



Institute
and Faculty
of Actuaries

The Bigger Picture

Practical Challenges of Reserve Risk

Kevin Chan FCAS FCIA
Michael Ramyar FIA

26 October 2015

Practical Challenges in Reserve Risk

- **Objectives of the paper**
 - Understand and agree on the challenges
 - Better position to resolve those challenges
 - Develop generally accepted approach
- **Taster Topics**
 - Disconnection between Reserving and Reserve Risk
 - How accurate is our reserve risk estimate?



Practical Challenges in Reserve Risk

Disconnection between Reserving and Reserve Risk



Disconnect between Reserving and Reserve Risk

- **Scaling Issues**

- The mean of the Simulation process doesn't tie back to the expected mean

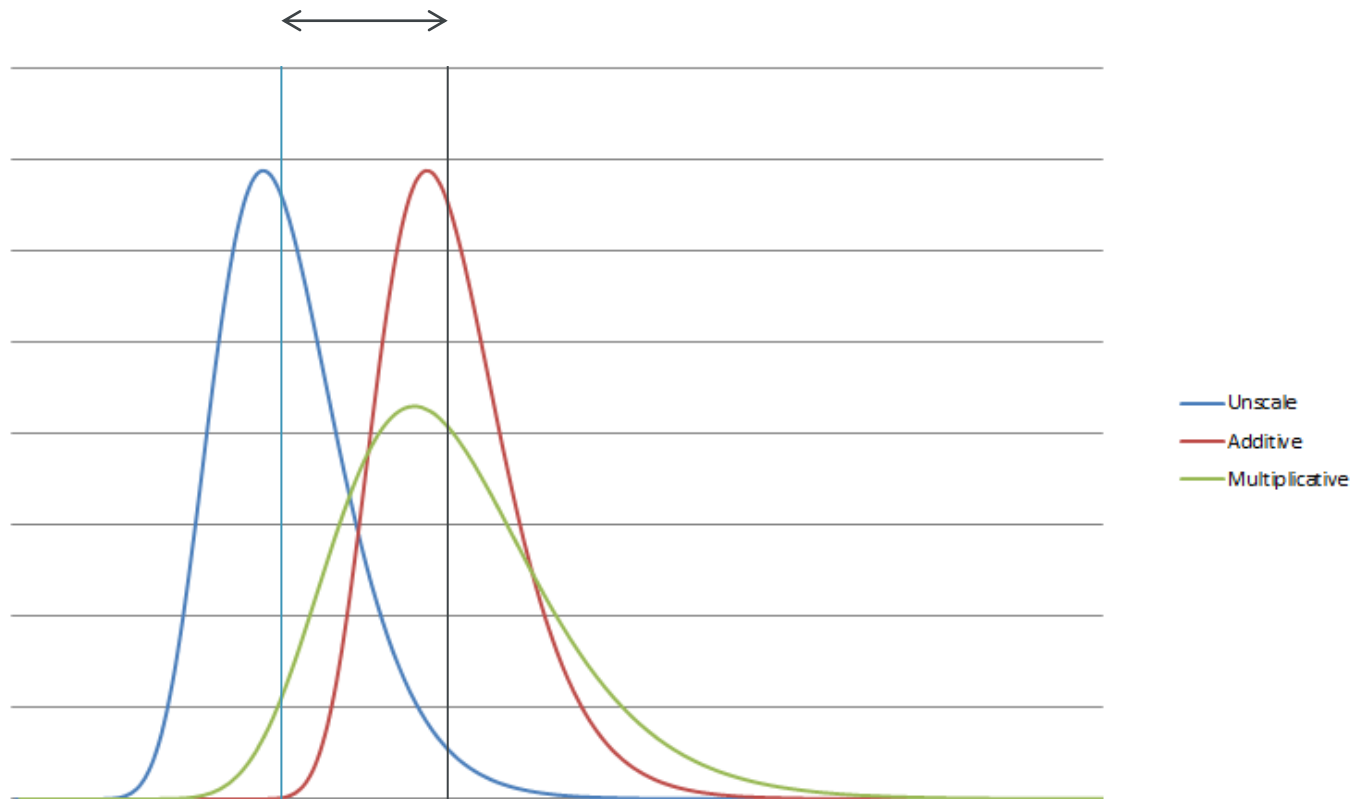
- **Scaling/Calibration Methods**

- Multiplicative, Additive or Mixed scaling
- What are they?
- Which is correct?
- More importantly - Why does it exist?



Disconnect between Reserving and Reserve Risk

- **Scaling/Calibration Methods**
 - Additive, Multiplicative, Mixed



Disconnect between Reserving and Reserve Risk

- **Inconsistencies in Data**

- Granularity
- Triangle Period
- Cut-off Date
- Incurred / Paid
- Gross vs Net

- **Inconsistencies in Model**

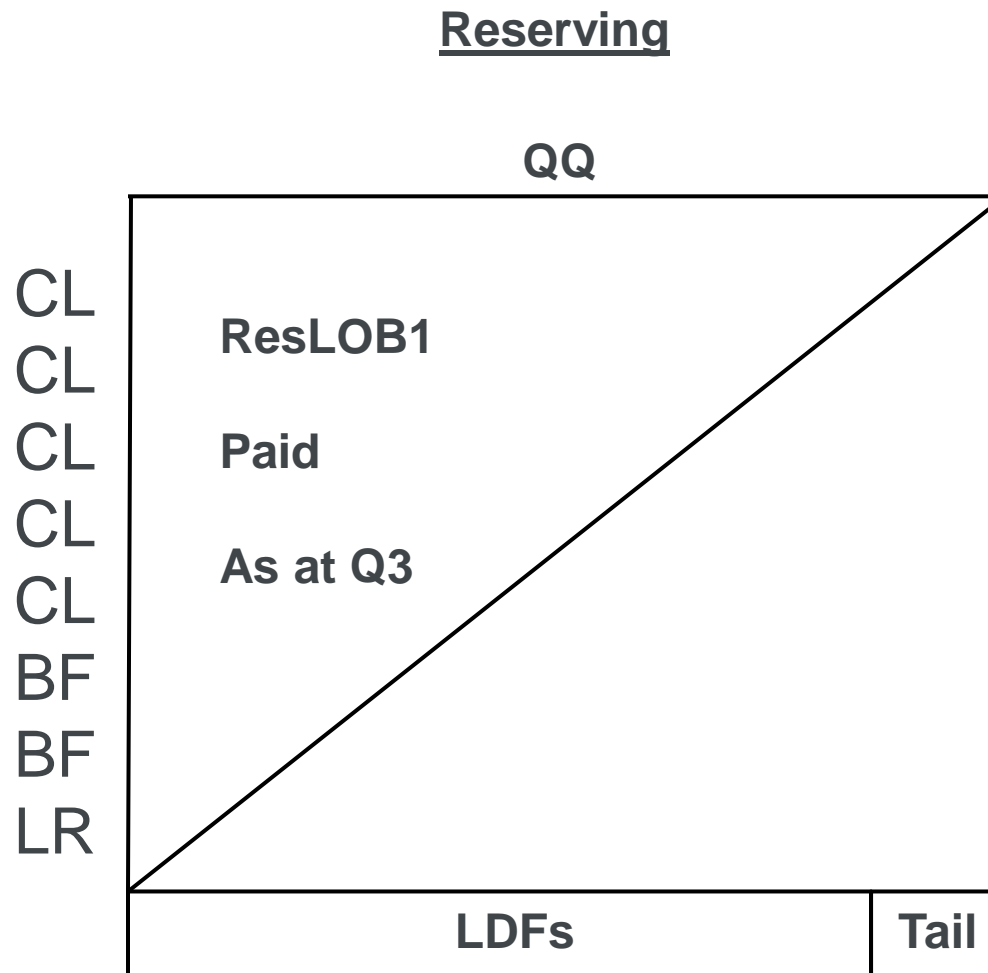
- Deterministic vs Stochastic
- Mix of Methods
- Non-triangle information

- **Inconsistencies in Parameters**

- Mack assumes volume weighted all years
- Curve fitting, Tail factor, external LDFs
- Amplified with inconsistencies in Data and Model

