GUY CARPENTER

THE PITFALLS OF EXPOSURE RATING
A PRACTITIONERS GUIDE

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GC Analytics

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Agenda

- **Some common pitfalls**
- **The presentation of exposure data**
  - Banded limit profiles vs. banded limit/attachment profiles vs. detailed risk list
  - How these affect the results of a pricing exercise
  - The effect of modelling portfolios with high excess layers
- **Sensitivity analysis**
  - Assessing the impact of making assumptions during the modelling process
- **Model Choice**
  - Deterministic vs. Stochastic

SOME COMMON PITFALLS

Some Common Pitfalls

- **The common pitfalls of exposure rating are well documented**
  - Appropriateness of exposure curves
  - Adequacy of original premium
  - Difficult matching exposure and experience results
- **Focus on topics that have received less attention**
  - How the **data** is presented and the impact that can have on the modelling
  - The **assumptions** that are made and how they are applied
  - The choice of exposure **model** (deterministic vs. stochastic)
- **We'll analyse and discuss these concepts in a practical setting with real data**

THE PRESENTATION OF EXPOSURE DATA

The Presentation of Exposure Data
Why is this an issue?

- **Companies present exposure data in different ways**
  - Banded limits Profile
    - With or without policy attachment information
  - Banded limit / attachment Profile
  - Detailed risk by risk data

- **Exposure rating results can significantly differ depending on the method chosen**
  - Implications for pricing and capital modelling

- **The following slides show these four ways of presenting data for the same portfolio**

The Presentation of Exposure Data
Banded limits profile

Limit Band	Average Limit (m)	Premium (m)
1m – 5m	2.76	8.845
5m – 10m	8.06	14.05
10m – 15m	13.24	6.485
15m – 25m	20.39	22.85
25m – 35m	30.29	16.51
35m – 50m	42.72	31.8
50m – 75m	63.66	34.35
75m – 100m	90.12	18.24
100m – 125m	112.29	16.03
125m – 150m	139.14	26.44
		195.6

The Presentation of Exposure Data
Banded Limits profile with average policy attachment per band

Limit Band	Average Limit (m)	Average Attachment (m)	Premium (m)
1m – 5m	2.76	0.37	8.845
5m – 10m	8.06	1.27	14.05
10m – 15m	13.24	8.97	6.485
15m – 25m	20.39	17.36	22.85
25m – 35m	30.29	28.68	16.51
35m – 50m	42.72	33.96	31.8
50m – 75m	63.66	52.29	34.35
75m – 100m	90.12	66.05	18.24
100m – 125m	112.29	38.51	16.03
125m – 150m	139.14	33.42	26.44
			195.6

The Presentation of Exposure Data
Banded limits / attachment profile

Deductible Band	0-1m	1m-2m	2m-5m	...	175m – 225m	Total
Limit Band	Premium (millions)					
1m – 5m	7.895	0.98	0.72	...	0.00	8.845
5m – 10m	13.51	0.05	0.38	...	0.00	14.05
10m – 15m	5.92	0.04	0.06	...	0.03	6.485
15m – 25m	18.36	0.83	0.99	...	0.17	22.85
25m – 35m	13.02	1.95	0.23	...	0.24	16.51
35m – 50m	25.25	1.02	0.55	...	0.83	31.8
50m – 75m	28.97	0.20	0.00	...	0.81	34.35
75m – 100m	13.67	1.24	1.06	...	0.15	18.24
100m – 125m	13.6	0.00	0.00	...	0.27	16.03
125m – 150m	22.33	0.00	1.80	...	1.72	26.44
Total	**162.5**	**6.32**	**5.79**	**...**	**4.22**	**195.6**

The Presentation of Exposure Data
Detailed risk list

Limit	Deductible	Premium	Participation	Stack Code
6.00	0.00	0.02	30.0%	1
6.00	0.00	0.01	18.5%	2
9.00	0.00	0.08	95.8%	3
20.00	80.00	0.10	50.0%	4
4.50	1.50	0.97	89.0%	5
200.00	210.00	0.25	20.0%	6
190.00	410.00	0.12	15.0%	6
⋮	⋮	⋮	⋮	⋮
7.70	0.00	0.03	30.0%	2299
0.98	0.00	0.01	80.0%	2300
Total		**195.6**		

