Exposure Based Pricing – Commercial Risks

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Hiten Kothari - December 4, 2015

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Contents

- Commercial Risks Background

- Basics of Exposure Curve

- Loading for large loss – An example

- Choosing an Exposure curve

- Exposure Curve Pricing - Pitfalls

Commercial Risks - Features

- **Heterogeneity** : Nature and size of risk and client's consideration for individuality

- **Exposure and internationality** : Spread b/w production sites, warehouse and sales office across geography. Possible global Supply chain and risk management practices.

- **Increased scope for judgement** : Underwriters tend to view commercial risks through rose tinted glasses and ability to justify low or competitive prices

- Policy Terms and Conditions, distribution channel etc.

- Inadequate claims data or unusual claims experience (good and bad!)

- Huge variations between theoretical price and actual market price

Standard Pricing Methods – Challenges

Pricing Methods

Frequency - Severity

Exposure Based - GLM

Burning Cost

Retrospective Pricing
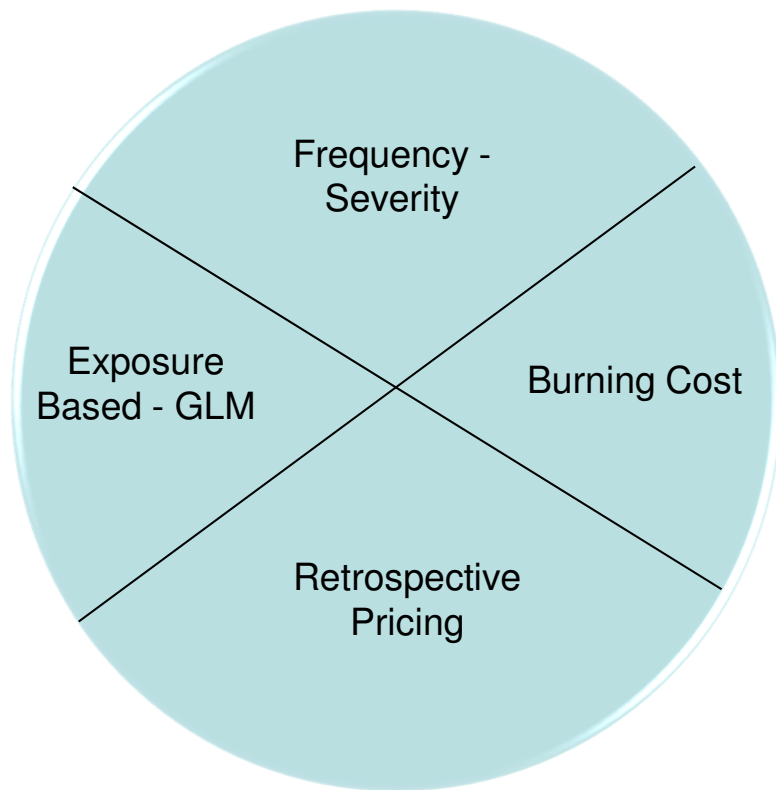
- GLM - **rating factors** to capture heterogeneity in Commercial risks and inadequate data

- Burning Cost – Unusual experience resulting in increased **volatility** in price

- Frequency-Severity – **Inadequate data** in respect of individual risks

- Retrospective Pricing – Premium adjustments can take time and one can argue whether it is risk pooling?

Commercial Risk Pricing

Good Risk or Bad Risk?

- Consider two similar risks

Risk A – Loss ratio around 20% over the last two years

Risk B – Has suffered for the last two years on account of large losses.

The premium has marginally increased

The premium for the risk has declined 50% over two years

Underwriter keen to write Risk A given that it is a Good Risk

Commercial Risk Pricing (2)

Good Risk or Bad Risk?

- Consider two similar risks

Risk A – Loss ratio around 20% over the last two years

Risk B – Has suffered for the last two years on account of large losses.

