Structured Reinsurance Case Studies

Casualty Actuarial Society's Seminar on Reinsurance

June 6, 2023

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Objectives

Risk Transfer Tests 1

A Quota Share Example 2

A Cat Aggregate Example 3

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Risk Transfer Tests

Risk Transfer Tests

For risk transfer testing, “reinsurer’s loss” ignore brokerage and internal expense, thus there is only a loss if ceded loss and loss adjustment expense exceeds ceded premium

Common Risk Transfer Tests

1) **10-10 Test**
   a. Requires at least a 10% probability that the reinsurer loses at least 10%
   b. Prob(ceded loss + LAE ratio ≥ 110%) ≥ 10%

2) **Expected Reinsurer Deficit (ERD)**
   a. Probability the Reinsurer Loses Money: Prob(ceded loss + LAE ratio ≥ 100%)
   b. Average Severity of the Reinsurer Loss | Reinsurer Loses Money
   c. ERD = (a. x b.) / E(Ceded Premium)

If this looks familiar, it should because it’s the formula for Pure Premium or Loss Cost: frequency x severity

10-10 and its Shortcomings

- A 10% chance of a 10% loss means the underwriting loss at the 90th percentile of the probability distribution of underwriting results, or the value at risk (VaR_{90})
- Measured using present values premium and loss

Two Major Shortcomings

1. The focus on the present value of loss only at the 90th percentile (VaR_{90}) ignores the information in the remainder of the tail represented by the percentiles beyond the 90th
2. Both the 10% probability and the 10% loss thresholds are arbitrary, with no specific guidance for either in accounting literature

Other Shortcomings

1. It has long been recognized that many reinsurance contracts having the characteristics of low underwriting loss frequency but high severity, such as property catastrophe excess of loss reinsurance, fail 10-10 on the basis that the probability of a 10% loss is less than 10%
2. Ordinary quota share reinsurance of many primary insurance portfolios, like low limits private passenger auto, which is generally characterized as having a high frequency of underwriting loss, but low severity may also fail because
3. It has failed to flag certain highly structured contracts as not significantly risk, for example contracts specifically engineered to produce a 10% chance of a 10% loss

Toward a Better Test

Expected Reinsurer Deficit (ERD)

Remember the two main shortcomings of 10-10?

1. The focus on the present value of loss only at the 90th percentile (VaR_{90}) ignores the information in the remainder of the tail represented by the percentiles beyond the 90th
2. Both the 10% probability and the 10% loss thresholds are arbitrary, with no specific guidance for either in accounting literature

How ERD addresses these two shortcomings:

1. The first can be remedied with TVaR
    a. Using TVaR incorporates the information about the loss potential in the right tail that the 10-10 test misses
    b. Simply replacing VaR_{90} with $TVaR_{90}$ fails to address the second shortcoming that the 10% probability threshold wrongly screens out low frequency-high severity and high frequency-low severity contracts
2. The second can be remedied by relaxing the requirement that both the probability and severity of loss be 10%
    a. ERD uses the probability the reinsurer loses money

ERD = $TVaR_{(1 – Probability\ the\ Reinsurer\ Loses\ Money)}$

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A Quota Share Example

Standard Quota Share

Standard Quota Share: The Setup

	Gross	% to Gross
Premium	$100M	100%
Loss	$64M	64%
Expense	$35M	35%
PHS	$20M	20%
Leverage	5 : 1	

Quota Share Terms:

- **Cession: 70%**
- **Ceding Commission 35%**

Net Premium: $30M

Net Leverage: 1.5 : 1

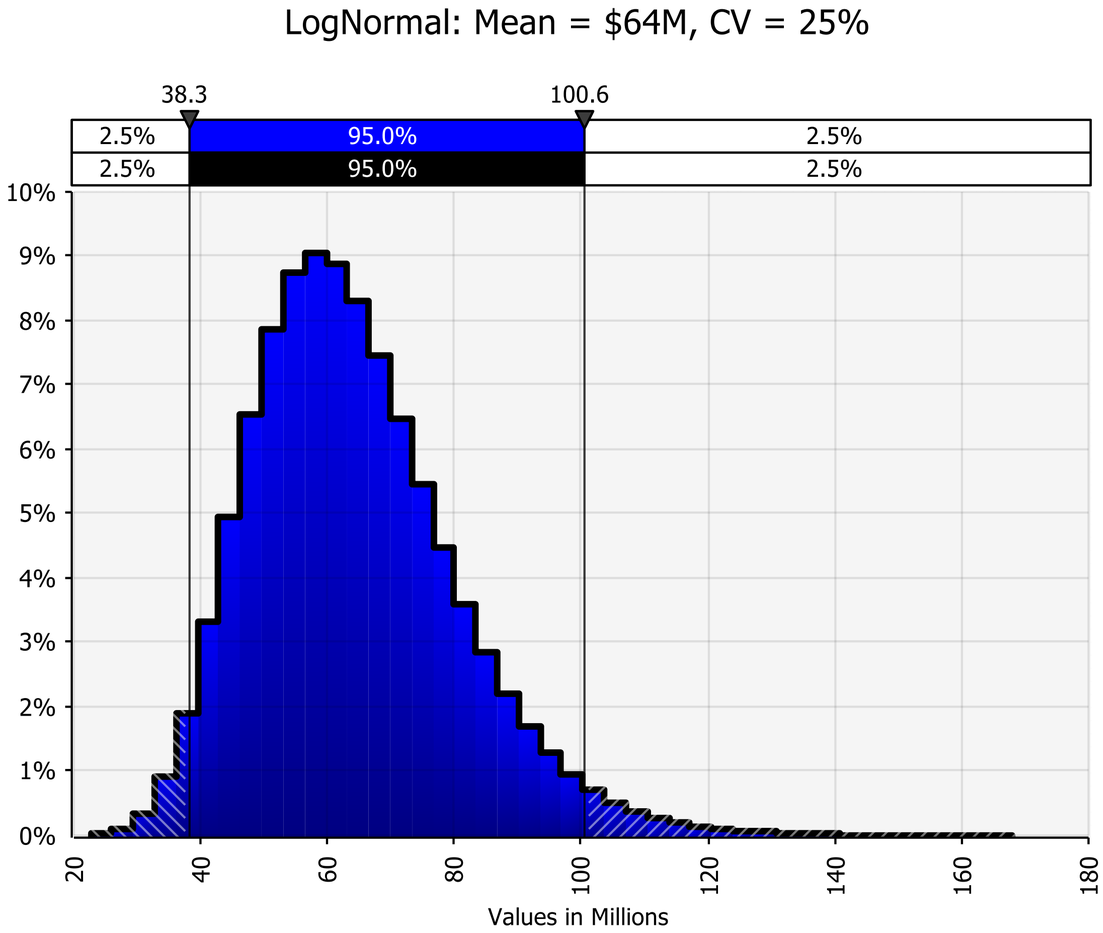
	$'s	%
Gross		
Premium	100.0	100.0%
Loss	64.0	64.0%
Expense	35.0	35.0%
U/W Income	1.0	1.0%
Ceded		
Premium	70.0	70.0%
Loss	44.8	64.0%
Expense	24.5	35.0%
U/W Income	0.7	1.0%
Net		
Premium	30.0	30.0%
Loss	19.2	64.0%
Expense	10.5	35.0%
U/W Income	0.3	1.0%