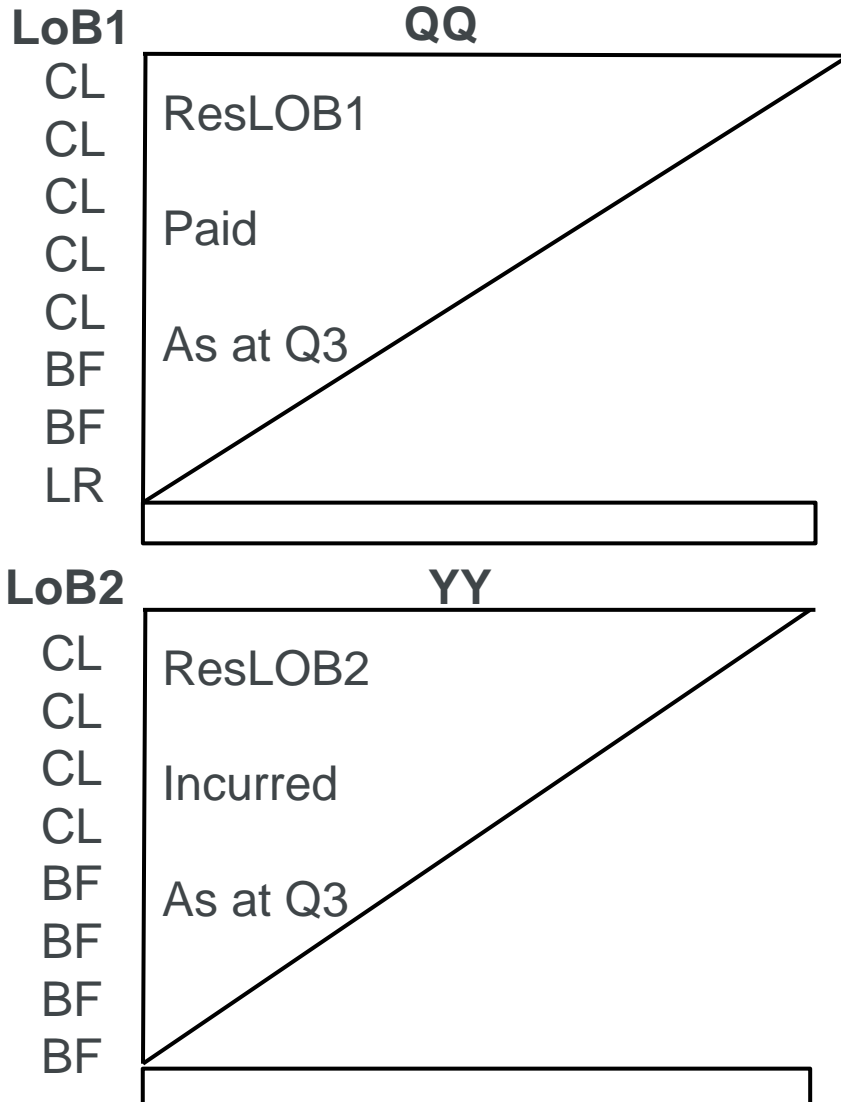


Disconnect between Reserving and Reserve Risk

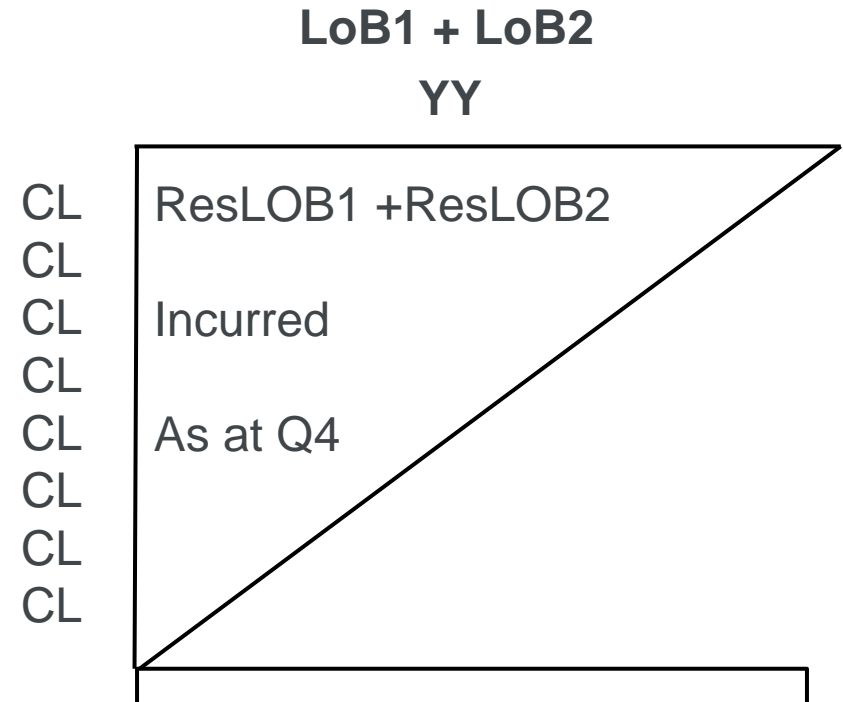


Disconnect between Reserving and Reserve Risk

Reserving (Example)



Reserve Risk (Common Approach)



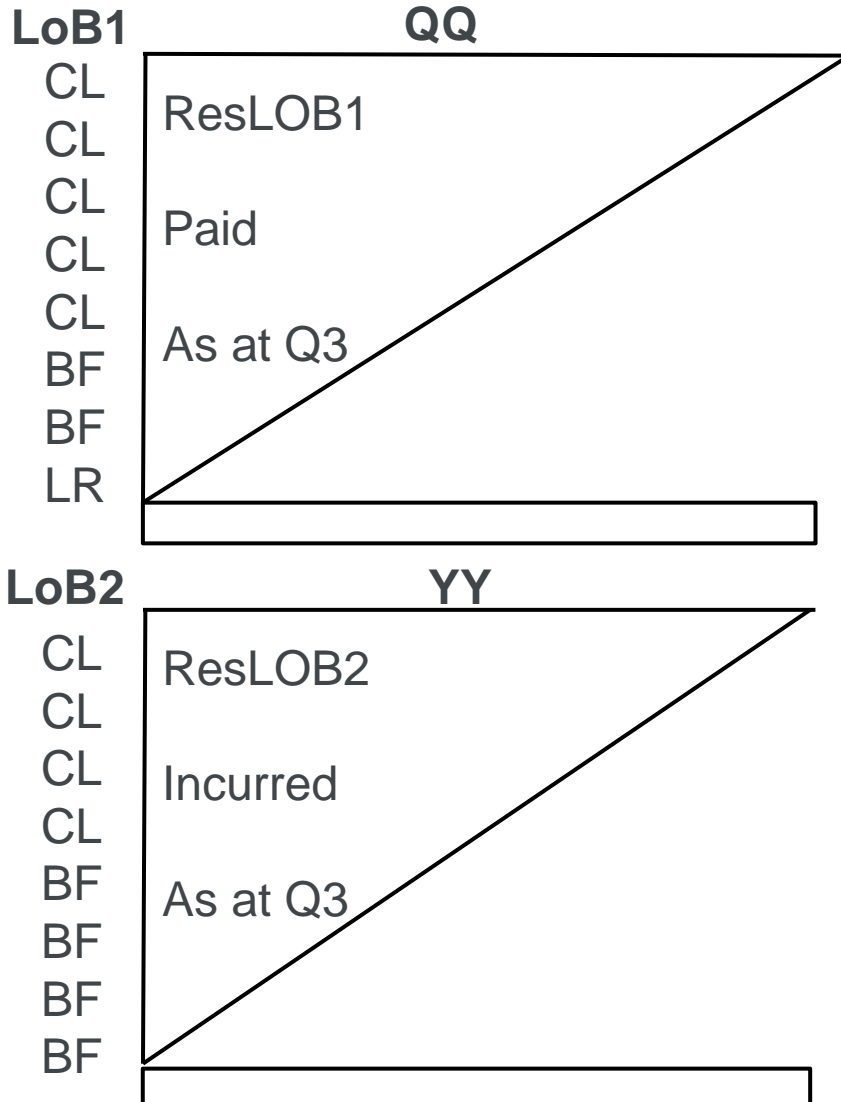
Mean reserves will
never balance - hence
scaling issues



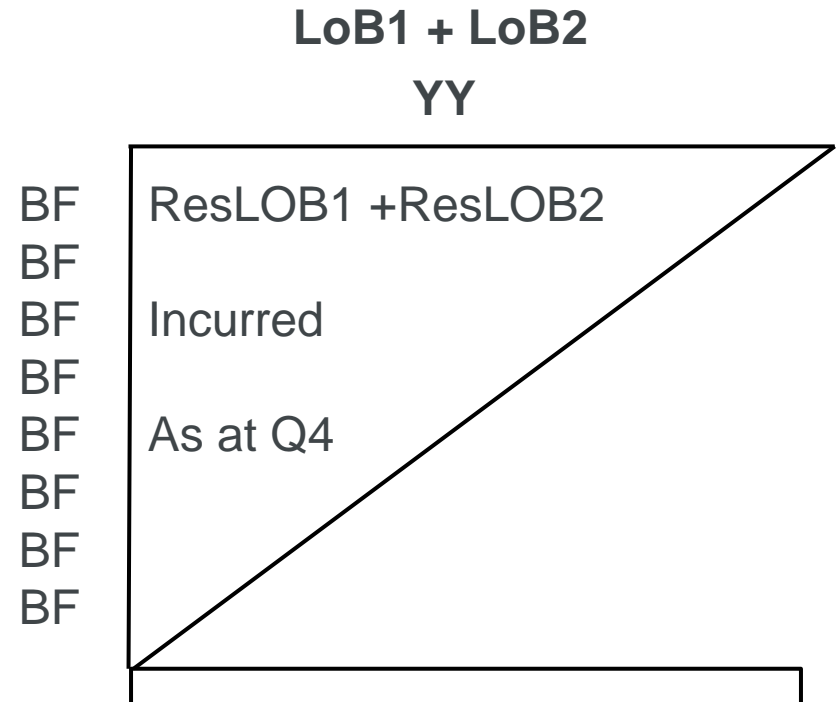
Institute
and Faculty
of Actuaries

Disconnect between Reserving and Reserve Risk

Reserving (Example)



Reserve Risk (Common Approach)