The premium for the risk has declined 50% over two years

The ~~market~~

The challenge is are we charging enough for Risk A so as to cater to the potential large loss.
Should discounts be restricted to **attritional losses only??**

Underwriter keen to write Risk A given that it is a Good Risk
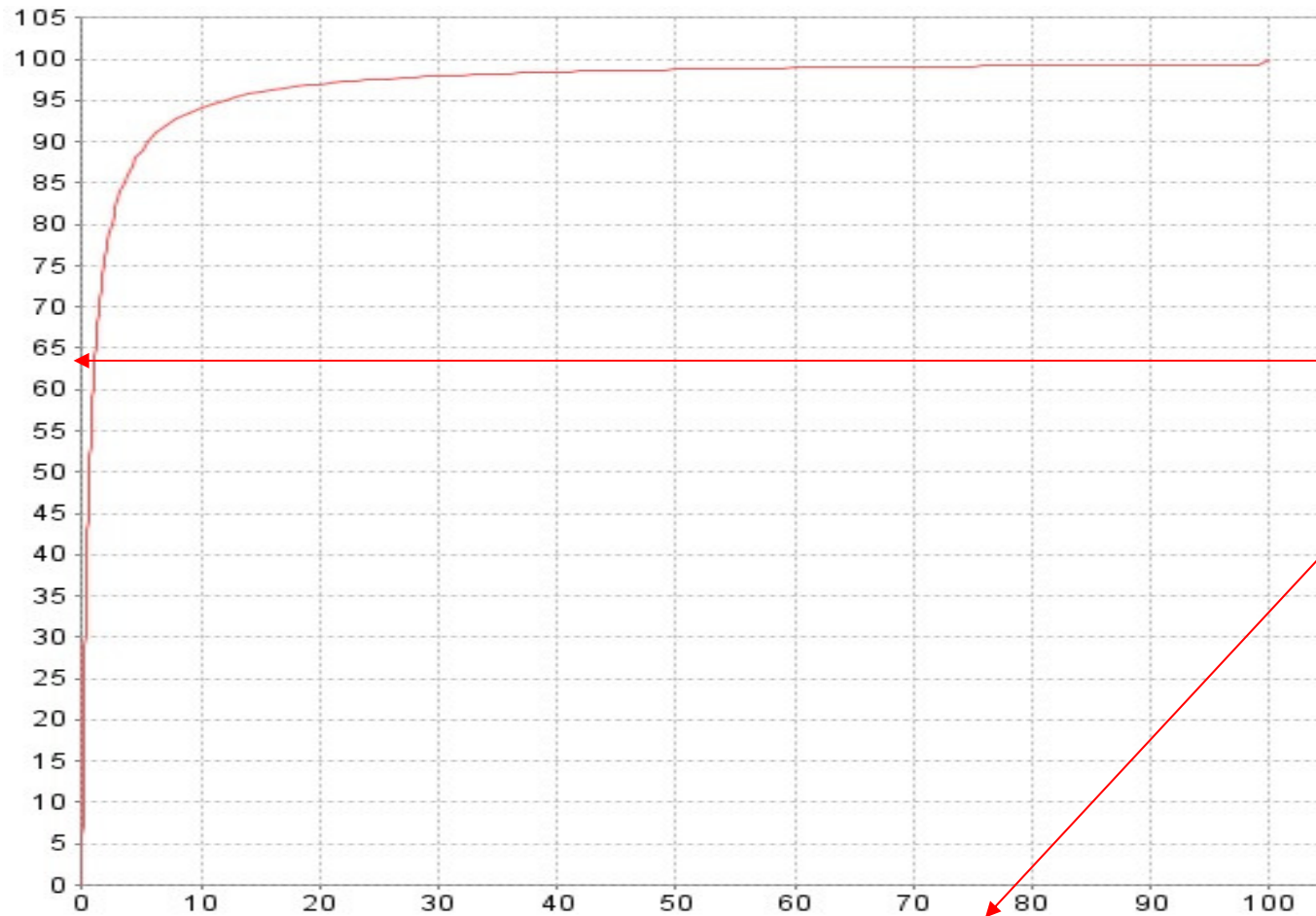
Commercial Risks – Large Risk loading