(000,000's)

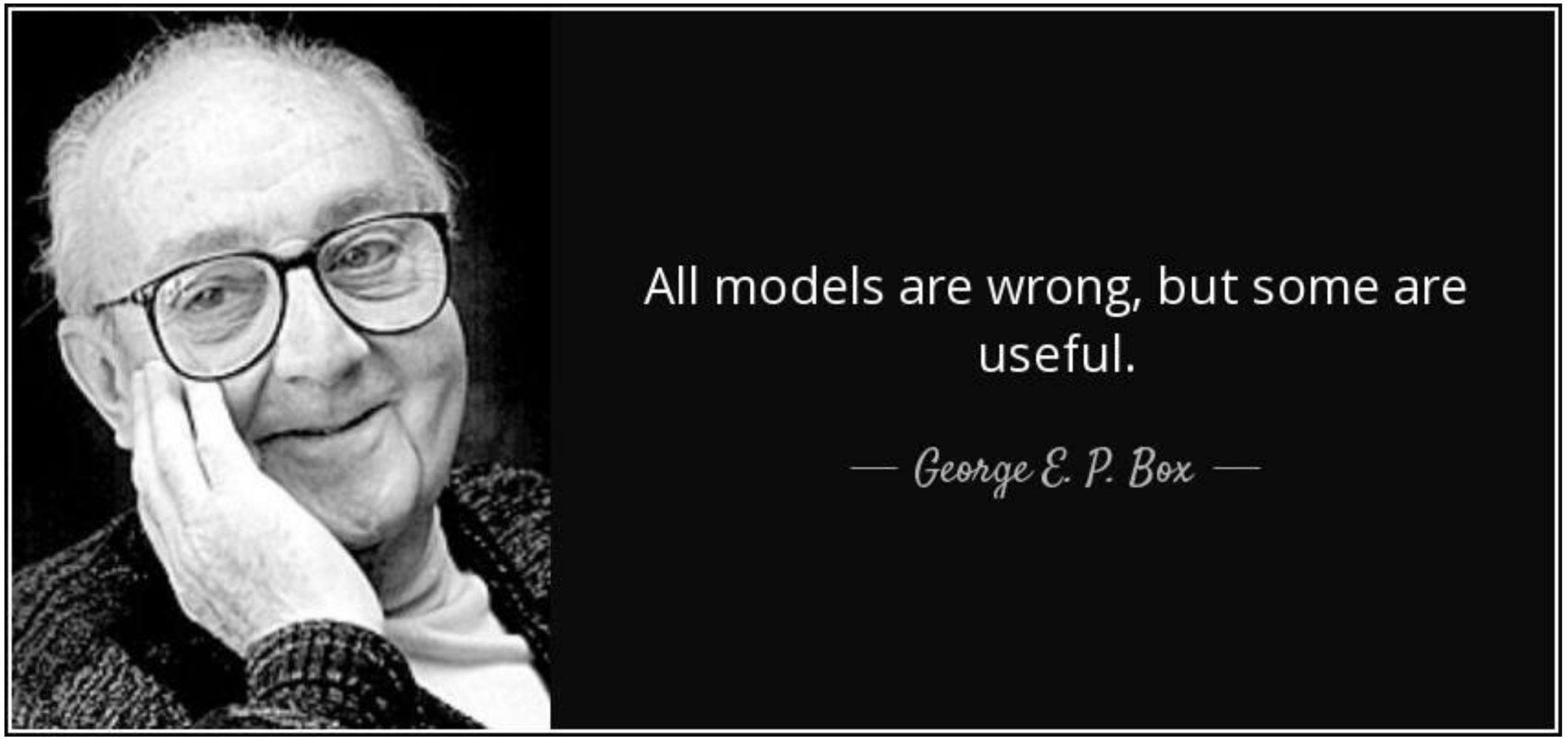
Ignores taxes in investment income

Standard Quota Share Modeling

Distribution	LogNormal
Mean	$64M
CV	25%
Std Dev	$16M
Cession	70%
Ceding Commission	35%
ERD	4.57%
VaR_{90}	(16.56%)