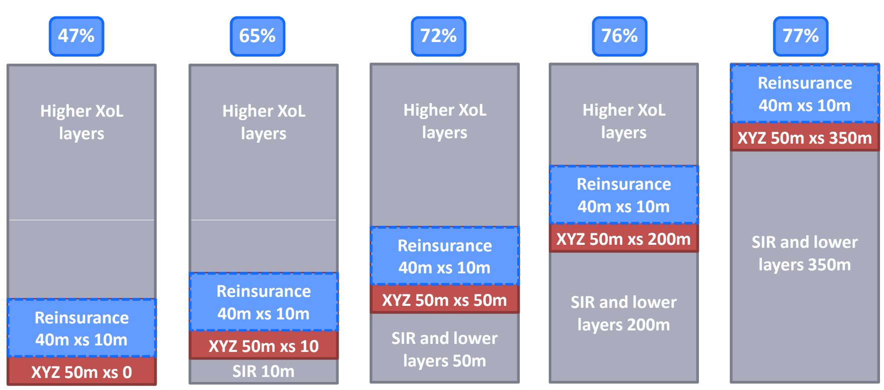
The Presentation of Exposure Data
Expected losses to reinsurance layers

- **Assumptions**
  - Written premium GBP 225M
  - 60% loss ratio
  - Medium severity exposure curve

	Exposure Modelling Method			
RI Layer	**Banded Limits Profile**	**Banded Limits profile (with attachments)**	**Banded Limit / Attachment Profile**	**Detailed**
25M xs 25M	5.67	26.79	12.8	10.34
50M xs 50M	2.905	16.38	6.865	5.58
50M xs 100M	0.59	3.315	1.45	1.305
Total	**9.16**	**46.48**	**21.11**	**17.22**

The Presentation of Exposure Data
Why attachment points are important in exposure modelling

- **Assume TIV is 400m, XYZ write 50m policy layer, reinsurance is excess of 10m**
  - Reinsurance represents 80% (40/50) of original policy coverage
  - The higher the original policy attachment, the closer the **% exposed** is to pro-rata (80%)



Sensitivity Analysis

Sensitivity Analysis
Where are the main drivers of uncertainty in exposure modelling

- **Several assumptions made in exposure modelling**
  - Loss ratio
  - Curve selection
  - Treatment of missing premium
  - Treatment of missing deductible information
- **Which assumptions are the most sensitive?**
- **Case study based on modelling the portfolio from the previous section**
  - Vary each assumption from the best estimate position to test sensitivity

Sensitivity Analysis
Summary of company and best estimate results

- **European property-casualty insurer**
  - GBP 225m written premium projection for 2012
  - Full policy data provided for each layer of every programme
  - GBP 195m premium captured in the data
  - Planned 2012 loss ratio of 60%
  - Reinsurance structure 125M xs 25M
- **Best estimate modelling results**

	Exposure Modelling Method
RI Layer	Detailed
25M xs 25M	10.34
50M xs 50M	5.58
50M xs 100M	1.305
Total	**17.22**

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Sensitivity Analysis
Varying the loss ratio

- **60% planned loss ratio – but what has been achieved?**
  - 53.6% loss ratio lowest achieved over last 10 years
  - 73.6% the highest
  - What happens if we use these loss ratios instead?
    - Change in expected loss proportional to change in los ratio

RI Layer	Best Estimate	52% Loss ratio	73.6% Loss Ratio
25M xs 25M	10.34	8.955	12.68
50M xs 50M	5.58	4.835	6.84
50M xs 100M	1.305	1.13	1.6
Total	**17.22**	**14.93**	**21.12**
		-13%	+23%

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Sensitivity Analysis
Varying the exposure curve

- **Medium severity curve deemed appropriate**
  - What impact does using light and heavy curves make?

RI Layer	Best Estimate	Light Curve	Heavy
25M xs 25M	10.34	8.61	12.02
50M xs 50M	5.58	5.035	6.14
50M xs 100M	1.305	1.265	1.34
Total	**17.22**	**14.92**	**19.5**
		-13%	+13%

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Sensitivity Analysis
Why didn't the exposure curve have a greater affect?

- **The results of varying the exposure curve may have been surprising**
  - Usually curve selection is the most scrutinised assumption
- **Consider splitting all the written layers into three "buckets"**
  - 1. No exposure to reinsurers
  - 2. Partial exposure to reinsurers
  - 3. Fully exposed to reinsurers
- **Example: Consider an insurance programme consisting of three stacking layers**
  - Layer 1. 10m xs 10m
  - Layer 2. 20m xs 20m
  - Layer 3. 60m xs 40m
  - XYZ Insurance Company writes 100% of all three layers
  - Reinsurance programme is 25m xs 25m, 50m xs 50m