Reinsurance Cost as proxy

- The Risk XOL cost can be used a proxy to large risk loading and can be apportioned amongst large risks
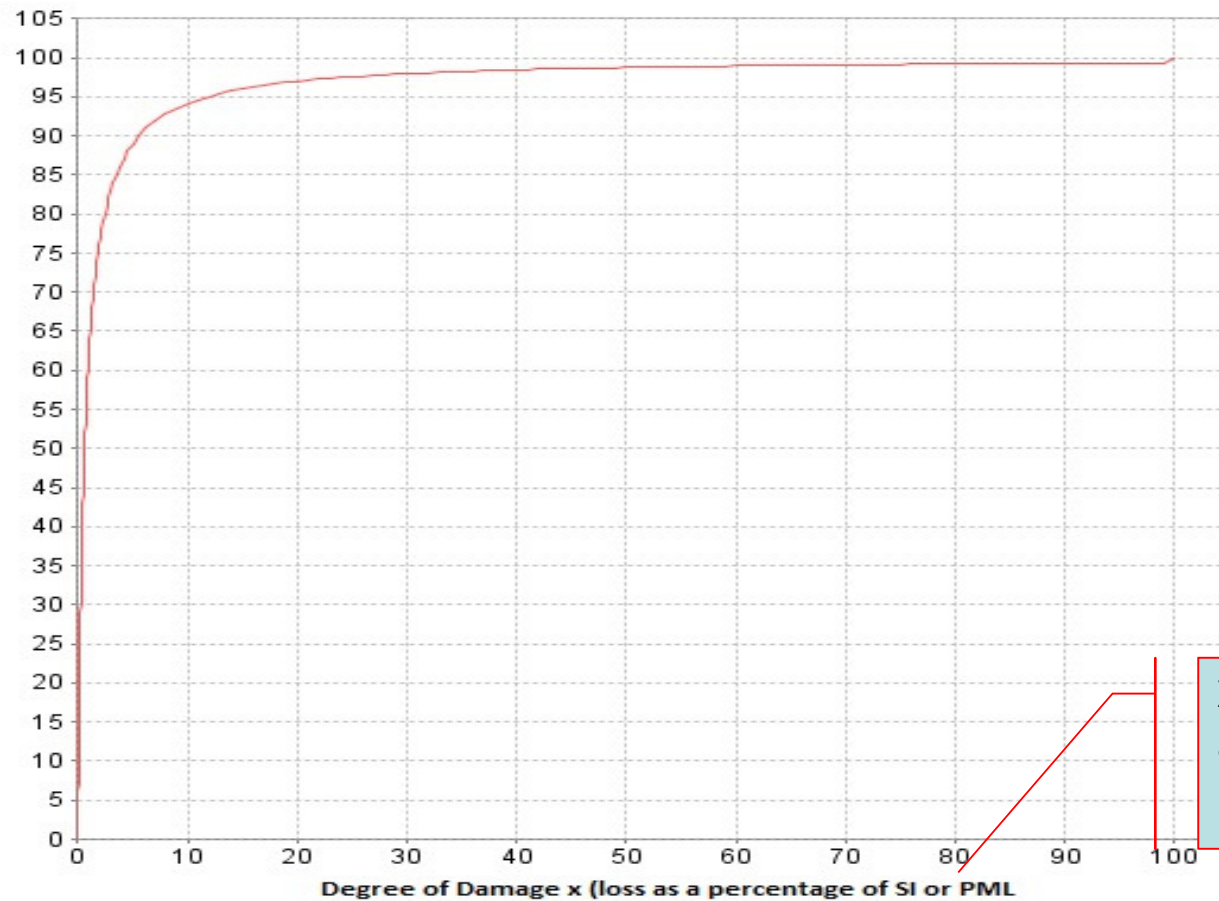
Exposure Curve

- Exposure Curve are widely used in pricing Excess of Loss reinsurance programs
- Swiss Re Curves, MBBEFD curve and Lloyds' curve are well known

Exposure Curve – Basics (2)

X-axis represent Loss amount as a % of Sum Insured or PML

Degree of Damage x (loss as a percentage of SI or PML

Exposure Curve – Basics (3)