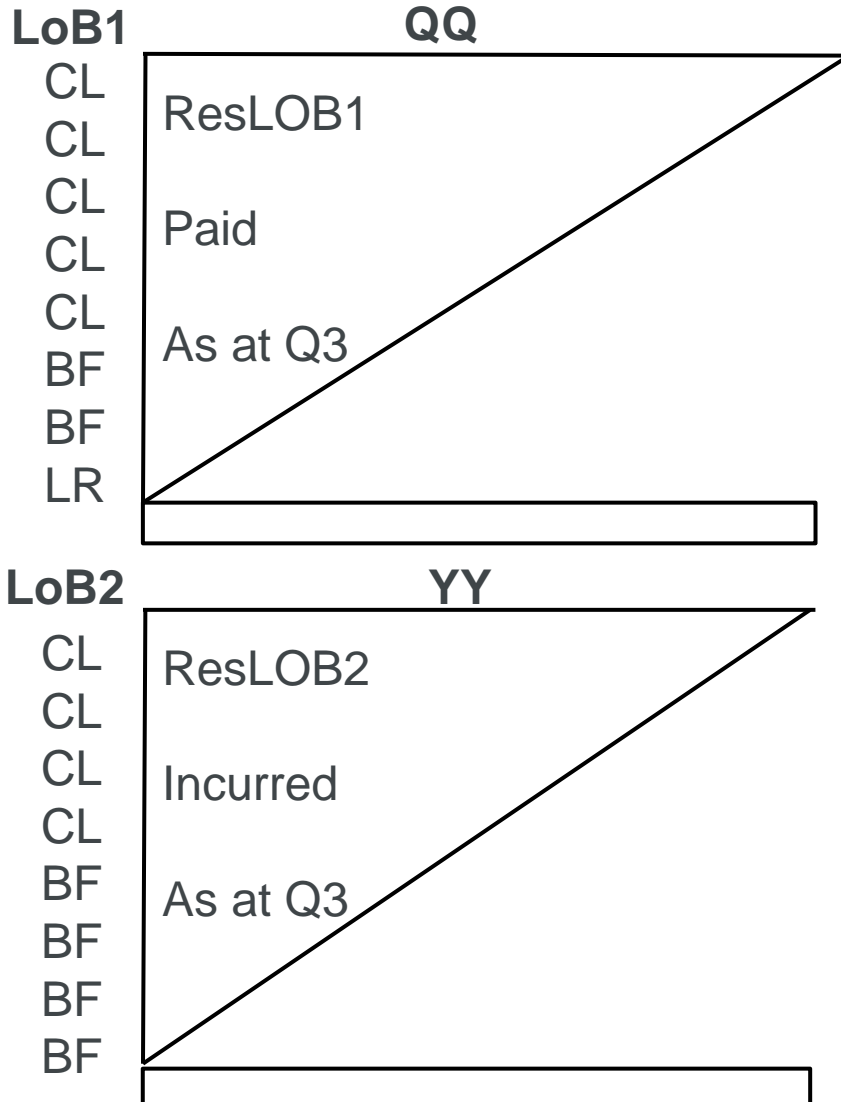
Mean reserves will
never balance - hence
scaling issues



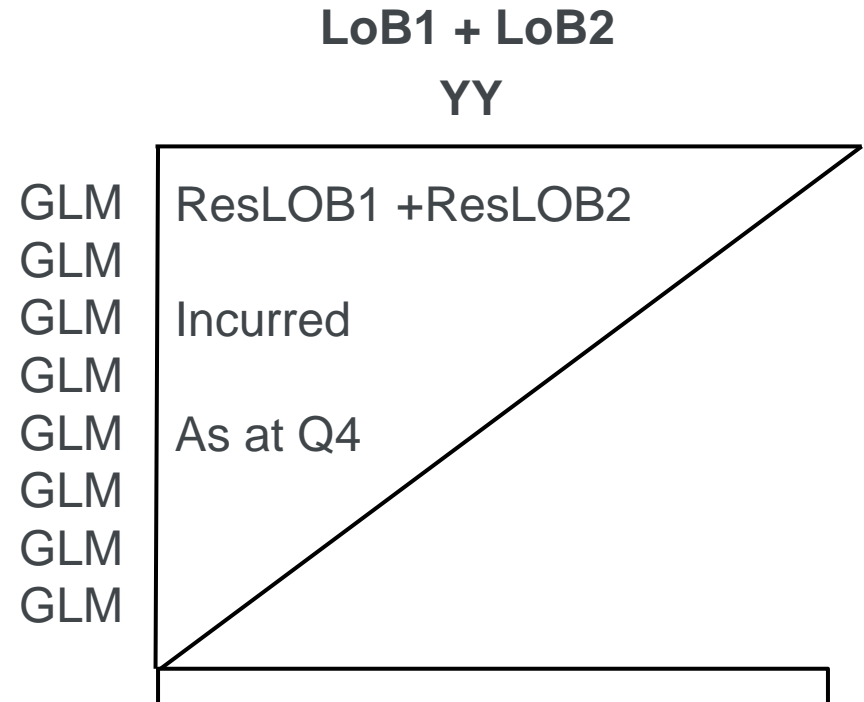
Institute
and Faculty
of Actuaries

Disconnect between Reserving and Reserve Risk

Reserving (Example)



Reserve Risk (Common Approach)



Mean reserves will
never balance - hence
scaling issues



Institute
and Faculty
of Actuaries

Disconnect between Reserving and Reserve Risk

- **Which scaling method is correct?**
 - Multiplicative? Additive? Mixed?
 - None are ideal
 - Scaling issue should not occur in the first place!
- **Practical Approach to Reserve Risk**
 - Only with an understanding of the sources of that a sensible approach can be made
 - E.g. Claim known with certainty should add no further uncertainty, additive may be more appropriate
- **Current Approach to Reserving & Reserve Risk**
 - Determine a mean and then fit a distribution around that mean
 - Historical reason
- **Ideal Approach to Reserving & Reserve Risk**
 - Determining a reserve distribution first and the mean is just a “by-product” for reserving



Disconnect between Reserving and Reserve Risk

- **Short term solution**
 - Multiplicative, Additive, Mixed scaling
 - Raise awareness of model/process limitations
 - Importance of validation highlighted
- **Long term solution**
 - Complete consistency between reserving and reserve risk
 - Incorporate more stochastic reserving methodologies into the reserving process



Practical Challenges in Reserve Risk

Accuracy of the Prediction Error



Variance vs MSEP

- **Variance**

- $Var(R) = E[(R - E(R))^2]$

- **Mean Square Error of Prediction (MSEP)**

- $\hat{R} \sim$ Estimate of reserve $R \sim$ Outcome of reserve

- $MSEP(\hat{R}) = E[(R - \hat{R})^2 | D]$

- $MSEP(\hat{R}) = (\hat{R} - E(R | D))^2 + Var[R | D]$

- $CoV(\hat{R}) = \sqrt{mse(\hat{R})} / \hat{R}$



True CoV vs Estimate CoV

TRUE CoV

$$\frac{\sqrt{mse p(\hat{R})}}{\hat{R}}$$

Not calculable in reality

Parameters are unknown

ESTIMATED CoV

$$\frac{\sqrt{\widehat{mse p}(\hat{R})}}{\hat{R}}$$

Formula (e.g. Mack)

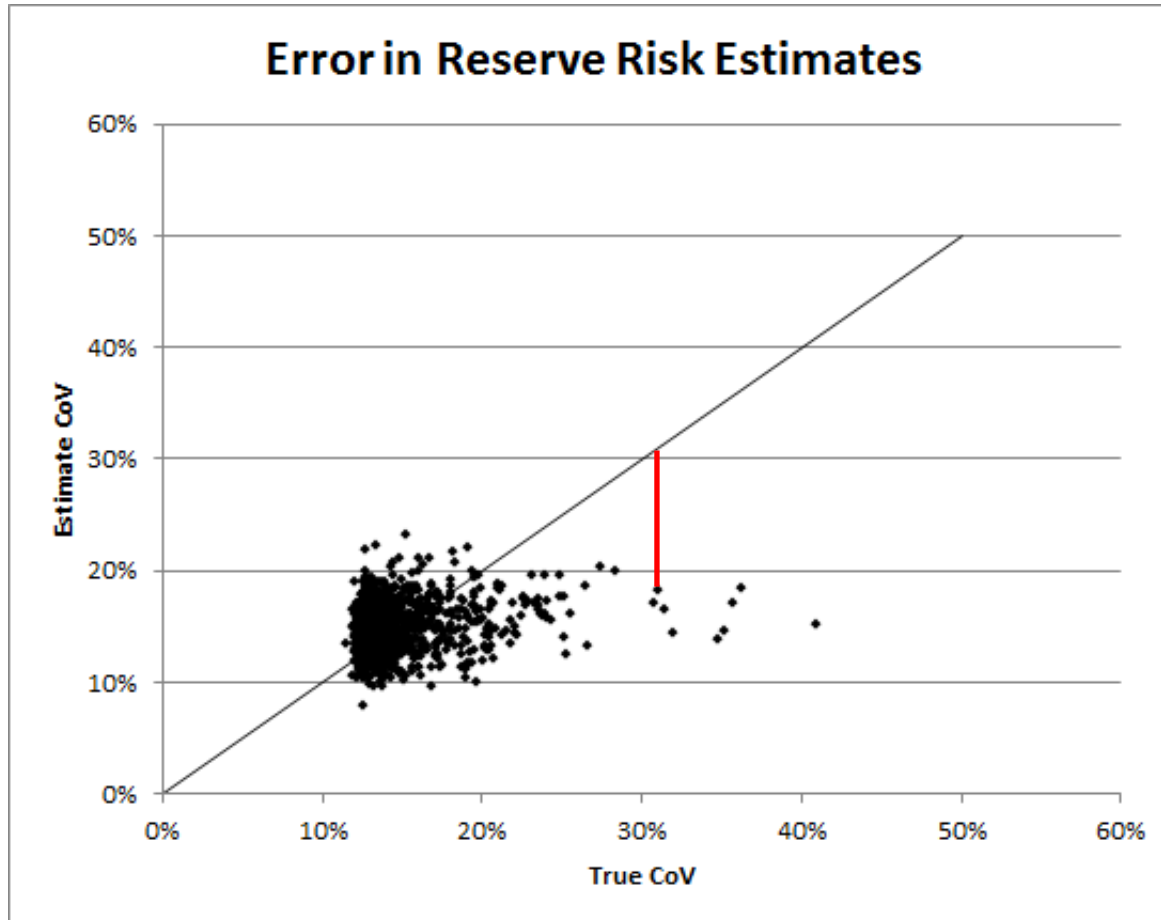
Empirical (e.g. Mack Bootstrap)

- **How wrong is our “estimation of wrong”?**
 - 1000 “True Mack” triangles from Mack Model with selected parameters
 - Each triangles are different though same set of parameters
 - Calculate **True CoV** using first principle
 - **Estimated CoV** from Mack Formula or Bootstrap



Institute
and Faculty
of Actuaries

How wrong is our “estimation of wrong”?



