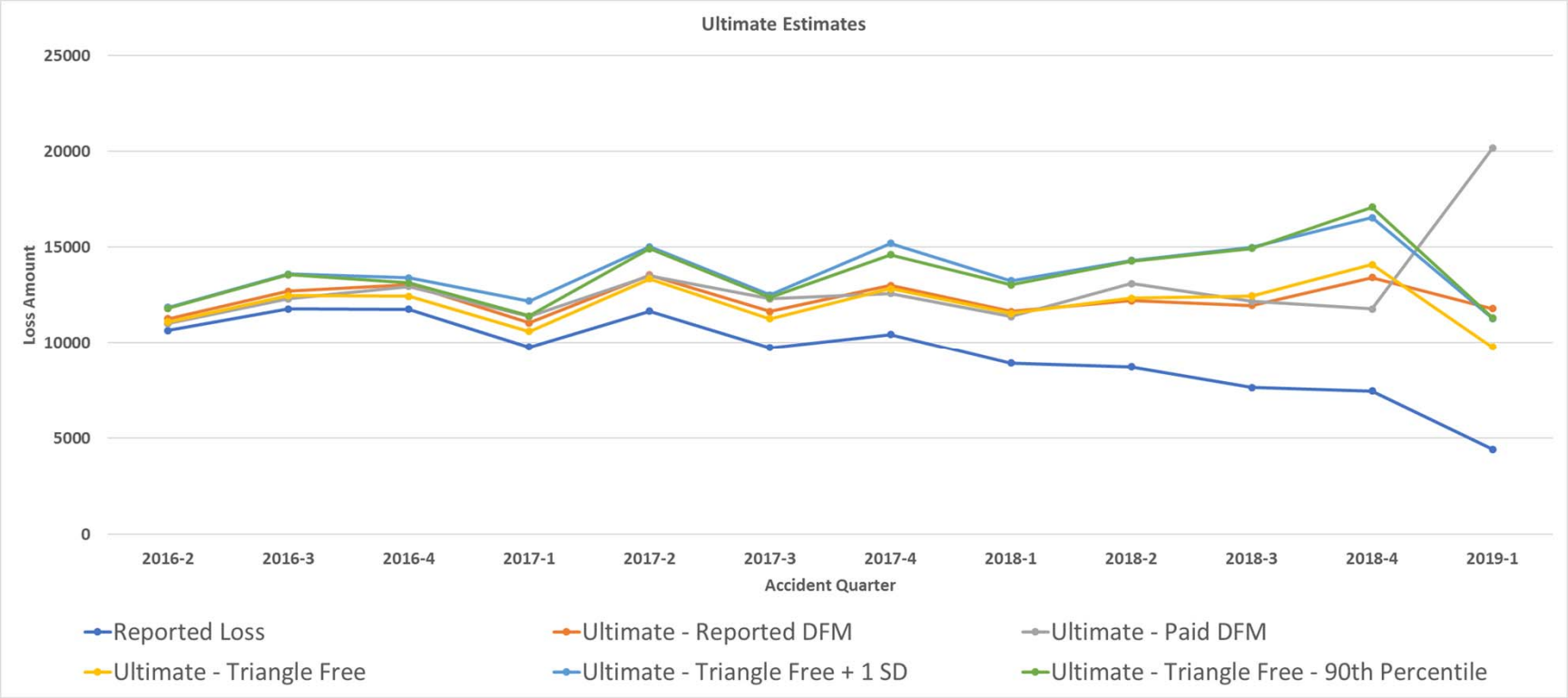
IBNER Results

	Incurred Loss		IBNER Estimate				
AQ	Closed Claims	Open Claims	Deterministic	Standard Dev	CV	90% Percentile	95% Percentile
2016-2	8,716	1,932	444	752	169%	1,151	2,120
2016-3	9,234	2,537	688	1,122	163%	1,783	2,617
2016-4	9,513	2,248	668	947	142%	1,361	2,367
2017-1	7,594	2,172	827	1,571	190%	1,634	2,129
2017-2	7,469	4,183	1,679	1,643	98%	3,233	3,960
2017-3	6,443	3,295	1,515	1,209	80%	2,611	3,641
2017-4	5,209	5,217	2,383	2,343	98%	4,140	5,564
2018-1	3,958	4,954	2,616	1,663	64%	4,079	5,360
2018-2	3,162	5,551	3,596	1,906	53%	5,495	6,159
2018-3	1,154	6,478	4,751	2,472	52%	7,186	8,853
2018-4	444	7,006	6,538	2,385	36%	9,447	10,721
2019-1	199	4,226	4,947	1,361	28%	6,283	6,787

IBNR Results

	Incurred Loss		IBNR Estimate				
AQ	Reported	IBNER	Deterministic	Standard Dev	CV	90% Percentile	95% Percentile
2016-2	10,649	444	1	5	557%	1	4
2016-3	11,771	688	1	5	368%	4	12
2016-4	11,761	668	3	11	373%	8	14
2017-1	9,766	827	4	14	329%	14	22
2017-2	11,652	1,679	13	34	260%	30	64
2017-3	9,738	1,515	11	33	301%	22	37
2017-4	10,426	2,383	18	28	156%	44	58
2018-1	8,911	2,616	19	30	156%	46	67
2018-2	8,713	3,596	35	56	162%	66	100
2018-3	7,632	4,751	60	77	128%	116	169
2018-4	7,450	6,538	100	69	68%	199	244
2019-1	4,425	4,947	394	141	36%	594	655

Results Comparison



In conclusion

Why Triangle Free Reserving?

Additional method to supplement triangle based analysis.

IBNER vs. IBNR split could be well suited to certain lines:

- Long tail lines (where IBNR is significant).
- WTW U.K. uses the method for captive insurers and corporate clients – works well on books where IBNER develops downwards while IBNR develops up.

Beyond the results – can provide interesting insights into drivers of development (particularly IBNER).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Appendix

Paper referenced:

Triangle Free Reserving: A non-Traditional Framework for estimating reserves and reserve uncertainly

- Pietro Parodi
- February 4, 2013