Before we get started, keep this in mind…



Standard Quota Share Sensitivity Testing

Ceding Commission	Coefficient of Variation 25.0% ERD	Coefficient of Variation 25.0% VaR_{90}
23.0%	1.64%	(4.56%)
25.0%	1.96%	(6.56%)
27.0%	2.34%	(8.56%)
29.0%	2.79%	(10.56%)
31.0%	3.30%	(12.56%)
33.0%	3.89%	(14.56%)
35.0%	4.57%	(16.56%)

- **Holding the volatility constant, the ERD and VaR_{90} decreases with the ceding commission**
- **This makes sense because the reinsurer's margin increases as the ceding commission decreases, thus reducing risk**
- **Note, with and ERD threshold of 1%, this QS with a CC as lows as 23% would pass risk transfer, but fails 10/10 between 27% and 29%**

Standard Quota Share More Sensitivity Testing

	Coefficient of Variation					
	25.0%		20.0%		15.0%	
Ceding Commission	ERD	VaR_{90}	ERD	VaR_{90}	ERD	VaR_{90}
23.0%	1.64%	(4.56%)	0.86%	(0.50%)	0.29%	3.59%
25.0%	1.96%	(6.56%)	1.10%	(2.50%)	0.42%	1.59%
27.0%	2.34%	(8.56%)	1.39%	(4.50%)	0.61%	(0.41%)
29.0%	2.79%	(10.56%)	1.76%	(6.50%)	0.86%	(2.41%)
31.0%	3.30%	(12.56%)	2.21%	(8.50%)	1.20%	(4.41%)
33.0%	3.89%	(14.56%)	2.75%	(10.50%)	1.65%	(6.41%)
35.0%	4.57%	(16.56%)	3.40%	(12.50%)	2.23%	(8.41%)

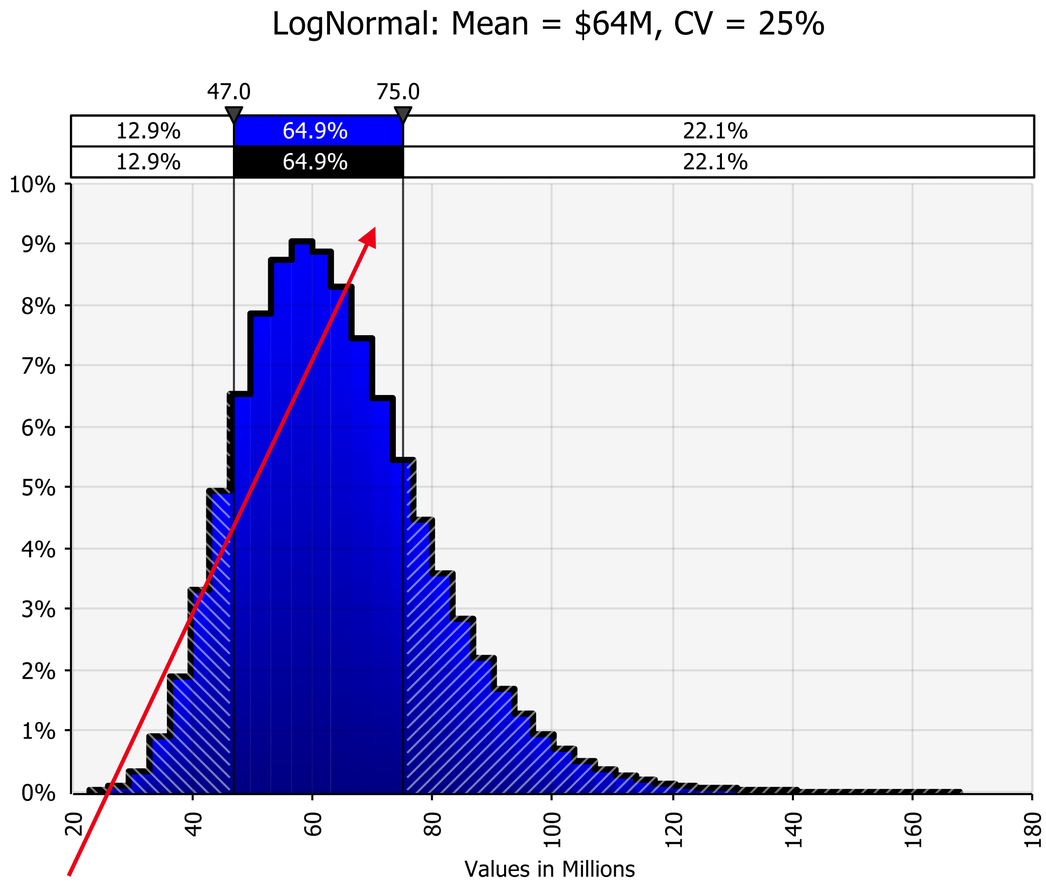
- **Intuitively, decreasing the volatility also decreases risk**
- **This is why it's important to be confident in assumptions and have them rooted in historical experience**
- **At a 15% CV the QS fails 10/10 even at a 35% CC, which matches the cedent's expense ratio and at CC's below 27%, the reinsurer has a high probability of making a gain in most loss scenarios**

Structured Quota Share

Structured Quota Share: Sliding Scale Commission

	Ceding Commission	Loss Ratio	Ceded Combined Ratio
Provisional	28%	64%	92%
Slide Down 1:1 to	17%	75%	92%
Slide Up 1:1 to	45%	47%	92%