- Each triangle has a different CoV



How wrong is our “estimation of wrong”?

	2/1	3/2	4/3	5/4	6/5	7/6	8/7	9/8	10/9
f	2.20	1.40	1.20	1.10	1.01	1.01	1.00	1.00	1.00
σ	300	150	100	75	50	20	5	0	0

	<i>Development</i>								
	2/1	3/2	4/3	5/4	6/5	7/6	8/7	9/8	10/9
<i>i</i>									
1	2.39	1.47	1.21	1.08	1.01	1.01	1.02	1.00	1.00
2	2.11	1.47	1.19	1.16	0.99	1.05	0.99	1.00	
3	2.34	1.34	1.18	1.15	1.00	0.99	1.02		
4	2.01	1.41	1.24	1.08	1.01	1.05			
5	1.89	1.31	1.16	1.24	1.13				
6	1.75	1.46	1.16	1.03					
7	2.41	1.38	1.23						
8	2.56	1.45							
9	1.97								

\hat{f}	2.16	1.41	1.20	1.12	1.03	1.03	1.01	1.00	1.00
$\hat{f} - f$	-0.04	0.01	0.00	0.02	0.02	0.02	0.01	0.00	0.00



How wrong is our “estimation of wrong”?

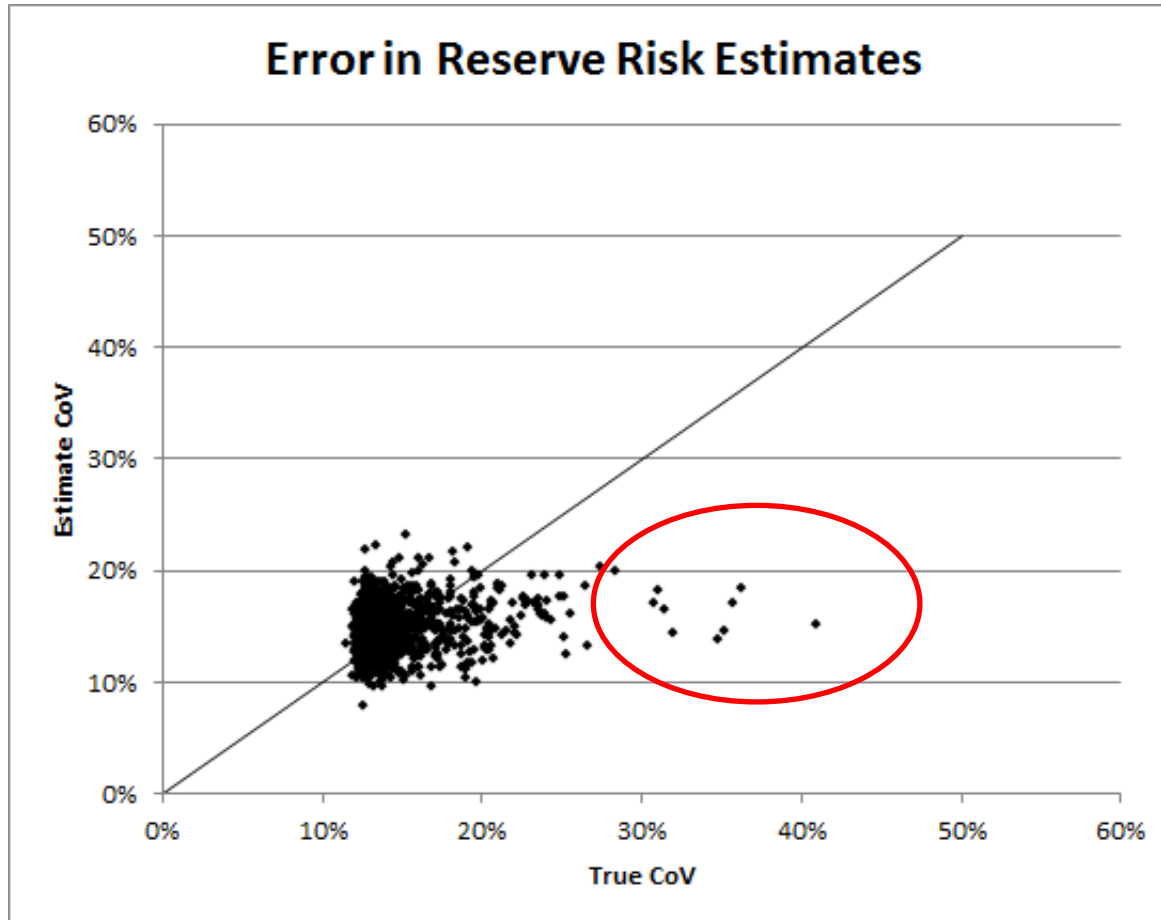
	2/1	3/2	4/3	5/4	6/5	7/6	8/7	9/8	10/9
f	2.20	1.40	1.20	1.10	1.01	1.01	1.00	1.00	1.00
σ	300	150	100	75	50	20	5	0	0

<i>Development</i>									
<i>i</i>	2/1	3/2	4/3	5/4	6/5	7/6	8/7	9/8	10/9
1	1.89	1.36	1.28	1.08	1.02	1.00	1.00	1.00	1.00
2	1.86	1.48	1.14	1.18	1.06	1.01	1.00	1.00	
3	2.10	1.30	1.21	1.20	1.01	0.99	1.00		
4	2.33	1.43	1.13	1.03	1.03	1.01			
5	2.34	1.34	1.26	1.11	0.97				
6	2.38	1.45	1.10	1.08					
7	2.41	1.37	1.10						
8	2.11	1.32							
9	2.75								

\hat{f}	2.24	1.38	1.17	1.11	1.02	1.00	1.00	1.00	1.00
$\hat{f} - f$	0.04	-0.02	-0.03	0.01	0.01	-0.01	0.00	0.00	0.00



How wrong is our “estimation of wrong”?



- Each triangle has a different CoV



How wrong is our “estimation of wrong”?

Extreme Triangle

	2/1	3/2	4/3	5/4	6/5	7/6	8/7	9/8	10/9
<i>f</i>	2.20	1.40	1.20	1.10	1.01	1.01	1.00	1.00	1.00
<i>σ</i>	300	150	100	75	50	20	5	0	0

<i>Development</i>									
<i>i</i>	2/1	3/2	4/3	5/4	6/5	7/6	8/7	9/8	10/9
1	2.36	1.45	1.24	1.05	1.04	1.02	1.00	1.00	1.00
2	2.75	1.33	1.25	1.21	0.81	1.01	1.00	1.00	
3	2.51	1.45	1.19	1.13	1.02	1.00	1.00		
4	2.46	1.34	1.20	1.06	1.00	1.01			
5	1.90	1.40	1.26	1.14	0.97				
6	2.28	1.57	1.28	1.03					
7	2.31	1.51	1.11						
8	2.35	1.42							
9	2.05								

<i>\hat{f}</i>	2.33	1.43	1.22	1.10	0.96	1.01	1.00	1.00	1.00
<i>$\hat{f} - f$</i>	0.13	0.03	0.02	0.00	-0.05	0.00	0.00	0.00	0.00

How wrong is our “estimation of wrong”?