Y-axis represents proportion of losses
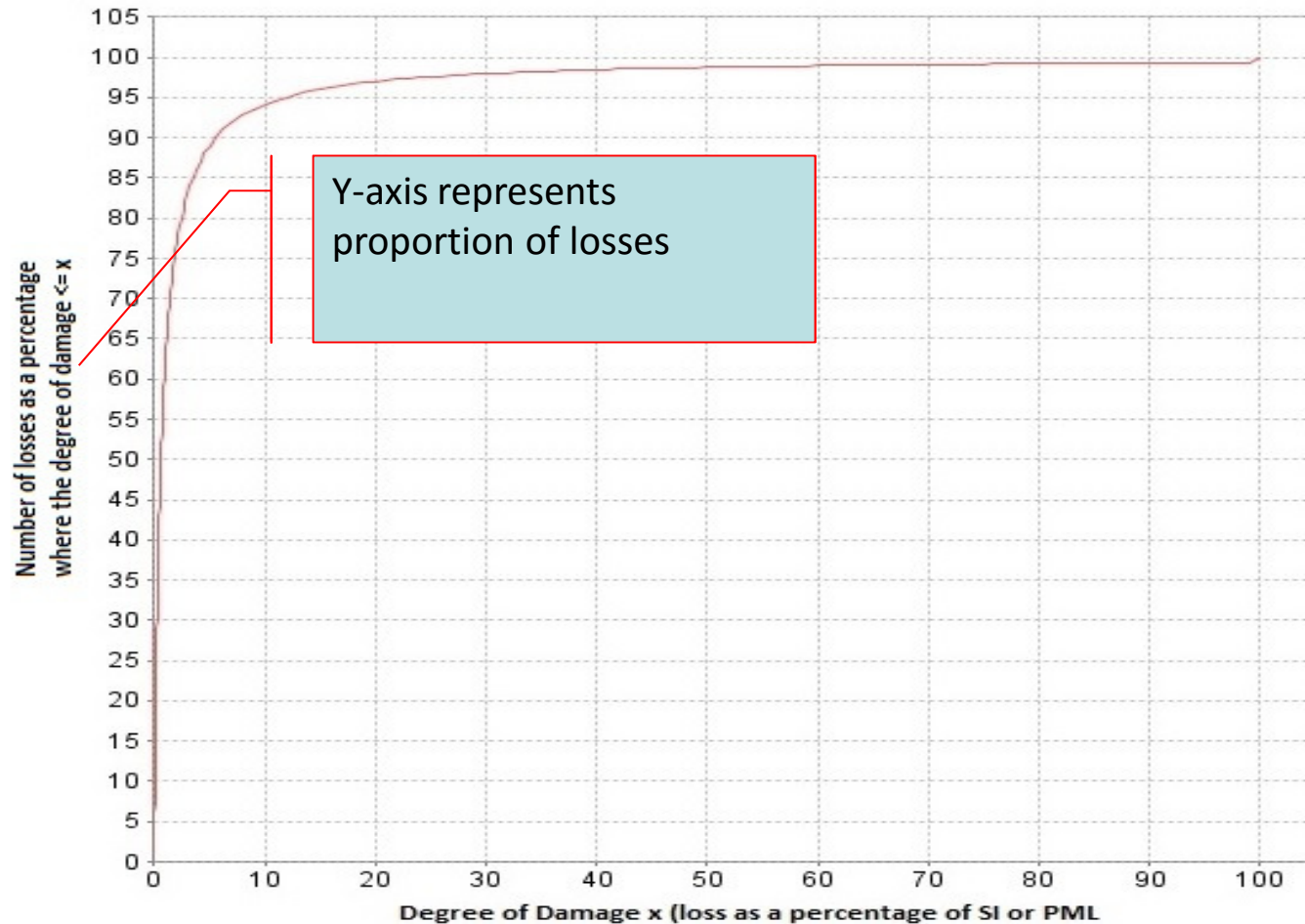
The exposure curve can be used to determine the number of losses and the severity of losses

Pricing using Exposure Curves - Process

Risk Profiles details - Sum Insured Bands, No of Risks, Premium, Loss Ratio etc.