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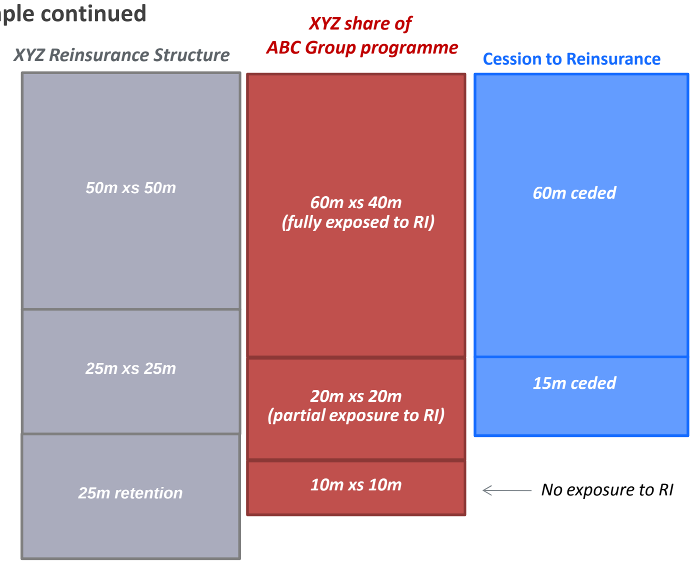
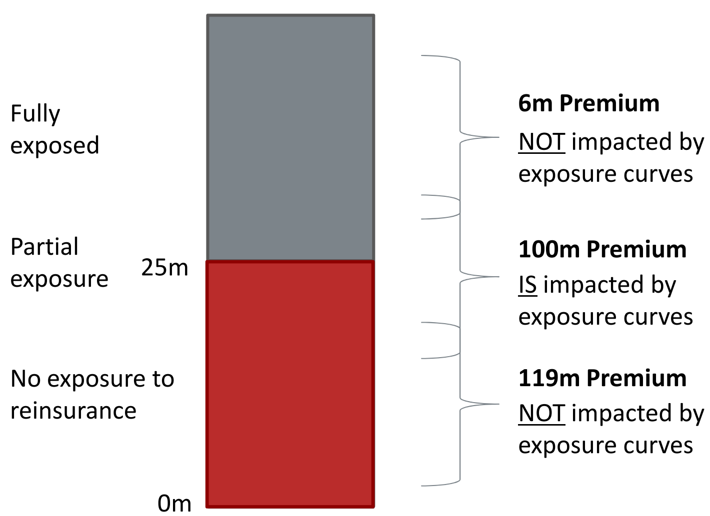
Sensitivity Analysis
Why didn't the exposure curve have a greater affect?

- **Example continued**



Sensitivity Analysis
3 'buckets' of premium for whole portfolio



Sensitivity Analysis
Varying the treatment of missing premium

- **Profiled premium (195m) scaled up to estimated GWP 225m**
  - Implies that the missing premium is equally spread throughout the portfolio
  - Some insurers/reinsurers take different approaches
    - May assume (or be told) that missing premium is all from risks below a threshold

RI Layer	Best Estimate	No Premium Scaling
25M xs 25M	10.34	8.985
50M xs 50M	5.58	4.85
50M xs 100M	1.305	1.135
Total	**17.22**	**14.97**

-13%

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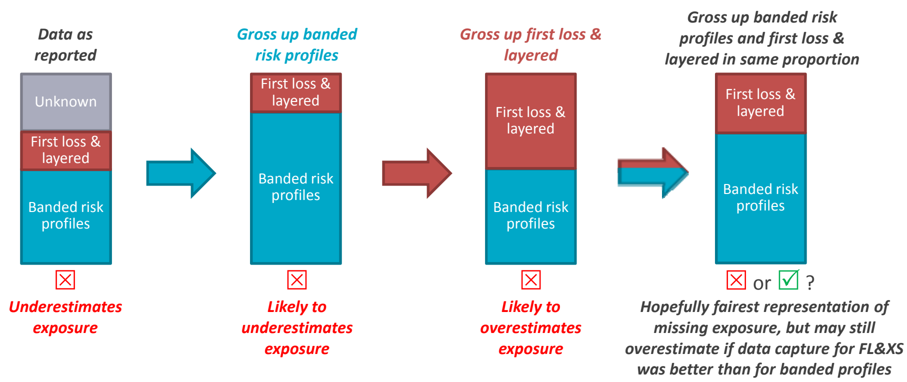
Sensitivity Analysis
The importance of good data capture

- **Exposure data is never captured 100%**
  - We model the missing exposure by *grossing up* the captured exposure
  - Grossing up based upon premium capture; alternative methods shown below
  - However, best method is to <u>maximise</u> the original data <u>capture</u>



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Sensitivity Analysis
Varying the treatment of deductibles

- **In the detailed modelling deductibles are accurately modelled per layer**
  - Sometimes deductible info isn't made available
  - Sometimes only an average deductible is disclosed