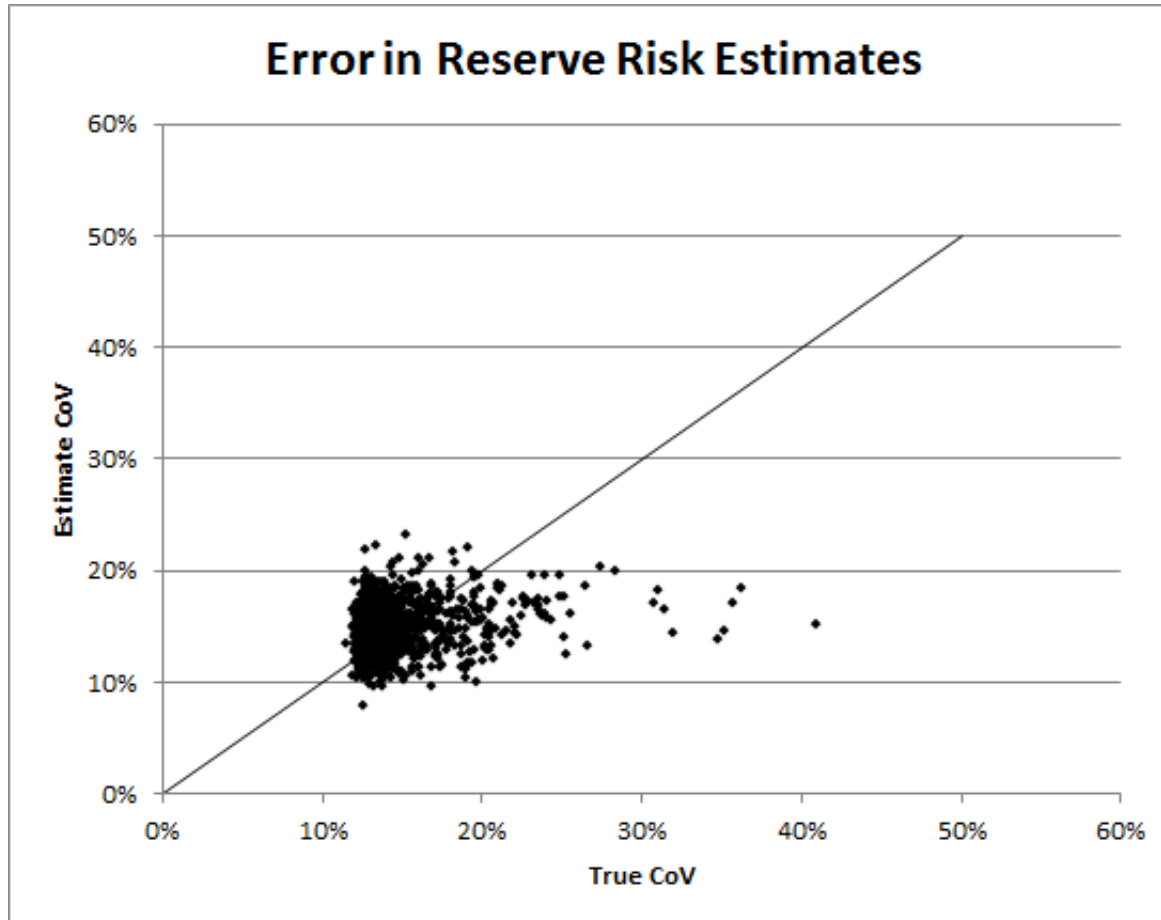
Extreme Triangle

	2/1	3/2	4/3	5/4	6/5	7/6	8/7	9/8	10/9
f	2.20	1.40	1.20	1.10	1.01	1.01	1.00	1.00	1.00
σ	300	150	100	75	50	20	5	0	0

Development									
i	2/1	3/2	4/3	5/4	6/5	7/6	8/7	9/8	10/9
1	2.09	1.42	1.12	1.13	0.98	1.00	1.00	1.00	1.00
2	1.96	1.43	1.14	1.05	0.97	1.08	1.01	1.00	
3	1.63	1.38	1.18	1.11	0.99	1.01	0.99		
4	2.15	1.19	1.28	1.01	1.07	0.95			
5	1.95	1.37	1.18	1.16	1.01				
6	2.19	1.36	1.16	1.06					
7	2.08	1.44	1.12						
8	2.18	1.35							
9	2.21								

\hat{f}	2.05	1.37	1.17	1.08	1.00	1.01	1.00	1.00	1.00
$\hat{f} - f$	-0.15	-0.03	-0.03	-0.02	-0.01	0.00	0.00	0.00	0.00

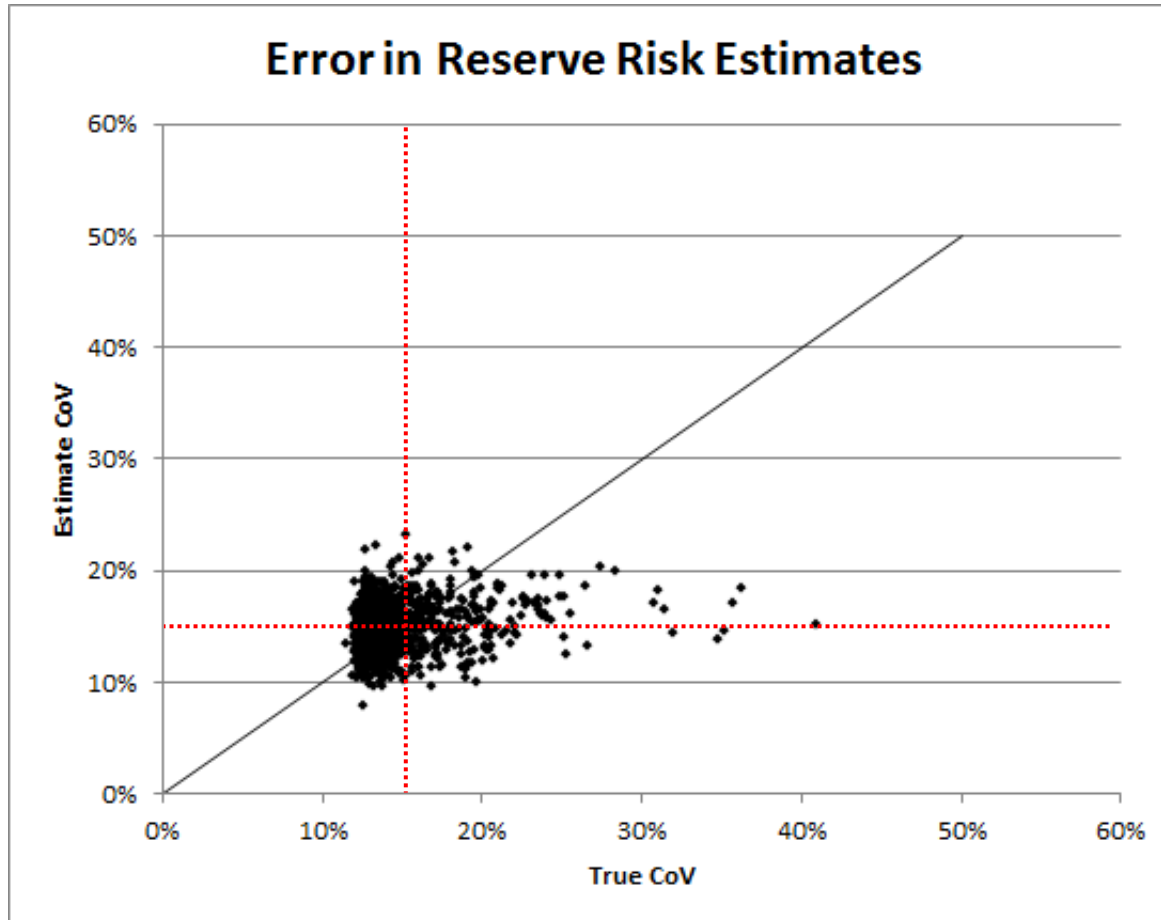
How wrong is our “estimation of wrong”?



- Each triangle has a different CoV
- True CoV has a wider range



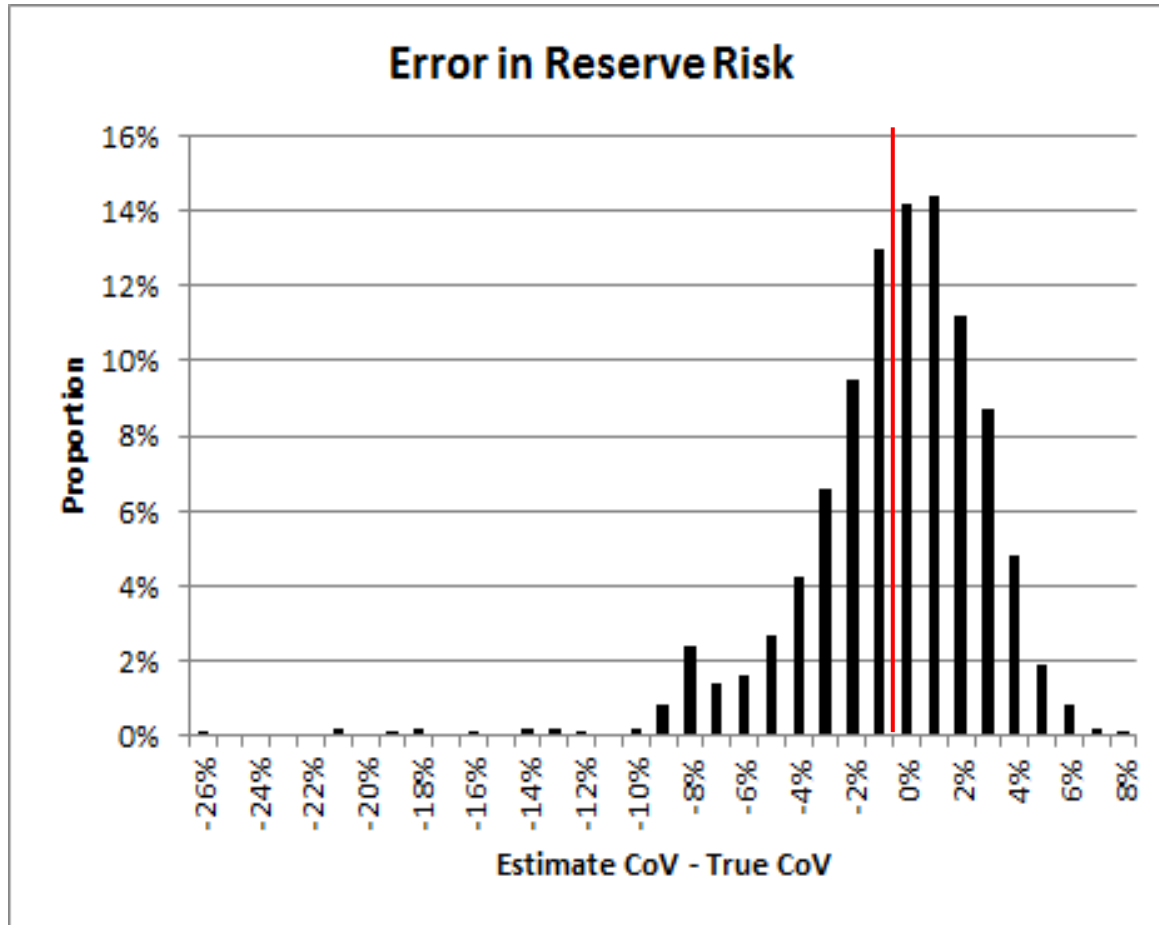
How wrong is our “estimation of wrong”?