Exposure Curve and Large Loss Threshold

No of Losses above Large Loss Threshold

Severity of Losses above the Threshold
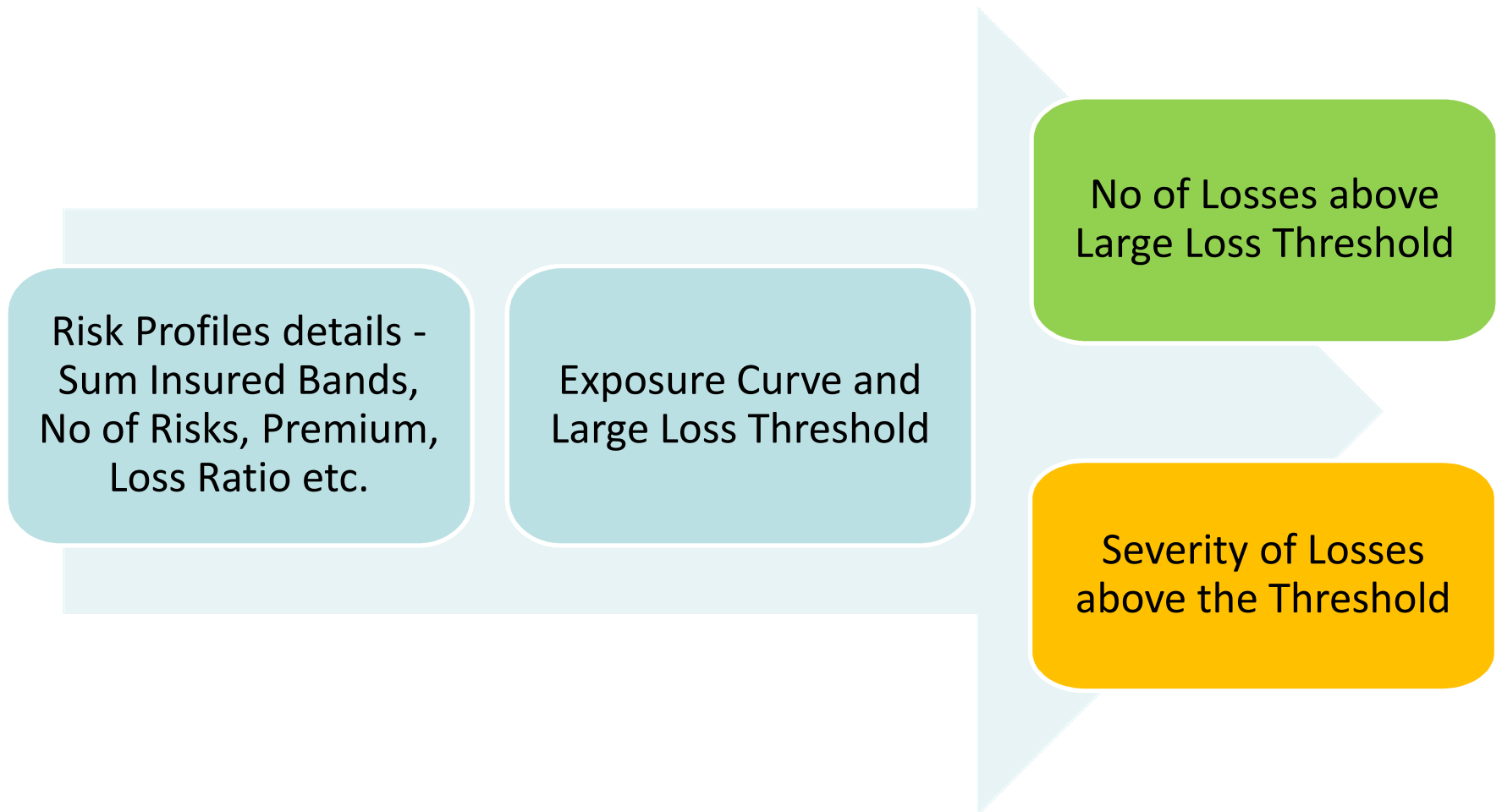
Exposure Curve Pricing – Example (1)

Data Inputs

- Risk Profile e.g. table below
- Large Loss Threshold e.g. INR 100,000,000
- Loss Ratio e.g. assume 70%

Risk Profile - Sum Insured / PML						
Band ID	Lower Band	Upper Band	# of Risks	Premium	Total Sum Insured / PML	Average Sum Insured / PML
1	0	10,000,000	5,700	51,300,000	34,200,000,000	6,000,000
2	10,000,000	50,000,000	1,500	76,500,000	51,000,000,000	34,000,000
3	50,000,000	100,000,000	1,000	80,000,000	80,000,000,000	80,000,000
4	100,000,000	250,000,000	750	142,500,000	142,500,000,000	190,000,000
5	250,000,000	500,000,000	500	200,000,000	200,000,000,000	400,000,000
6	500,000,000	1,000,000,000	250	150,000,000	200,000,000,000	800,000,000
7	1,000,000,000	2,500,000,000	125	178,125,000	237,500,000,000	1,900,000,000
8	2,500,000,000	5,000,000,000	100	300,000,000	400,000,000,000	4,000,000,000
9	5,000,000,000	10,000,000,000	50	800,000,000	400,000,000,000	8,000,000,000
10	10,000,000,000	25,000,000,000	25	950,000,000	475,000,000,000	19,000,000,000

Exposure Curve Pricing – Example (2)

Data Inputs

- Exposure Curve – Could be continuous or discrete distribution. Continuous curve can also be converted into a discrete distribution by dividing the curve into small fragments as shown in the example below.