RI Layer	Best Estimate	No Deductibles	Average Deductible
25M xs 25M	10.34	7.15	18.92
50M xs 50M	5.58	3.675	7.665
50M xs 100M	1.305	0.475	1.16
Total	**17.22**	**11.3**	**27.75**
		-34%	+61%

Sensitivity Analysis

- **Traditionally we apply the same assumptions to the whole limit profile**

- **Varying the exposure curve by limit**
  - Lower parts of the limits profile could be a different business mix to higher parts
  - Exposure curves adequacy at different parts of the portfolio

- **Varying the loss-ratio by limit**
  - Different parts of the portfolio have different margins
  - Flat loss-ratio has pro-rata effect on the expected loss cost
  - Applying a loss-ratio distribution will be more realistic
    - Sensitive to parts that contribute to total loss cost

Model Choice

Model Choice
Stochastic vs. deterministic

- **Traditional exposure pricing – split original premiums to reinsurance layer**
  - Simple and intuitive
  - Hard to get standard deviation around mean
- **Stochastic modelling**
  - Extend traditional approach to find frequency and severity parameters
  - Allows to be used in wider context e.g. underwriting model
  - Hybrid pricing model between experience and exposure
  - Full distribution of outcomes allows scenario testing

Model Choice
Average loss severity and expected loss count

- **Severity: Average loss severity**
  - Average of the losses that entered the reinsurance layer

$$\textit{Average Loss Severity} = \frac{\textit{Total Reinsurance Layer Loss}}{\textit{Expected Loss Count}}$$

Premium x Loss Ratio x Cession Percentage

- **Frequency: Expected loss count**
  - Expected number of claims to enter the layer
  - Calculated by creating a very small unit layer excess of the same reinsurance retention

$$\textit{Expected Loss Count} = \frac{\textit{Total Unit Layer Loss}}{\textit{Average Unit Layer Severity}}$$

Premium x Loss Ratio x Cession Percentage to Unit Layer

Unit layer limit

Model Choice
Concept behind expected loss count

- **Average unit layer severity = Unit layer limit** – *how?*
  - Average severity tends to the layer limit as size of limit tends to 0

$$P[X < (Lim + Ded) | X > Ded] \to 0 \text{ as } Lim \to 0$$

  - Therefore:
    - As the size of the limit tends to 0 there is a greater chance that each loss to the layer will be a total loss
  - So:
    - If EVERY loss is TOTAL LOSS then AVERAGE LOSS is the size of the LAYER LIMIT
  - We now know:
    - **Total loss** = premium x loss ratio x cession percentage to unit layer
    - **Average severity** = unit layer limit

$$\textit{Frequency} = \frac{\textit{Total Loss}}{\textit{Average Severity}}$$

Model Choice
CDF - how are they created

- **CDF's:** Calculated using the same approach as used for expected loss count to a layer

$$\text{Expected Loss Count} = \frac{\text{Premium} \times \text{Loss Ratio} \times \text{Cession Percentage to Unit Layer}}{\text{Unit Layer Limit}}$$

- **Method:**
  - **Step 1:** Expected loss count calculated for series of small dummy layers above increased retention points
  - **Step 2:** Relativities between the expected loss count used to create a conditional CDF

$$F_x\left(x \middle| X \geq Min\right) = P\left[X \leq x \middle| X \geq Min\right] = 1 - \frac{\text{Expected Loss Count (x)}}{\text{Expected Loss Count (Min)}}$$

Model Choice
Example

- To create a CDF with 100 points between 100k and 1m.
- **Either**, fixed "additive" increments of 9k (=(1m-100k)/100).
- **Or**, "multiplicative" increments of 1.0233 (= (1m/100k)^(1/100))
- The expected loss count will be calculated for 100 points
- The CDF can then be calculated using the ratio of expected loss count

Example:

P[X ≤ 127|X>100] = **0.05** = 1 – **9.5**/**10**

Loss ('000) "Additive"	Expected loss count	CDF
100	10	0
109	9.9	0.01
118	9.8	0.02
127	9.5	0.05
982	0.2	0.98
991	0.1	0.99
1000	0	1

Summary

Summary
Final thoughts

- **Modelling via exposure methods is straightforward and well understood**
  - Stochastic modelling
    - Advantageous compared to traditional exposure modelling
    - Standard deviation around mean
    - Price loss sensitive features
    - Easy to incorporate into capital model
- **Understanding stress points of data not so straightforward**
  - Presentation of data can significantly alter the results of exposure modelling
    - Treatment of policy deductibles critical when excess of loss business written
    - Understand assumption sensitivities i.e. in some cases, choice of curve doesn't make a big difference
- **Exposure rating tool has its place in the rating toolbox**
  - Industry view versus company specific view
  - How to handle:
    - Correlations between risks
    - Catastrophe risks
    - Business interruption

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