Practical Solutions to Common Pricing Pitfalls

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Agenda

- **Background**
- **Outline 12 common pricing pitfalls**
- **Present practical solutions**
- **Areas of applications**
  - Insurance pricing
  - Reinsurance pricing
  - Planning and forecasting
  - Rating plan design

Background

- Lack of consistency in application of methods among pricing actuaries
- Blind use of pricing tools and methods
  - Across lines of business
  - Across business segments (personal lines, commercial lines, London Market business)
- Over confidence in numeric results considering
  - Data incompleteness
  - Volatility
  - Experience rating - not fully credible
  - Exposure rating – lack of benchmarks

Basic Definitions

- Accident Year / Exposure Year : when “event occur” and premium is earned
  - Claims made – report year
  - Occurrence – event occurrence year
- Underwriting Year (Year of Account): from 1/1 to 31/12
  - Written premium on policies incepting 1/1 – 31/12
  - Losses against policies incepting 1/1 – 31/12
- Policy Year (Contract Year) : RAD or LOD
  - RAD – written premium and losses on policies incepting
  - LOD – earned premium and losses on policies in force

1 – Data Type and Loss Trend Factor

Example

- Risks Attaching Treaty effective 1/7/2007
- Data type : Accident Year / Exposure Year
- Loss inflation : 6% p.a.
- Common exhibit

AY	Losses	Trend Factor
1997	12,367,652	1.7908
1998	13,876,652	1.6895
1999	9,889,293	1.5938
2000	14,989,823	1.5036
2001	5,685,995	1.4185
2002	4,458,873	1.3382
2003	10,288,844	1.2625
2004	11,232,453	1.1910
2005	7,653,423	1.1236
2006	11,299,843	1.0600

Assumes one year difference between accident year losses and treaty year losses

1 – Data Type and Loss Trend Factor

Common pitfalls

- Pricing tools do not take into account basis of data provided
  - Accident Year / Exposure Year
  - Underwriting Year
  - Policy Year (in line with contract to be priced)
- Trending losses to beginning of exposure period
- Do not take into account contract type (RAD or LOD)

1 – Data Type and Loss Trend Factor

Practical solution

- Trend factor depends on:
  - Data type of experience period
  - Type of contract : RAD or LOD
- Assume policies written uniformly and losses occur uniformly throughout year
- Calculate average loss date in experience period
- Calculate average loss date in exposure period
- Difference in average loss date between experience and exposure determines trend factor

1 – Data Type and Loss Trend Factor

For treaty effective 1/7/2007, at 6% p.a. trend factors are

Year	RAD			LOD		
	Accident Year	Underwriting Year	Policy Year	Accident Year	Underwriting Year	Policy Year
1997	1.8992	1.8442	1.7917	1.8448	1.7914	1.7914
1998	1.7917	1.7398	1.6903	1.7404	1.6900	1.6900
1999	1.6903	1.6414	1.5944	1.6419	1.5944	1.5944
2000	1.5944	1.5482	1.5041	1.5487	1.5039	1.5039
2001	1.5041	1.4606	1.4190	1.4610	1.4187	1.4187
2002	1.4190	1.3779	1.3387	1.3783	1.3384	1.3384
2003	1.3387	1.2999	1.2627	1.3003	1.2627	1.2627
2004	1.2627	1.2261	1.1912	1.2265	1.1910	1.1910
2005	1.1912	1.1567	1.1238	1.1571	1.1236	1.1236
2006	1.1238	1.0912	1.0602	1.0916	1.0600	1.0600

Two year difference between AY 2006 and PY 2007

2 – Adjusting Premium for Rate Changes

- Rate changes usually given on underwriting year basis
- Need to apply to earned premium (for loss ratio forecasting)
- Need to estimate premium adjustment for contract year