Sample Exposure Curve							
							All figures in %
% TSI/EML	Exceedance	% TSI/EML	Exceedance	% TSI/EML	Exceedance	% TSI/EML	Exceedance
0	0	0.52835	46	7.156383	92	53	98.813032
0.006263	1	0.550027	47	8	92.779909	54	98.834186
0.012655	2	0.572539	48	9	93.527217	55	98.854579
0.019178	3	0.595934	49	10	94.133786	56	98.874252
0.025837	4	0.620265	50	11	94.635953	57	98.893241
0.032636	5	0.64559	51	12	95.058535	58	98.911583
0.03958	6	0.671971	52	13	95.419063	59	98.929309
0.046673	7	0.699476	53	14	95.73027	60	98.94645
0.053921	8	0.728177	54	15	96.001628	61	98.963034
0.061328	9	0.758154	55	16	96.240332	62	98.979089
0.068899	10	0.789495	56	17	96.45194	63	98.994638
0.076641	11	0.822295	57	18	96.640818	64	99.009707
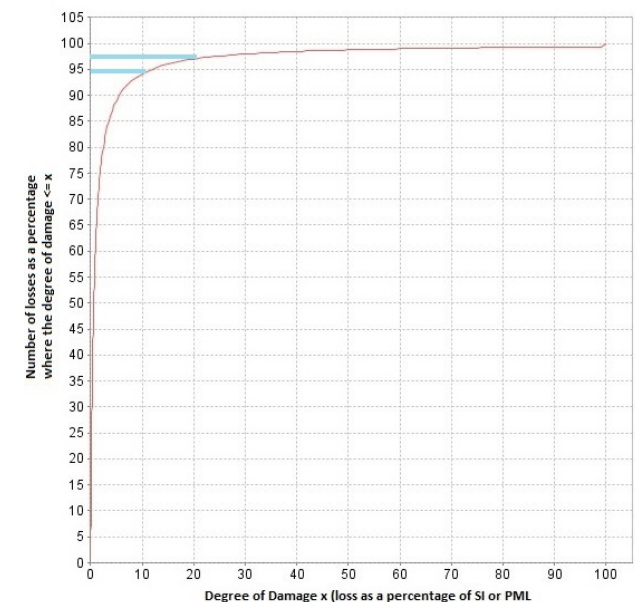
Exposure Curve Pricing – Example (3)

Assumptions

- Expected loss ratio (as a percentage of total premium) is constant across all risk bands.
- Average loss (as a percentage of exposure) is constant over all risk bands.

Note

Each of the above assumption can be relaxed/mitigated by adapting the overall methodology to allow for loss ratio corresponding to each risk bands and using separate exposure curve commensurate to the risk band. However, lack of adequate data and judgment on suitability of exposure curve needs to be taken in to consideration.