- Each triangle has a different CoV
- True CoV has a wider range
- Correct on average



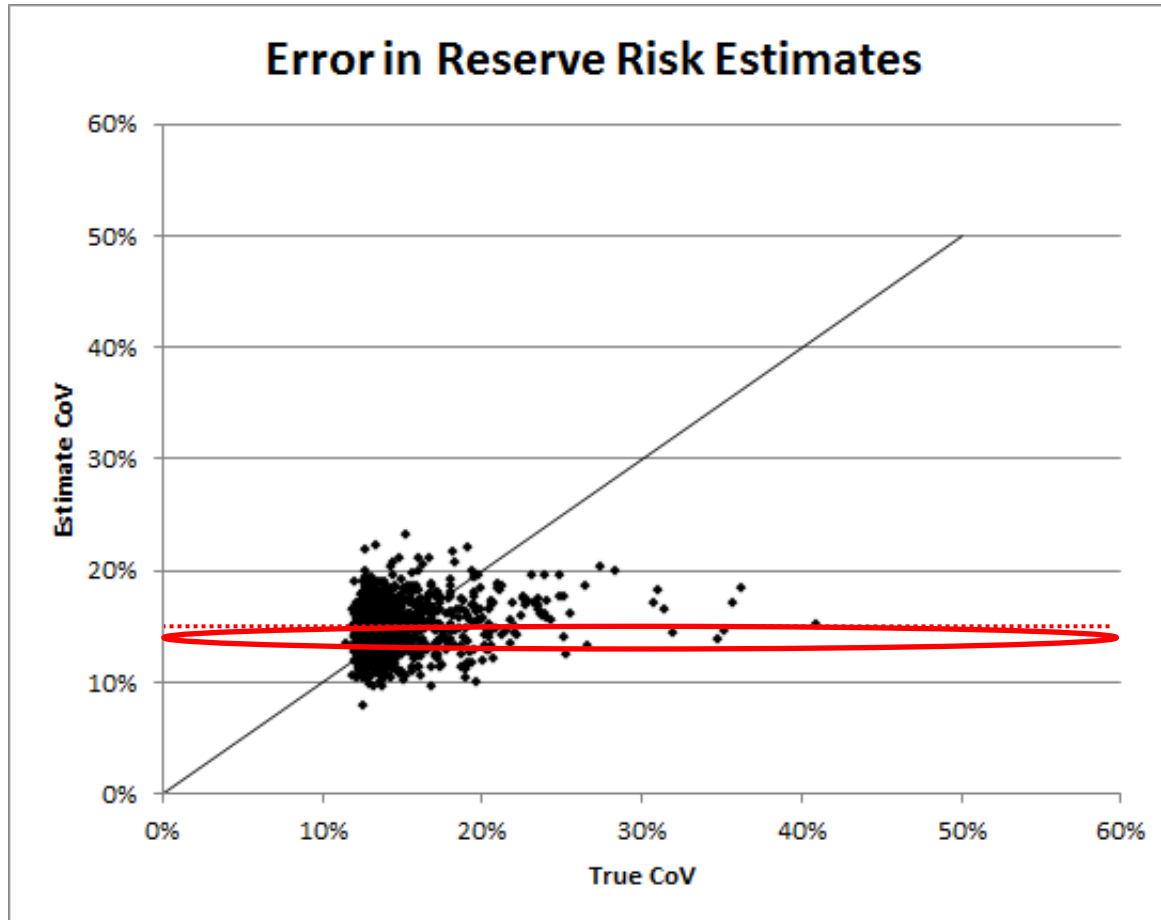
How wrong is our “estimation of wrong”?



- Each triangle has a different CoV
- True CoV has a wider range
- Correct on average



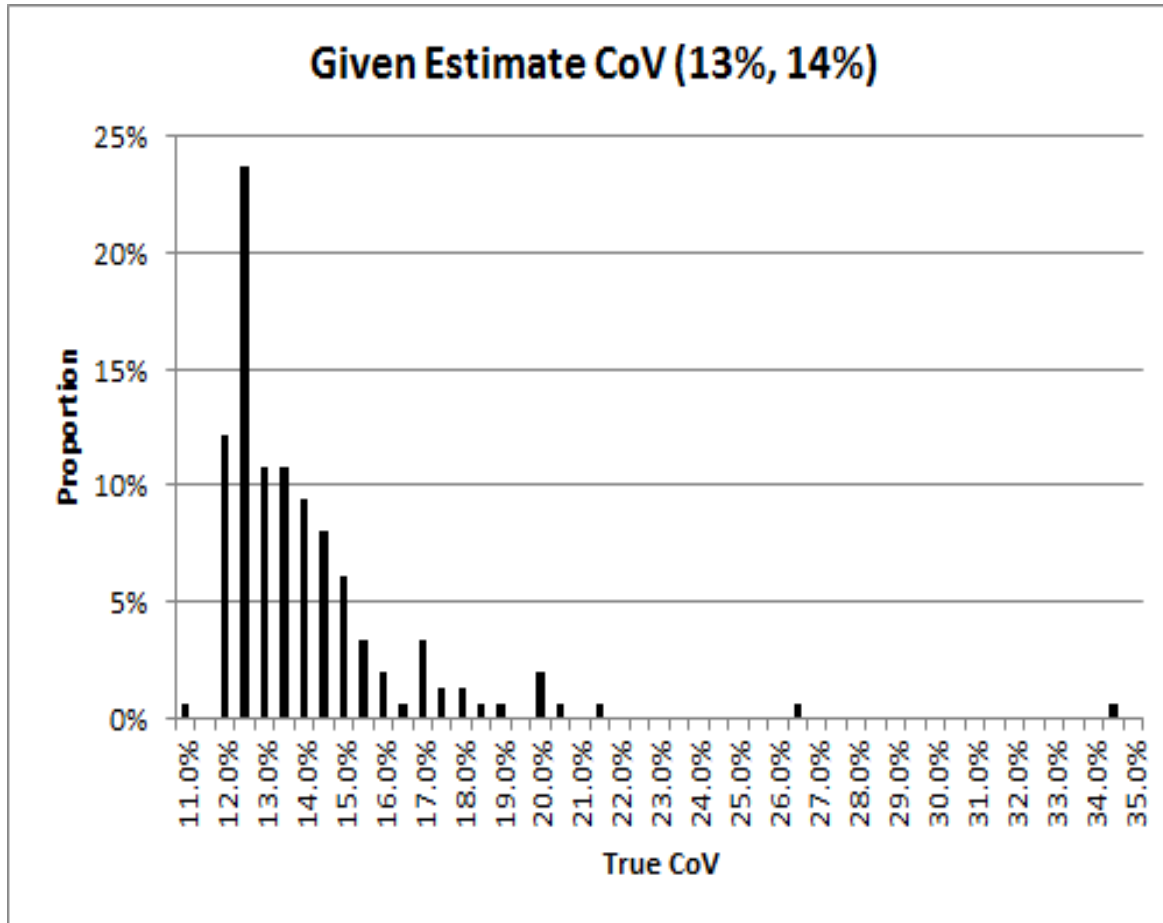
How wrong is our “estimation of wrong”?



- Each triangle has a different CoV
- True CoV has a wider range
- Correct on average
- Cross Section



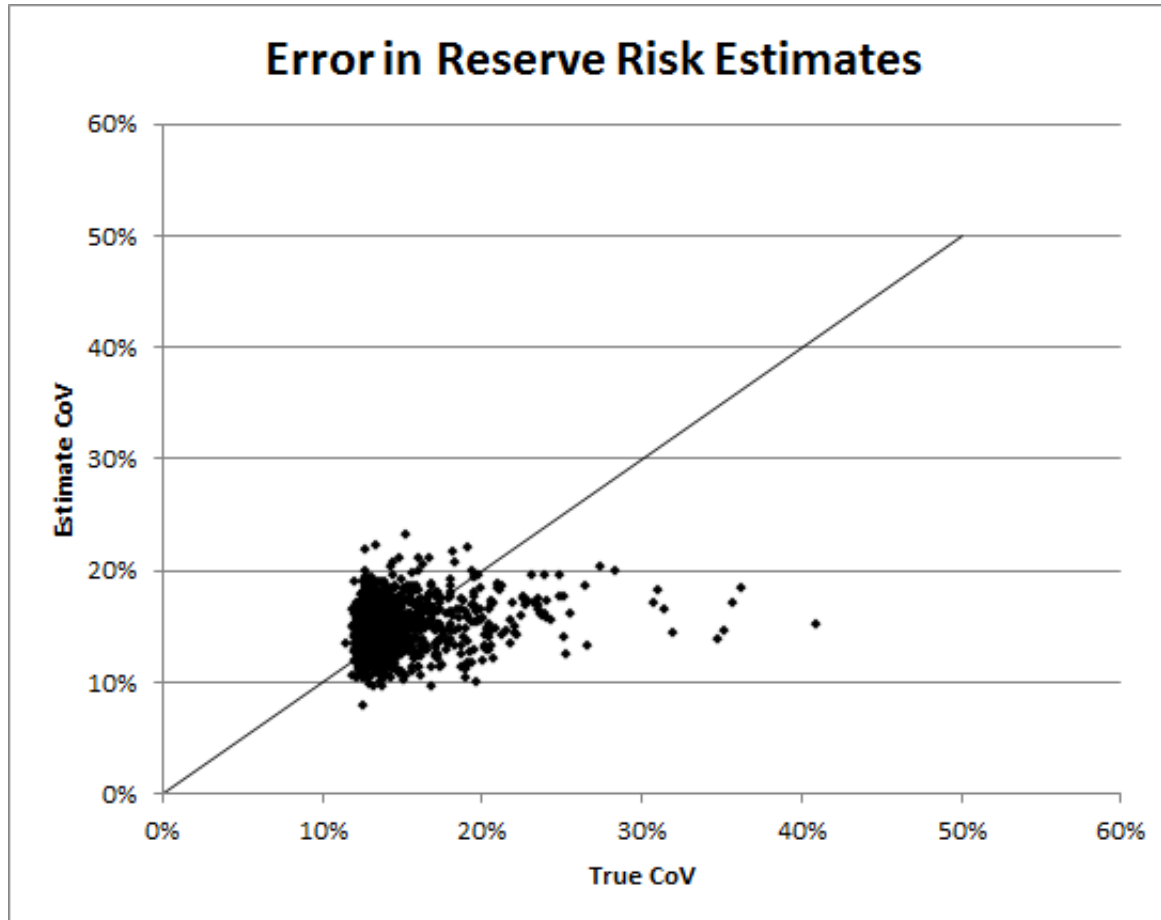
How wrong is our “estimation of wrong”?