2 – Adjusting Premium for Rate Changes

Common pitfalls

- Earn the rate change and then estimate rate index

Premium Adjustment Factors (On-level factors) to EY 2007

Underwriting Year	Rate Change	Earned Rate Change	Earned Rate Index
1997	0%	1.0377	1.1014
1998	-15%	1.2208	1.1908
1999	-10%	1.3952	1.3640
2000	-5%	1.5083	1.4767
2001	10%	1.4715	1.4434
2002	40%	1.1772	1.1482
2003	25%	0.8885	0.8748
2004	0%	0.7898	0.7873
2005	-5%	0.8100	0.8075
2006	-15%	0.9000	0.8959
2007	-5%	1.0000	1.0000

- Ignore basis of the contract (RAD or LOD) and effective date
- Ignore rate changes for all years contract is exposed

2 – Adjusting Premium for Rate Changes

Practical solution

- Calculate relative rate index at each time period (compound effect of rate changes)
- Using parallelogram rule calculate
  - Average relative rate index for exposure period (RAD or LOD)
  - Average relative rate index for each experience period (Exposure Year, Underwriting Year or Policy Year)
- Premium adjustment or on-level factor

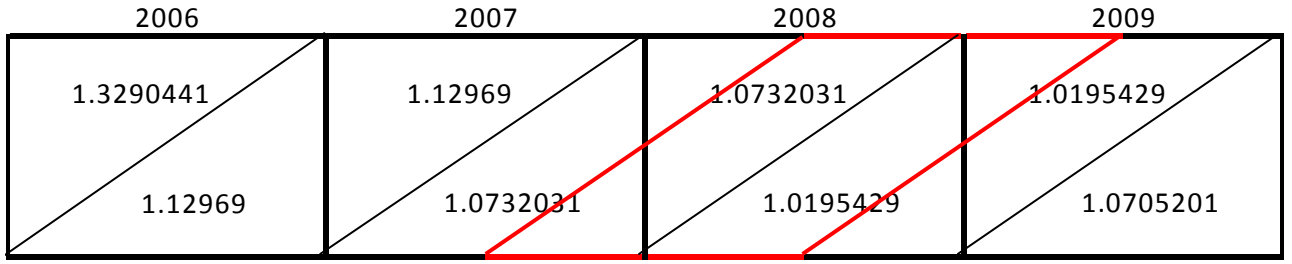
$$\text{OL Factor} = \frac{\text{Avg. Relative Rate Exposure Period}}{\text{Avg. Relative Rate Experience Period}}$$