- The reinsurer is not willing to support the quota share at a 99% expected combined ratio as this doesn't leave much room for error at a razor thin 1% margin
- Thus, proposes a sliding scale commission that locks in 8% margin for 65% of the nominal loss distribution
- **This structure produces an ERD of 0.91%, which is below the 1% generally acceptable threshold**



The model choice indicates 22.1% probability (1 in 4.5-year return period) of capping the CC at the minimum

Structured Quota Share Sensitivity Testing

Minimum Ceding Commission	Maximum Ceding Commission 45.0% ERD	Maximum Ceding Commission 45.0% VaR_{90}
23.0%	1.57%	(4.06%)
22.0%	1.43%	(3.08%)
21.0%	1.31%	(2.10%)
20.0%	1.20%	(1.12%)
19.0%	1.09%	(0.15%)
18.0%	1.00%	0.83%
17.0%	0.91%	1.81%

Note: margin within slide is 8% ; coefficient of variation is 25%

- Holding the volatility constant, the ERD and VaR_{90} decreases with the ceding commission
- This sliding scale QS passes the 1% ERD threshold for all minimum CCs except for 17%
- However, it does not pass the 10/10 rule for any scenario
- Recommend pushing minimum CC to at least 19%

Structured Quota Share Sensitivity Testing

Impact of changing the maximum ceding commission

Minimum Ceding Commission	Maximum Ceding Commission 45.0% ERD	45.0% VaR_{90}	43.0% ERD	43.0% VaR_{90}	47.0% ERD	47.0% VaR_{90}
23.0%	1.57%	(4.06%)	1.57%	(4.06%)	1.57%	(4.06%)
22.0%	1.43%	(3.08%)	1.43%	(3.08%)	1.43%	(3.08%)
21.0%	1.31%	(2.10%)	1.31%	(2.10%)	1.31%	(2.10%)
20.0%	1.20%	(1.12%)	1.20%	(1.12%)	1.20%	(1.12%)
19.0%	1.09%	(0.15%)	1.09%	(0.15%)	1.09%	(0.15%)
18.0%	1.00%	0.83%	1.00%	0.83%	1.00%	0.83%
17.0%	0.91%	1.81%	0.91%	1.81%	0.91%	1.81%

Note: margin within slide is 8% ; coefficient of variation is 25%

- **Holding the volatility constant, a change to the maximum ceding commission has no impact to ERD or 10/10, since both are concerned with downside and the maximum ceding commission only impacts upside, this result is**

Structured Quota Share: Sliding Scale Commission

What is wrong with this structure?

What happens at the provisional ceding commission of 28% at a 64% loss ratio?

	Ceding Commission	Loss Ratio	Ceded Combined Ratio
Provisional	28%	64%	92%
Slide Down 1:1 to	19%	73%	92%
Slide Up 1:1 to	45%	47%	92%

- At the provisional ceding commission of 28%, which is paid at the gross expected loss ratio of 64%, the cedant suffers a 115.3% net combined ratio, equating in a $4.6M loss
- This puts further strain on their surplus position, putting it at $15.4M

	$'s	%
Gross		
Premium	100.0	100.0%
Loss	64.0	64.0%
Expense	35.0	35.0%
U/W Income	1.0	1.0%
Ceded		
Premium	70.0	70.0%
Loss	44.8	64.0%
Expense	19.6	28.0%
U/W Income	5.6	8.0%
Net		
Premium	30.0	30.0%
Loss	19.2	64.0%
Expense	15.4	51.3%
U/W Income	(4.6)	(15.3%)

(000,000's)

Ignores taxes and investment income

Structured Quota Share: Sliding Scale Commission

What is wrong with this structure?

What happens at the minimum ceding commission of 19% at a 73% loss ratio?

	Ceding Commission	Loss Ratio	Ceded Combined Ratio
Provisional	28%	64%	92%
Slide Down 1:1 to	19%	73%	92%
Slide Up 1:1 to	45%	47%	92%

- At the minimum ceding commission of 19%, which is paid at a gross loss ratio of 73%, the cedant suffers a 145.3% net combined ratio, equating in a $13.6M loss
- This almost puts the cedant out of business, leaving it with just $6.4M of surplus
- Note, the minimum commission will be hit 25.5% of the time, or once every 3.9-years

	$'s	%
Gross		
Premium	100.0	100.0%
Loss	73.0	73.0%
Expense	35.0	35.0%
U/W Income	(8.0)	(8.0%)
Ceded		
Premium	70.0	70.0%
Loss	51.1	73.0%
Expense	13.3	19.0%
U/W Income	5.6	8.0%
Net		
Premium	30.0	30.0%
Loss	21.9	73.0%
Expense	21.7	72.3%
U/W Income	(13.6)	(45.3%)

(000,000's)