- Each triangle has a different CoV
- True CoV has a wider range
- Correct on average
- Cross Section



How wrong is our “estimation of wrong”?

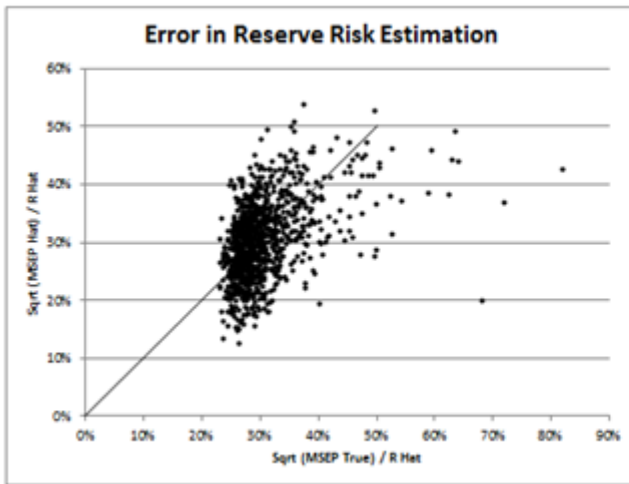


- Each triangle has a different CoV
- True CoV has a wider range
- Correct on average
- Cross Section
- By Year / Parameter / Process

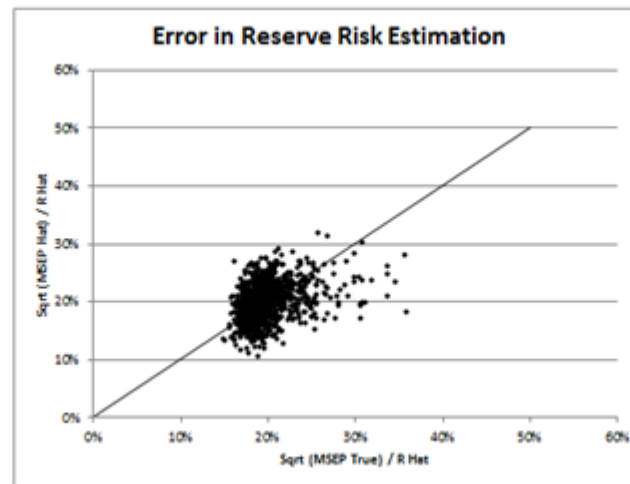


How wrong is our “estimation of wrong”?

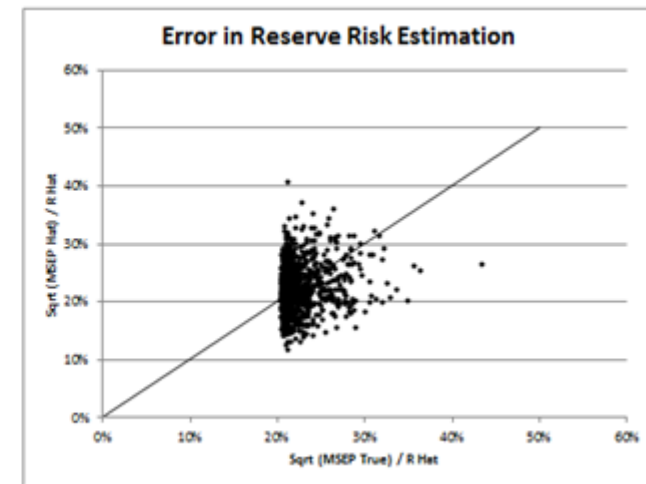
YEAR 8



YEAR 9



YEAR 10



Institute
and Faculty
of Actuaries

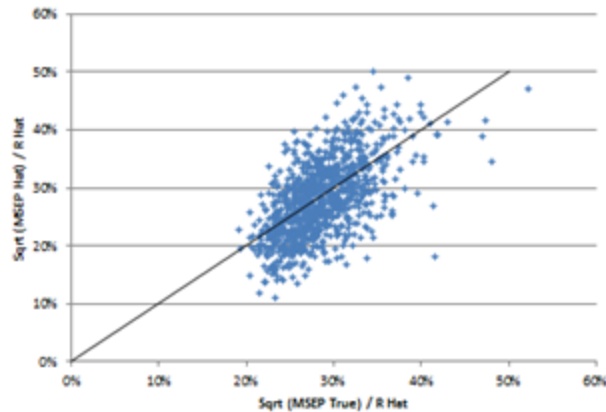
How wrong is our “estimation of wrong”?

YEAR 8

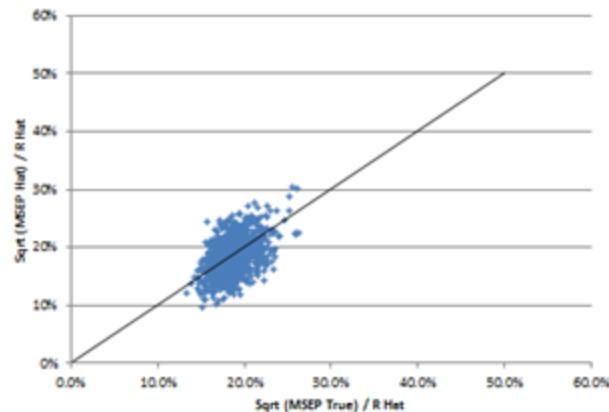
YEAR 9

YEAR 10

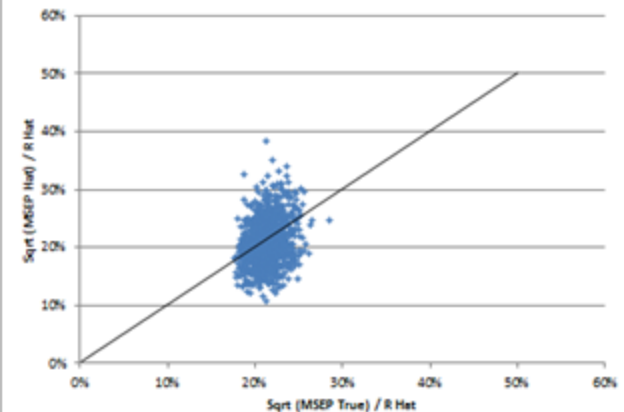
Error in Reserve Risk Estimation (Process)



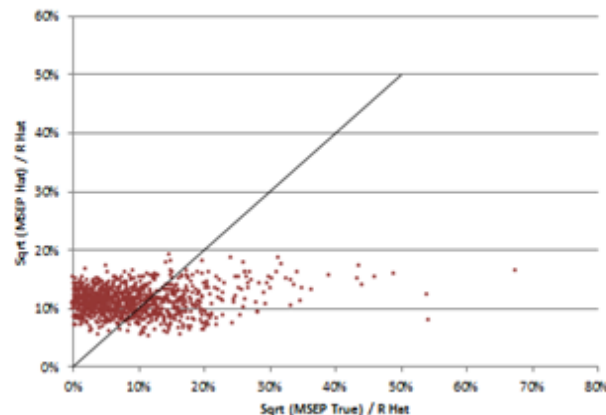
Error in Reserve Risk Estimation (Process)



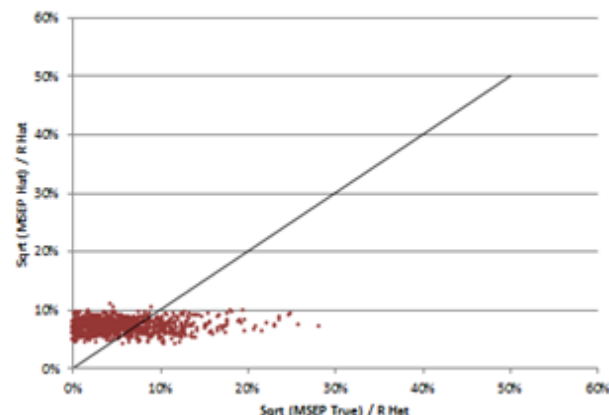
Error in Reserve Risk Estimation (Process)



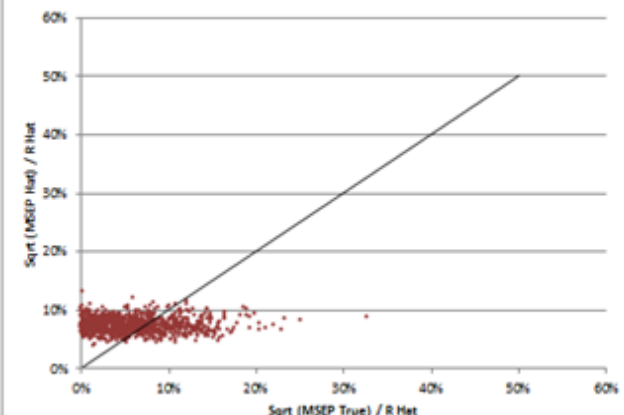
Error in Reserve Risk Estimation (Parameter)



Error in Reserve Risk Estimation (Parameter)



Error in Reserve Risk Estimation (Parameter)



Institute
and Faculty of
Actuaries

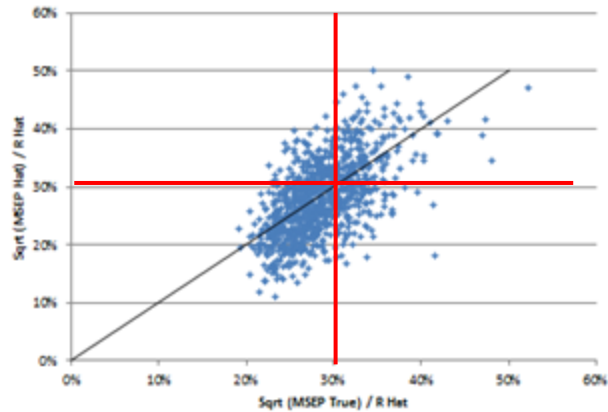
How wrong is our “estimation of wrong”?