2 – Adjusting Premium for Rate Changes

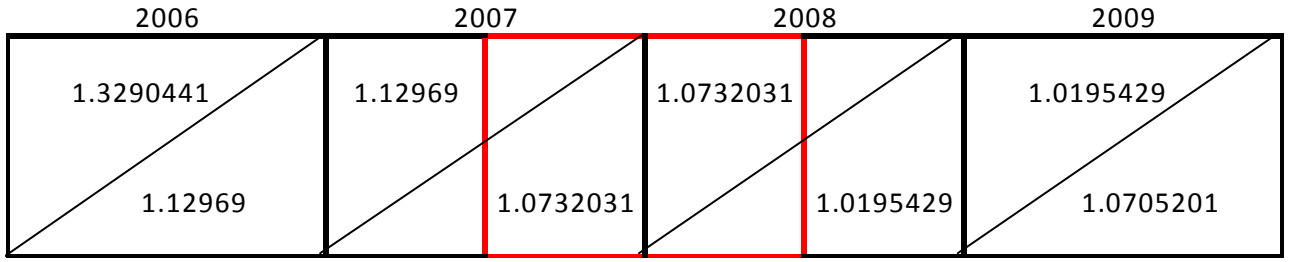
Example

Treaty effective 1/7/2007

Treaty Effective 1/7/2007 (RAD); PY Rate Index = 1.0464



Treaty Effective 1/7/2007 (LOD); PY Rate Index = 1.0736



2 – Adjusting Premium for Rate Changes

Example

On-level factors to policy year 2007, effective date 1/7/2007

Year	U/W Year Rate Change	Accident Year	Underwriting Year	Policy Year (RAD)	Policy Year (LOD)
1997	0%	1.0464	1.0464	1.1312	1.0941
1998	-15%	1.1312	1.2310	1.2958	1.2510
1999	-10%	1.2958	1.3678	1.4029	1.3927
2000	-5%	1.4029	1.4398	1.3712	1.4495
2001	10%	1.3712	1.3089	1.0908	1.2930
2002	40%	1.0908	0.9349	0.8311	0.9635
2003	25%	0.8311	0.7479	0.7479	0.7871
2004	0%	0.7479	0.7479	0.7671	0.7722
2005	-5%	0.7671	0.7873	0.8511	0.8177
2006	-15%	0.8511	0.9263	0.9500	0.9355
2007 Est	-5%				
2008 Est	-5%				
2009 Est	5%				

3 – Trending Aggregate Losses

Common Pitfall

Use same claims trend factor for aggregate losses than for individual losses

Issues

- Aggregate losses often mixture of primary and excess losses (e.g. London Market business)
- Aggregate losses net of deductible/excess and capped by policy limit
- Limit profile determines potential increase in severity of portfolio
- Severity trend factor usually assumed ground up and unlimited
- Frequency trend factor applied to aggregate losses but not individual losses

3 – Trending Aggregate Losses

Example

- Assume 5% severity trend (ground up and unlimited).
- Assume no frequency trend.

Claim No.	Loss	Policy Limit	Trended Loss
1	1,000,000	1,000,000	1,000,000
2	500,000	1,000,000	525,000
3	700,000	750,000	735,000
Total	2,200,000		2,260,000
		Avg. Trend Factor	**2.73%**

Limited severity trend factor

3 – Trending Aggregate Losses

Ideal solution

Apply trend to each loss allowing for deductible/ excess and policy limit

But

- Individual data not always available
- Policy data not always available for each claim

3 – Trending Aggregate Losses

Practical solution

Use limit profile (limit and attachment) and severity curve to estimate aggregate trend factor.*

Example

Assume 5% severity trend and lognormal distribution (10,2)

			Written Premium	
Limit	Attachment	Annual Trend Factor	Scenario 1: Predominantly Excess Business	Scenario 2: Predominantly Primary Business
1,000,000		1.0360	0	5,000,000
3,000,000		1.0417	0	5,000,000
5,000,000		1.0438	2,500,000	3,000,000
10,000,000		1.0462	0	5,000,000
3,000,000	2,000,000	1.0703	5,000,000	2,500,000
5,000,000	5,000,000	1.0800	3,000,000	0
10,000,000	10,000,000	1.0885	5,000,000	0
10,000,000	20,000,000	1.0956	5,000,000	0
		Aggregate Trend Factor	**7.908%**	**4.520%**

*See Mata, A.J. and Mark A. Verheyen (2005) **An Improved Method for Experience Rating Reinsurance Treaties**. Casualty Actuarial Society Forum 2005, pp 171-214

4 – Trending Individual Losses

Common pitfall

Apply trend factor to individual losses without accounting for limit, excess and participation.

Issues

- Individual losses are ceding company's gross net losses not ground up losses
- Particularly an issue with London Market data where capacity spread over multiple layers

4 – Trending Individual Losses

Example

Reinsurance Layer: $3MM xs $2MM

Gross Net Loss = $2MM

Trend Factor 10% p.a.