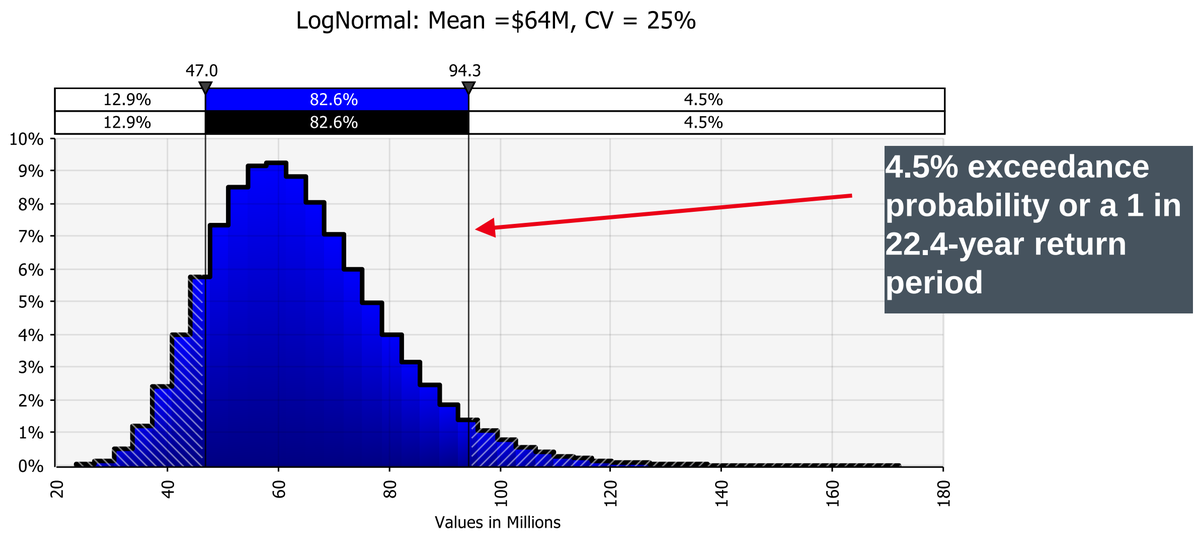
Ignores taxes and investment income

Structured Quota Share: Sliding Scale Commission

What is wrong with this structure?

What loss ratio puts the cedant out of business?

	Ceding Commission	Loss Ratio	Ceded Combined Ratio
Provisional	28%	64%	92%
Slide Down 1:1 to	19%	73%	92%
Slide Up 1:1 to	45%	47%	92%



	$'s	%
Gross		
Premium	100.0	100.0%
Loss	94.3	94.3%
Expense	35.0	35.0%
U/W Income	(29.3)	(29.3%)
Ceded		
Premium	70.0	70.0%
Loss	66.0	94.3%
Expense	13.3	19.0%
U/W Income	(9.3)	(13.3%)
Net		
Premium	30.0	30.0%
Loss	28.3	94.3%
Expense	21.7	72.3%
U/W Income	(20.0)	(66.7%)

(000,000's)

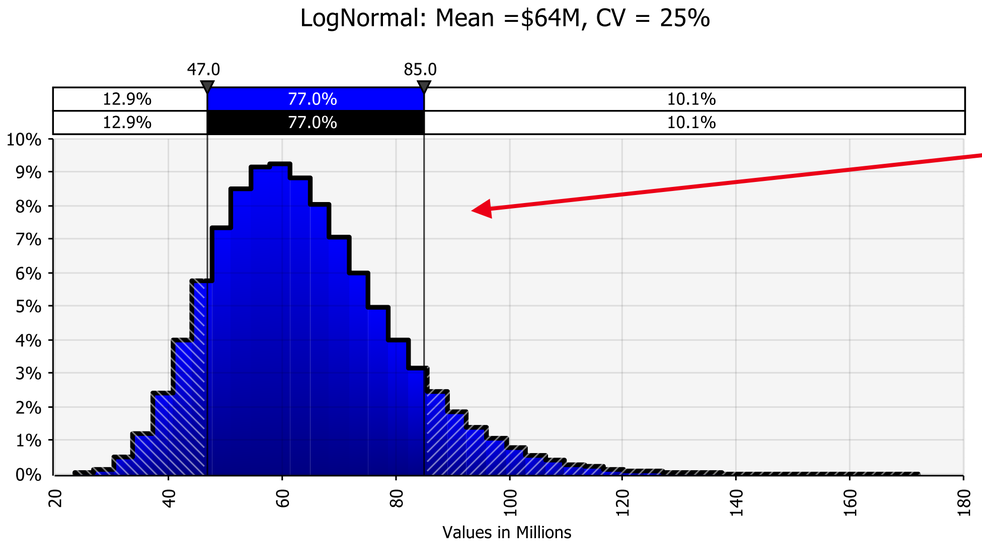
Ignores taxes and investment income

What if there was no quota share?

	$'s	%
Gross		
Premium	100.0	100.0%
Loss	85.0	85.0%
Expense	35.0	35.0%
U/W Income	(20.0)	(20.0%)
Ceded		
Premium	0	0.0%
Loss	0	0.0%
Expense	0	0.0%
U/W Income	0	0.0%
Net		
Premium	100.0	100.0%
Loss	85.0	85.0%
Expense	35.0	35.0%
U/W Income	(20.0)	(20.0%)

(000,000's)

Ignores taxes and investment income



10.1% exceedance probability or a 1 in 9.9-year return period

While the structured, sliding scale commission quota share causes the cedant to cede a lot of profit, it does serve a valuable purpose:

- It provides much needed capital relief:
  - Reducing leverage from 5:1 to 1.5:1
- It increases the gross loss ratio at which the cedant goes insolvent:
  - 85% without the quota share and 94.3% with it

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A Cat Aggregate Example

What is a cat aggregate?