YEAR 8

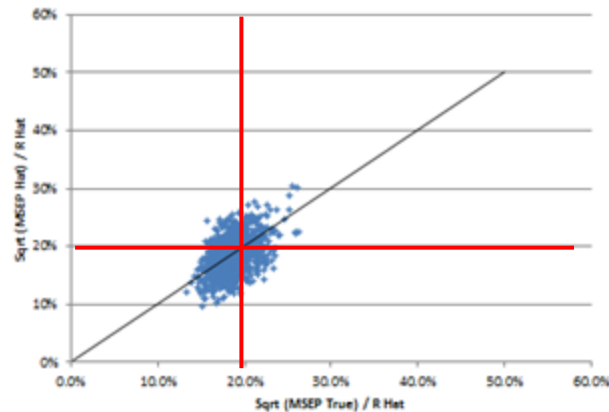
YEAR 9

YEAR 10

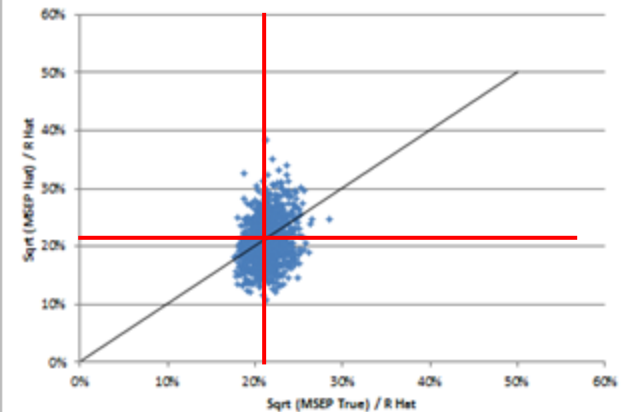
Error in Reserve Risk Estimation (Process)



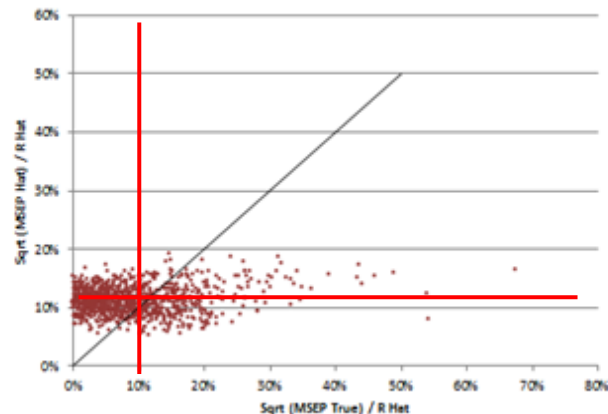
Error in Reserve Risk Estimation (Process)



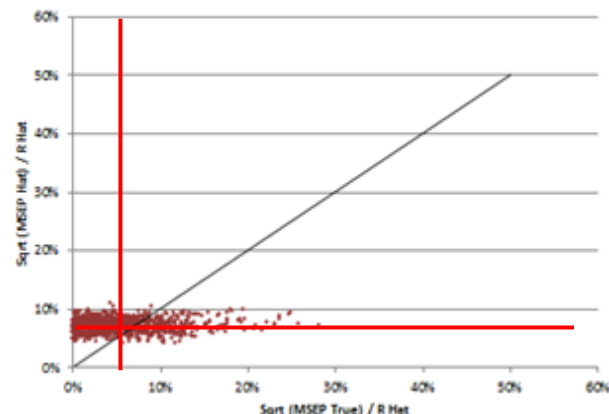
Error in Reserve Risk Estimation (Process)



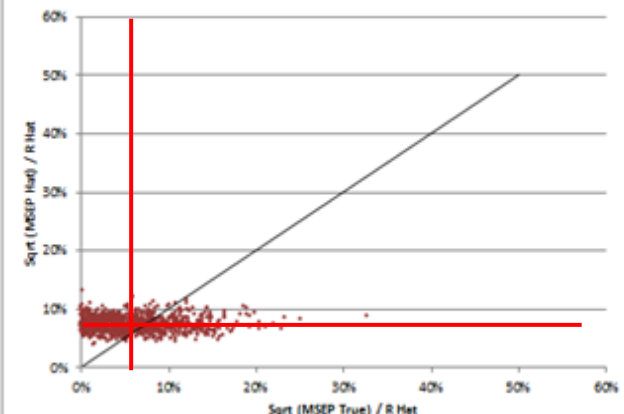
Error in Reserve Risk Estimation (Parameter)



Error in Reserve Risk Estimation (Parameter)

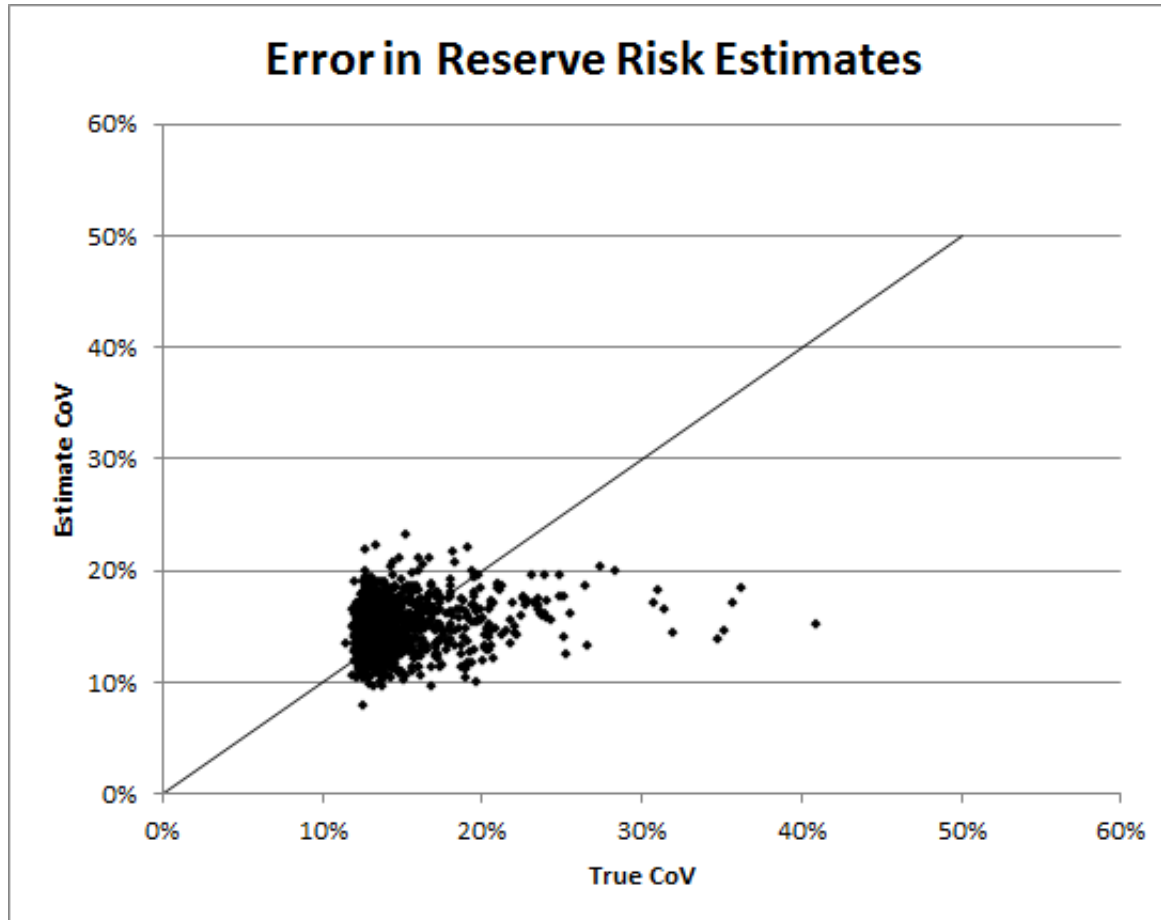


Error in Reserve Risk Estimation (Parameter)



Institute
and Faculty
of Actuaries

How wrong is our “estimation of wrong”?



- Each triangle has a different CoV
- True CoV has a wider range
- Correct on average
- Cross Section
- By Year / Parameter / Process
- Model Risk removed in the study



The Bigger Picture

Practical Challenges in Reserve Risk

Kevin Chan

kevin.chan@xlcatlin.com

Michael Ramyar

michael@ramyar.co.uk



Institute
and Faculty
of Actuaries