Standard method

Trended Loss in Layer = $200,000

	Scenario 1 : 2m loss from 20% of $20MM xs $10MM	Scenario 2 : 2m loss from 10% of primary $20MM
Ground up loss	20,000,000	>20,000,000
Trended Ground up loss	22,000,000	>20,000,000
Trended Gross Loss	2,400,000	2,000,000
Trended Loss in Layer	**400,000**	**0**

Significant difference depending on limit, attachment and participation

4 – Trending Individual Losses

Ideal solution

- Calculate ground up loss based on limit, attachment and participation
- Trend ground up loss and re-apply limit, attachment and participation

But

- Policy data not always available at claim level

4 – Trending Individual Losses

Practical solution

- Use limit profile, severity distribution and exposure rating method to estimate aggregate excess trend in reinsurance layer
- Apply the aggregate excess trend to nominal losses in reinsurance layer*
- Method works well for reinsurance layers with frequency of losses
- Trending over policy limits compensates for not trending losses below attachment point

*See Mata, A.J. and Mark A. Verheyen (2005) **An Improved Method for Experience Rating Reinsurance Treaties**. Casualty Actuarial Society Forum 2005, pp 171-214

5 – XOL Experience Rating

Common pitfall

Apply experience rating method to individual claims without accounting for loss event

Issues

- Ceding companies may record claims at policy level
- Same loss could be spread over several policies leading to multiple claim records for same underlying loss
- Need to understand how data is presented

5 – XOL Experience Rating

Example

Effective Date 1/7/2007 (RAD)

XOL Treaty: $5MM xs $5MM

Severity Trend = 10%

								Standard Experience Rating (without allowing for event)		Revised Experience Rating Method	
Claim No.	Insured Name	Loss Date	Incurred Amount	% Share	Limit	Attachment	Ground Up Loss	Trended Loss	Ceded Loss	Trended Loss	Ceded Loss
1	A	3/4/2003	5,000,000	50%	10,000,000	0	10,000,000	8,311,040	3,311,040	5,000,000	0
2	A	3/4/2003	2,000,000	20%	10,000,000	10,000,000	20,000,000	3,324,416	0	2,000,000	2,000,000
3	A	3/4/2003	3,000,000	10%	50,000,000	50,000,000	80,000,000	4,986,624	0	5,000,000	5,000,000
Total								16,622,081	3,311,040	12,000,000	7,000,000

5 – XOL Experience Rating

Ideal solution

- Calculate ground up loss based on limit, attachment and participation
- Trend ground up loss and re-apply limit, attachment and participation

But

- Policy data not always available at claim level

5 – XOL Experience Rating

Practical solution

- Based on insured name and loss date estimate UNL across all policies
- Consider that UNL is not ground up but the sum of losses across several layers
- Apply trend to UNL not appropriate (discussed in Pitfall No.4)
- Use the aggregate trend method* to estimate trend in reinsurance layer
- Apply aggregate trend factor to nominal UNL in reinsurance layer

*See Mata, A.J. and Mark A. Verheyen (2005) **An Improved Method for Experience Rating Reinsurance Treaties**. Casualty Actuarial Society Forum 2005, pp 171-214

6 – XOL Exposure Rating

Common pitfalls

- Use aggregate limit profile to exposure rate London Market business
- Use standard exposure rating formulae without accounting for capacity spread over several layers

Issues

- Companies spread their capacity over several layers
- Reinsurance treaty applies to UNL
- For exposure rating need to use individual policy details and allow for capacity spread