No of Large loss above Threshold

2. $\lambda_i = \dfrac{LR * Premium_i}{E(X) * Avg\ SI_i}$

i = Band ID,
E(X) = Exposure Curve Mean
λ = # losses

3. Determine # losses above threshold using curve

1. Calculate # losses for each risk band

 # Loss >= Large Loss Threshold

4. λ_i = 0 for Avg SI < Large Loss threshold

5. $\lambda_L = \sum_{i=1}^{n} \lambda_i$
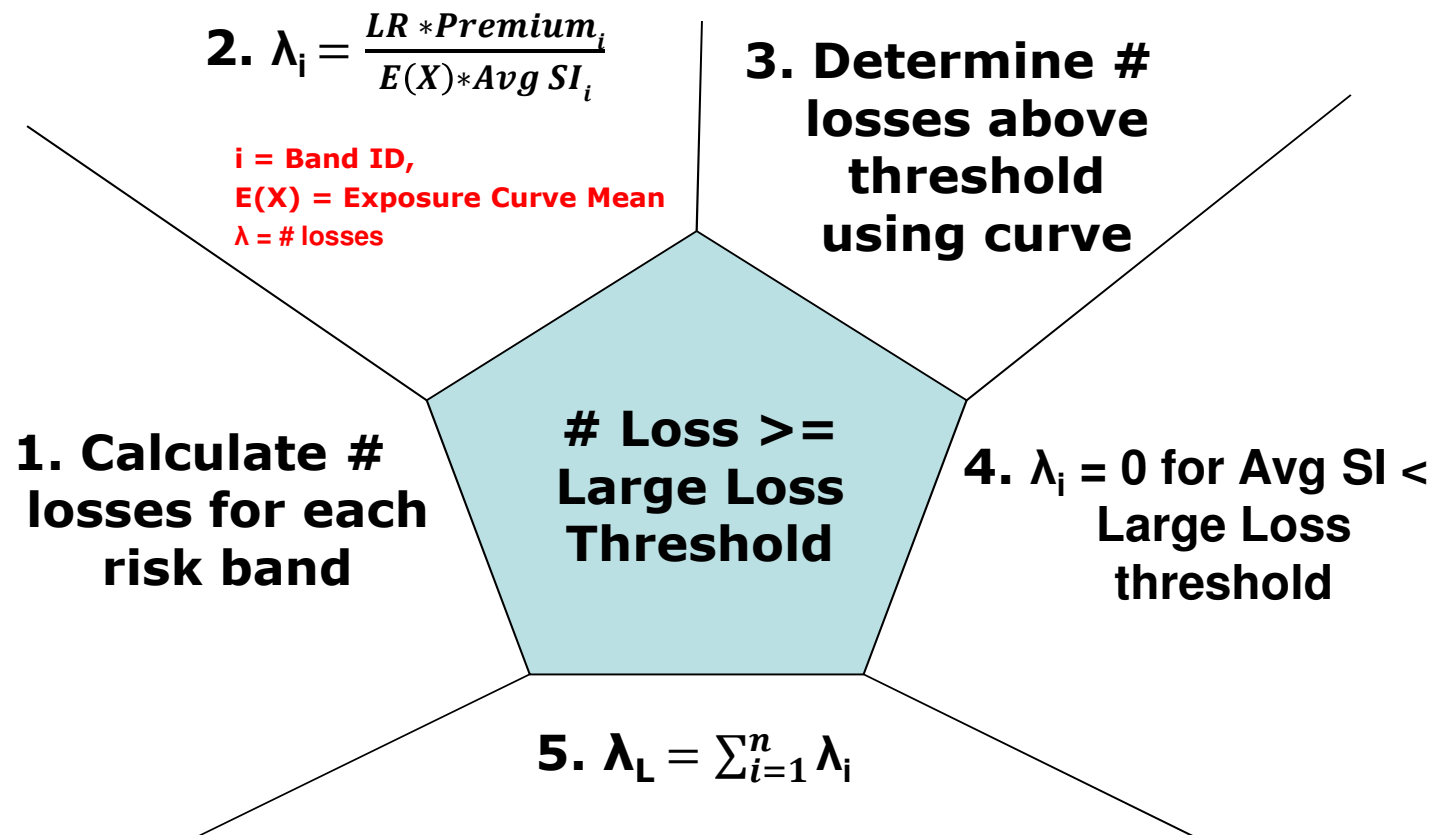
Exposure Curve Pricing – Example (4)

		Risk Profile - Sum Insured / PML				
					LR = 70%; E(X) = 3.18%; LT = 100,000,000	
Band ID	Premium (A)	Average Sum Insured / PML (B)	$\lambda_i = \dfrac{A * LR}{E(X) * B}$	$\theta = \dfrac{LT}{B}$	# Large Losses = if θ > 1 Then 0 Else Interpolate	# Large Loss
1	51,300,000	6,000,000	188.21	16.66667	0.000	
2	76,500,000	34,000,000	49.53	2.94118	0.000	
3	80,000,000	80,000,000	22.01	1.25000	0.000	
4	142,500,000	190,000,000	16.51	0.52632	0.197	
5	200,000,000	400,000,000	11.01	0.25000	0.269	2.53
6	150,000,000	800,000,000	4.13	0.12500	0.196	
7	178,125,000	1,900,000,000	2.06	0.05263	0.218	
8	300,000,000	4,000,000,000	1.65	0.02500	0.328	
9	800,000,000	8,000,000,000	2.20	0.01250	0.729	
10	950,000,000	19,000,000,000	1.10	0.00526	0.595	

Exposure Curve Pricing – Example (5)