Per Occurrence Limit: $7M

Per Occurrence Retention: $3M

Loss	Subject	Cumulative
$4M	$1M	$1M
$2M	$0	$1M
$6M	$3M	$4M
$10M	$7M	$11M
$8M	$5M	$16M
$1M	$0	$16M
$5M	$2M	$18M
$15M	$7M	$25M
$9M	$6M	$31M
$20M	$7M	$38M
$11M	$7M	$45M
$6M	$3M	$48M
$5M	$2M	$50M
$16M	$7M	$57M

Aggregate Limit: $15M

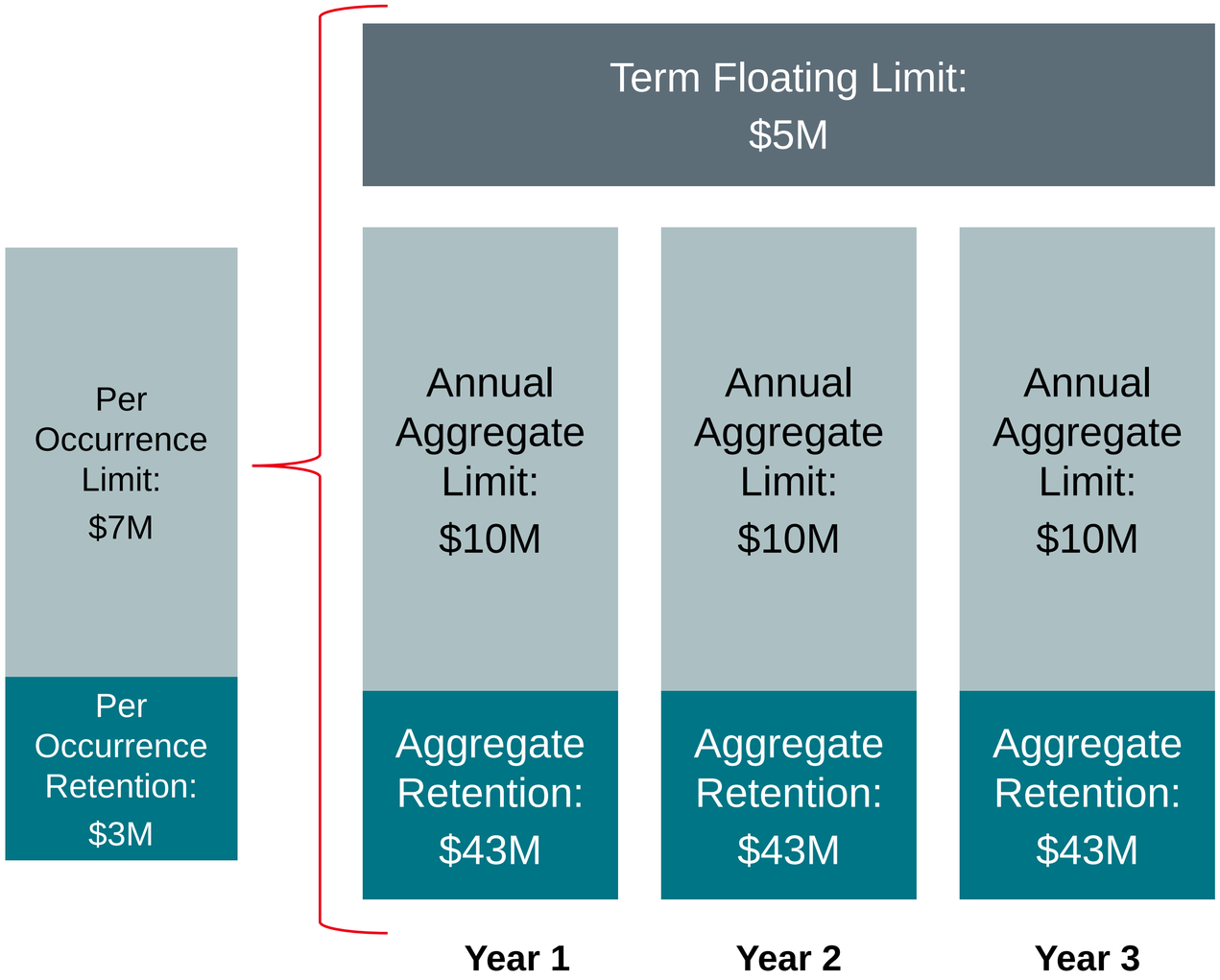
Aggregate Retention: $43M

Ceded Loss:

- **$14M**

A cat aggregate with a twist

Catastrophe Aggregate 43: Four Limits Over Three Years



Structure Highlights

Three-year term **locks in coverage and rate**

- Subject to an adjustment mechanism for year two and three to account for exposure changes
- Guarantee of one aggregate limit per year with additional limit available over three years

Aggregate limit + Floating limit provided in Year 1, or the floating limit can be used across the three-year term, until exhausted