6 – XOL Exposure Rating

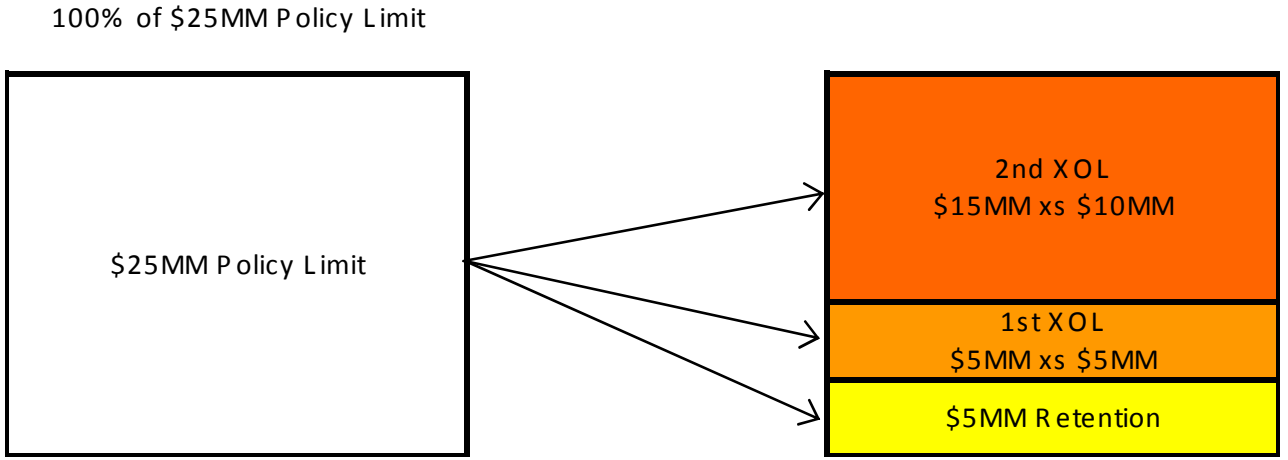
Example

Assume $25MM capacity

1st XOL $5MM xs $5MM

2nd XOL $15MM xs $10MM

If capacity used in one policy



6 – XOL Exposure Rating

Standard exposure rating formula

$$\%\ \text{Loss in Layer} = \frac{E[X \wedge \min(L + A + a, l + a)] - E[X \wedge \min(A + a, l + a)]}{E[X \wedge l + a] - E[X \wedge a]}$$