		Risk Profile - Sum Insured / PML				
					LR = 70%; E(X) = 3.18%; LT = 100,000,000	
Band ID	Premium (A)	Average Sum Insured / PML (B)	$\lambda_i = \dfrac{A * LR}{E(X) * B}$	$\theta = \dfrac{LT}{B}$	# Large Losses = if θ > 1 Then 0 Else Interpolate	# Large Loss
1	51,300,000	6,000,000	188.21	16.66667	0.000	
2	76,500,000	34,000,000	49.53	2.94118	0.000	
3	80,000,000	80,000,000	22.01	1.25000	0.000	
4	142,500,000	190,000,000	16.51	0.52632	0.197	
5	200,000,000	400,000,000	11.01	0.25000	0.269	
6	150,000,000	800,000,000	4.13	0.12500	0.196	2.53
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9	800,000,000	8,000,000,000	2.20	0.01250	0.729	
10	950,000,000	19,000,000,000	1.10	0.00526	0.595	

Sample Exposure Curve	
% TSI/EML	**Exceedance**
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50	98.74
51	98.77
52	98.79
53	98.81
54	98.83
55	98.85
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$$0.197 = 16.51 * \left\{ 1 - \frac{98.79 + (98.81 - 98.79) * \dfrac{52.63 - 52}{53 - 52}}{100} \right\}$$

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Average Large Loss above Threshold

1. Determine average large loss for each small fragment

2. Calculate large loss severity for each risk band based on the curve μ_i

Average Large Loss above Threshold

3. The average large loss is

$$\mu = \frac{\sum \mu_i}{\lambda}$$

Exposure Curve Pricing – Example (6)

Band ID	Premium (A)	Average Sum Insured / PML (B)	$\theta = \dfrac{LT}{B}$	# Large Losses above Threshold	Large Losses Severity = if θ > 1 Then 0 Else Interpolate (C)	Large Loss Severity above threshold θ * C	Average Large Loss above Threshold
					LR = 70%; E(X) = 3.18%; LT = 100,000,000		
1	51,300,000	6,000,000	16.66667	0	-	-	
2	76,500,000	34,000,000	2.94118	0	-	-	
3	80,000,000	80,000,000	1.25000	0	-	-	
4	142,500,000	190,000,000	0.52632	0.197	164,544,502	32,415,267	
5	200,000,000	400,000,000	0.25000	0.269	241,727,055	65,024,578	626,127,875
6	150,000,000	800,000,000	0.12500	0.196	316,460,638	62,026,285	
7	178,125,000	1,900,000,000	0.05263	0.218	421,259,359	91,834,540	
8	300,000,000	4,000,000,000	0.02500	0.328	538,566,119	176,649,687	
9	800,000,000	8,000,000,000	0.01250	0.729	702,661,656	512,240,347	
10	950,000,000	19,000,000,000	0.00526	0.595	1,084,311,053	645,165,077	

Risk Profile - Sum Insured / PML

% TSI/EML	Area above curve
…	…
50	0.8490
51	0.8557
52	0.8621
53	0.8683
54	0.8744
55	0.8802
…	…

Sample Exposure Curve

$$164{,}544{,}502 = 190{,}000{,}000 * \{0.8621 + (0.8683 - 0.8621) * \frac{52.63 - 52}{53 - 52}\}$$

Exposure Curve Pricing – Example (7)

Large Loss Loading

- Large Loss Loading = No of losses above Threshold * Average Loss above Threshold

- The loading for each risk band can be based on the total large loss loading or can be based on respective risk band as ascertained above

Selecting Exposure Curve

Exposure Curve	Swiss Re parameter c	Type of Risks	Basis
Gasser Y1	1.5	Personal Lines	Sum Insured
Gasser Y2	2	Commercial Lines (small–scale)	Sum Insured
Gasser Y3	3	Commercial Lines (medium–scale)	Sum Insured
Gasser Y4	4	Industrial and large commercial	PML
Gasser Y5	5	Lloyds' curve for Industry	Top Location
	6 to 8	Large-scale industry / multi-national companies	PML

Exposure Curve Pricing – Pitfalls

- **Appropriateness of Exposure curve** – Understanding the underlying data used for building exposure curve and what it represents

- **Tail Factors and Trends** – treatment of open claims in the data and adjustments for the underlying trends for claims and frequency

- **Unforeseen Events –** Curve only represents the historical data and does not allow for new claim types e.g. property damage due to Cyber

Thank you!