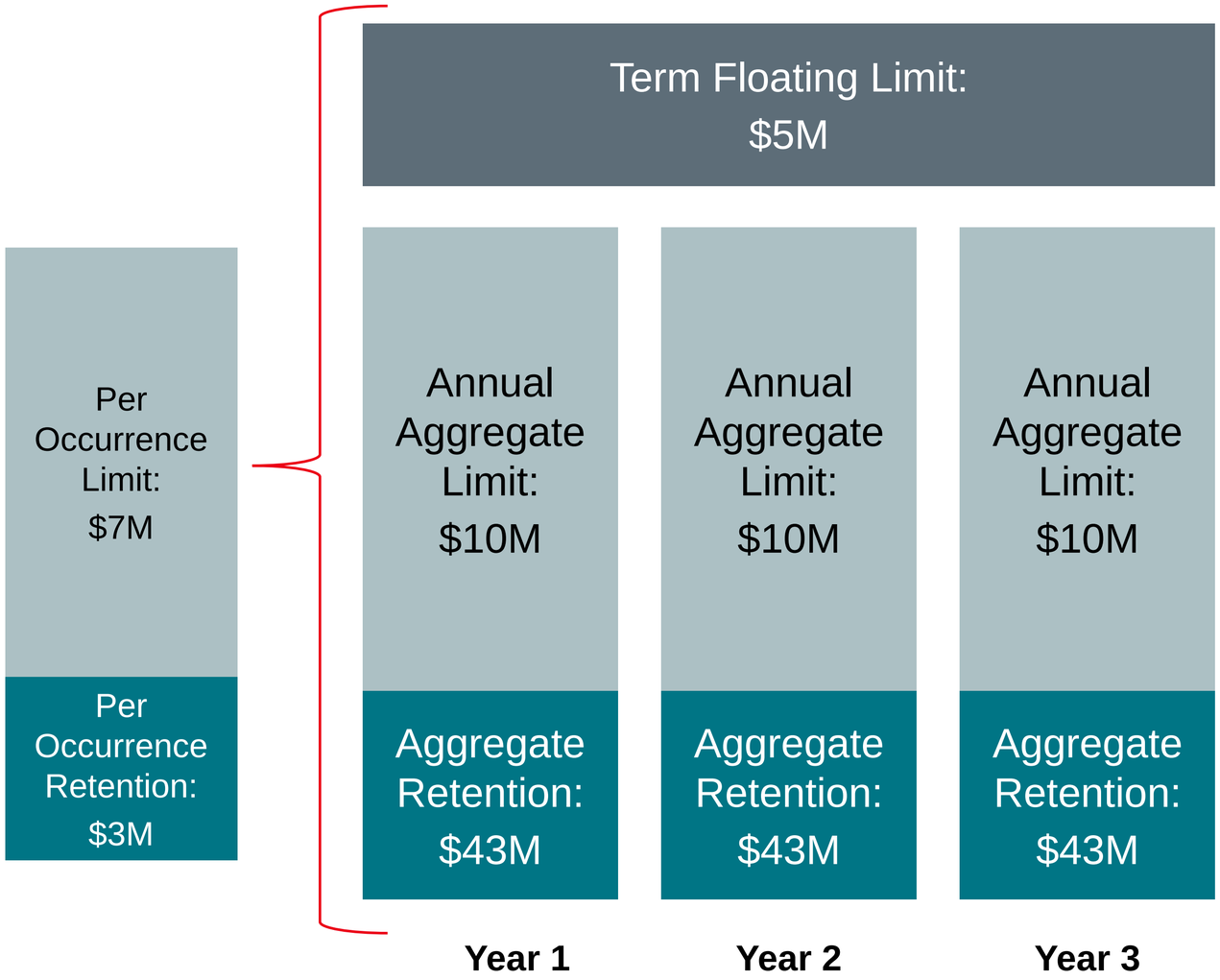
Profit Share to Cedant after Reinsurer's risk charge / margin

Cedant has **unilateral right to commute** the contract at end of year one or year two if the experience account is positive

- If contract goes full three-year term, cedant gets 100% of positive experience account balance at commutation
- Cedant may choose to not commute a positive experience account balance in order to keep the premium rate from prior year (anticipating increase in price)

A cat aggregate with a twist

Catastrophe Aggregate 43: Four Limits Over Three Years



Cedant Benefits

Efficient aggregate coverage where traditional catastrophe coverage may be prohibitively expensive

- Especially following a loss impacted year

A **lower cost in no loss scenarios** recognized through profit share features

A **guaranteed limit** available in both years 2 and 3 at a fixed cost, subject to an adjustment mechanism to account for change in exposure

Reinsurer Benefits

Greater downside protection because the annual funding is higher than the total premium for the traditional single-year aggregate

Consistent reinsurer risk profile maintained throughout term via annual premium or layer adjustments

Less capital allocated over the term – in this example only $35M of limit instead of the $45M that would be required if written on traditional basis

How do we price a cat agg 43 and model for risk transfer?

Year	Loss ID	Loss	Subject
2018	1	$4M	$1M
2018	2	$2M	$0
2018	3	$6M	$3M
2018	4	$10M	$7M
2018	5	$8M	$5M
2018	6	$1M	$0
2018	7	$5M	$2M
2018	8	$15M	$7M
2018	9	$9M	$6M
.	.	.	.
.	.	.	.
2022	1	$6M	$3M
2022	2	$5M	$2M
2022	3	$16M	$7M

- Start with a list of trended and developed historical events that would have been subject to the cat aggregate
- Based on expected loss to layer, decide on appropriate model to model for risk transfer and tail risk

Modeling Approaches

Year	Event ID	Losses	Occ Layer
2013	1	975.1	0
2013	2	1,539.7	0
2013	3	13,253.4	7,000.0
2013	4	7,173.2	4,173.2
2013	5	13,567.4	7,000.0
2013	6	14,395.5	7,000.0
•	•	•	•
•	•	•	•
•	•	•	•
2022	1	6,634.4	3,634.4
2022	2	8,631.3	5,631.3
2022	3	6,560.0	3,560.0
2022	4	2,006.2	0
2022	5	1,593.5	0
2022	6	1,701.8	0
2022	7	3,280.4	280.4

(000s)

Year	Event Count	Agg Loss	Subj Loss	Ced to Agg
2013	15.0	120,372.5	43,746.8	1,746.8
2014	16.0	94,834.3	34,290.2	
2015	24.0	126,752.2	45,913.0	3,913.0
2016	14.0	147,977.0	55,011.4	13,011.4
2017	16.0	97,371.9	43,535.5	1,535.5
2018	9.0	56,418.6	19,536.5	
2019	12.0	76,584.7	37,157.9	
2020	11.0	82,380.3	34,022.3	
2021	11.0	116,294.4	49,991.1	7,991.1
2022	10.0	44,365.3	19,860.0	
Average	13.8	96,335.1	38,306.5	2,819.8
Std Dev	4.4	32,404.7	11,826.4	4,401.6
CV	31.6%	33.6%	30.9%	156.1%

(000s)

- You have decided to use a 10-year exposure period
- The table above left list's historical events (e.g., PCS) for each subject year
- The table above right summarizes by year

- For modeling to price the cover, we could use a LogNormal distribution with $38.3M as the mean and $11.8M as the Std Dev
- Or we could use a non-parametric approach simulate from the 138 historical events or an average of 13.8 per year

A quick sidebar

- Many companies are rating property by peril
- Instead of buying a cover to protect against critical cat events only, e.g., named storms, PCS events
- A company could buy a weather occurrence and/or a weather aggregate cover to cover all weather-related events, subject to a two-risk warranty
- A company could then gather all weather-related losses by day and create new occurrences optimized to the per-occurrence retention and limit

Date	Peril	Claims	Loss Amount
1/1/2018			
1/2/2018			
1/3/2018			
1/4/2018			
1/5/2018			
1/6/2018			
1/7/2018			
1/8/2018			
1/9/2018			
1/10/2018			
1/11/2018			
•			
•			
•			

Moving forward with the non-parametric approach

1. Simulate frequency using a Poisson Distribution with the mean equal to the historical subject period average
2. Randomly select the number of individual events simulated in 1) above from historical event list
3. Apply occurrence terms ($7M xs $3M contributing occurrence loss) to each event selected in 2) above
4. Add total from 3) and apply cat agg terms
5. Repeat 1) through 4) 10K to 25K times

Note: contract will have an adjustment mechanism (either to premium or retention) to assure risk to contract in year two and three matches year one

Other assumptions:

- Payment pattern
- Discount rate
- Correlation between years
  - Despite historical data indicating the correlation between the years is insignificant, I judgmentally used 20% between adjacent years (1:2, 2:3) and 10% between gap years (1:3)

Testing correlation between years:

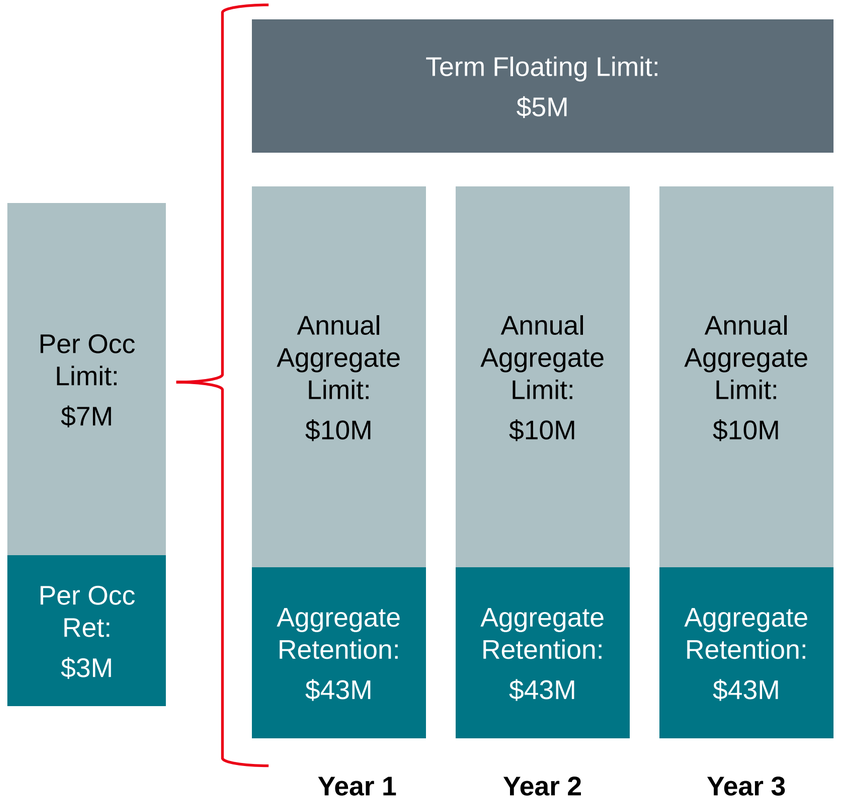
AY	Total	Shift_One_Year	Shift_Two_Years
2012	56,980.6	120,372.5	94,834.3
2013	120,372.5	94,834.3	126,752.2
2014	94,834.3	126,752.2	147,977.0
2015	126,752.2	147,977.0	97,371.9
2016	147,977.0	97,371.9	56,418.6
2017	97,371.9	56,418.6	76,584.7
2018	56,418.6	76,584.7	82,380.3
2019	76,584.7	82,380.3	116,294.4
2020	82,380.3	116,294.4	44,365.3
2021	116,294.4	44,365.3	
2022	44,365.3		

Correlation / p-value

	Year 1	Year 2	Year 3
Year 1	1.00	0.03 / 0.92	-0.06 / 0.89
Year 2	0.03 / 0.92	1.00	0.18 / 0.64
Year 3	-0.06 / 0.89	0.18 / 0.64	1.00

Modeling/Pricing Results

		% to Premium
Premium	$8M	100%
Margin	$2.2M	27.5%
Experience Account / Profit Commission	$5.8M	72.5%
P(Commutation)	90.1%	
E(Time of Commutation)	1.4 Years	
ERD	1.9%	
VaR_{90}	+36.8%	



- Cedant has unilateral right to commute at end of year 1 or 2 if experience account balance is positive
- Risk transfer is robust as measured by ERD but non-existent using the 10/10, highlighting a major pitfall of

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