where

L = Reinsurance Limit

A = Reinsurance Attachment

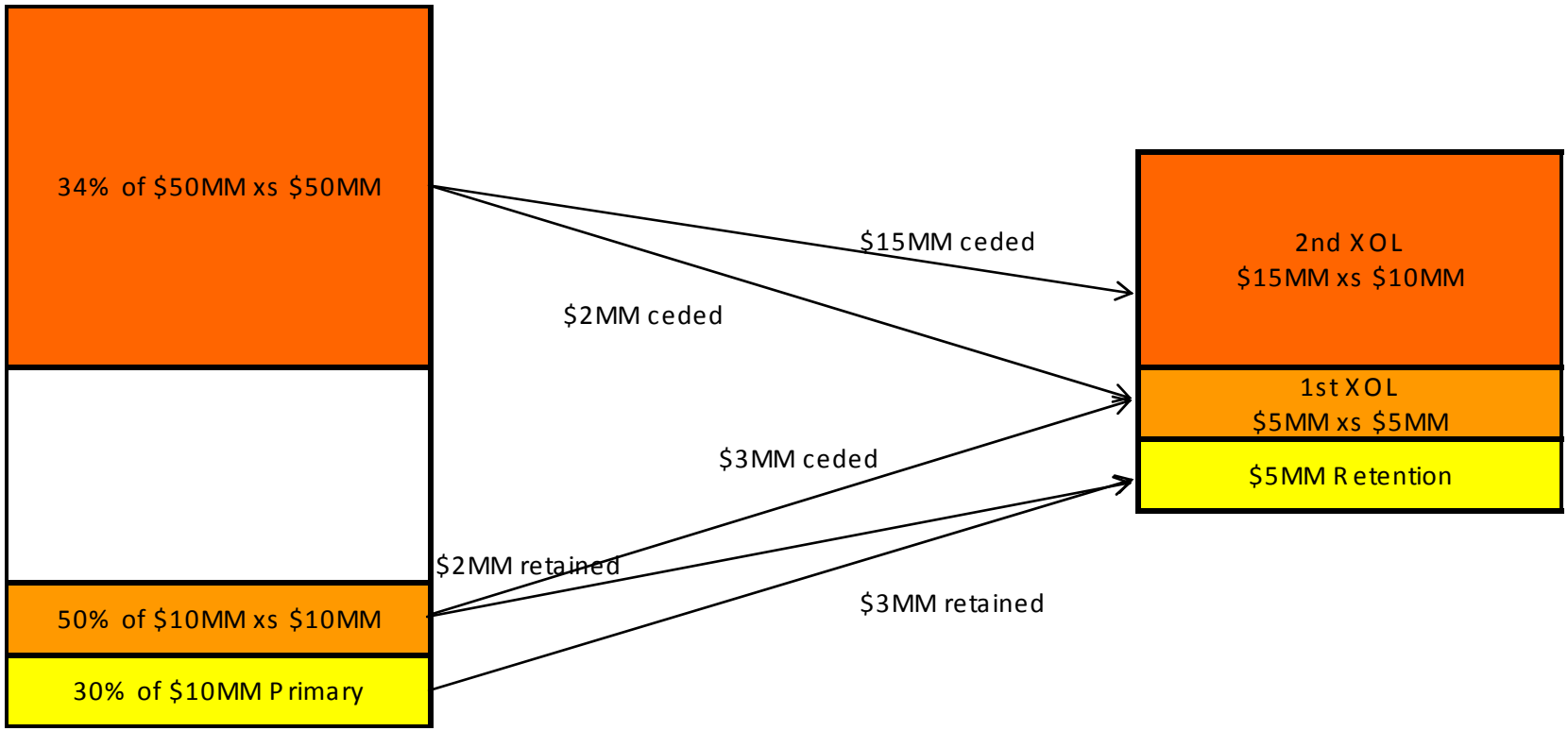
l = Policy Limit

a = Policy Attachment

6 – XOL Exposure Rating

Example

If capacity spread over various layers



6 – XOL Exposure Rating

Practical solution

- Link policies from individual policy list
  - Sort by insured name
  - Sort by attachment point in ascending order

- Revise reinsurance limit and attachment applicable to each written policy accounting for
  - Retention
  - Capacity written in each policy and exposure to each reinsurance layer

6 – XOL Exposure Rating

Example

Capacity $25MM spread over 3 layers

Reinsurance programme:

1st excess: $5MM xs $5MM

2nd excess: $15MM xs $10MM

Revised Reinsurance Layers*

Policy Limit		Policy Attachment	Capacity	$5MM Retention	$5MM xs $5MM	$15MM xs $10MM
10,000,000	xs	0	3,000,000	3,000,000	-	-
10,000,000	xs	10,000,000	5,000,000	2,000,000	$3MM xs $2MM	-
50,000,000	xs	50,000,000	17,000,000	0	$2MM xs $0	$15MM xs $2MM

*Mata, A.J. (2007) A recursive algorithm to exposure rate London Market business (pre-print)

6 – XOL Exposure Rating

Example

				Standard Method*			Revised Method*		
Participation	Policy Limit		Policy Attachment	$5MM Retention	$5MM xs $5MM	$10MM xs $10MM	$5MM Retention	$5MM xs $5MM	$10MM xs $10MM
30%	10,000,000	xs	0	26,100	0	0	26,100	0	0
50%	10,000,000	xs	10,000,000	21,600	0	0	9,370	12,230	0
34%	50,000,000	xs	50,000,000	2,151	1,962	2,517	0	887	5,743
			Total	**49,851**	**1,962**	**2,517**	**35,470**	**13,118**	**5,743**

* Assuming ILF power curve with alpha = 0.6

7 – ALAE and Exposure Rating

Common pitfalls

- Use same curve regardless of ALAE treatment
- Use same adjustment for limit and attachment

Issues

- ALAE vary with size of loss
- Different ALAE treatment in policy and reinsurance treaty
- Curves fitted to indemnity or indemnity plus ALAE
- Mismatch between curve and reinsurance layer

7 – ALAE and Exposure Rating

Practical solution:

- Estimate total ALAE as % of total indemnity
- Estimate ALAE as % of indemnity by loss size
  - Should obtain a decreasing curve
- Use loss distribution to make total ALAE consistent when split by layer
- Use ALAE percentages to adjust policy limits and reinsurance limit and attachment

7 – ALAE and Exposure Rating

Apply following adjustments:

Insurance Policy	Reinsurance Treaty	Indemnity	Indemnity + ALAE
Included	**Included**	Adjust reinsurance limit and attachment	OK
Included	**Pro-rata in addition**	Adjust policy limit	Adjust policy limit and reinsurance limit and attachment
In addition	**Included**	Adjust reinsurance limit and attachment	Adjust policy limits
In addition	**Pro-rata in addition**	OK	Adjust reinsurance limit and attachment

8 – Fitting Loss Distributions

Common pitfalls

- Fit loss distributions to data as given
- Do not allow for deductibles, limits and incompleteness of data

Issues

- Loss distributions should be for ground up data
- Data often net of deductible and capped at policy limit
- Ceding companies often provide losses greater than certain value

8 – Fitting Loss Distributions

Ideal solution

- If policy detail at claim level available
  - Add back deductible/excess
  - Allow for censoring for limit losses
  - Use conditional probabilities if loss list greater than a certain value
- Write the likelihood function of each loss
- Find parameters by maximising likelihood function

8 – Fitting Loss Distributions

F(x) cumulative distribution function

f(x) probability density function

- For limits losses the likelihood function is:

$$1-F(x)=P(X>L)$$

- If losses greater than *u,* the likelihood function is:

$$f(x)/(1-F(u))$$

8 – Fitting Loss Distributions

Practical solution

- If policy details not available it is not appropriate to fit loss distributions
- Purpose of the exercise?
- Bootstrap simulation may be used to estimate uncertainty around loss cost

9 – ILFs and Currency

Common pitfalls

- Ignore effect of quoting currency in rating plans
- ILFs curve independent of currency

Issues

- Insured in countries with weak currency may seek quotes in stronger currencies
- Multinational companies may buy insurance in different currency to home country currency
- For same exposure and capacity premium should be consistent

9 – ILFs and Currency

Example

Country of domicile : India

Exposure base INR 800MM

Base rate 3%

ILF Table

Limit	ILFs
1,000,000	1.0000
2,000,000	1.4142
3,000,000	1.7321
4,000,000	2.0000
5,000,000	2.2361
6,000,000	2.4495
7,000,000	2.6458
8,000,000	2.8284
9,000,000	3.0000
10,000,000	3.1623

9 – ILFs and Currency

Example

Quotes ignoring effect of currency

FX to GBP	1.00	2.00	1.40
Quoting Currency	GBP	USD	EUR
Exposure	£10,000,000	$20,000,000	€ 14,000,000
Limit	£5,000,000	$10,000,000	€ 7,000,000
Premium Quoting Currency	~~£670,820~~	£1,897,367	£1,111,216
Premium Original Currency	INR 53,665,631	INR 75,894,664	INR 63,498,031

Purchasing insurance in stronger currency leads to lower premium for same exposure and capacity

9 – ILFs and Currency

Practical solution

- A global rating plan should be design in a base currency
- Base rate for basic limit of base currency
- ILFs in base currency
- Covert all rating factors to base currency; calculate premium and re-convert to quoting currency
- Use country relativities to allow differences in loss costs by country

9 – ILFs and Currency

Example

Rating plan in GBP

Base rate 3% for GBP 1MM limit

ILFs in GBP

FX to GBP	1.00	2.00	1.40
Quoting Currency	GBP	USD	EUR
Exposure	£10,000,000	$20,000,000	€ 14,000,000
Limit	£5,000,000	$10,000,000	€ 7,000,000
Premium Quoting Currency	£670,820	£1,341,641	£939,149
Premium Original Currency	**INR 53,665,631**	**INR 53,665,631**	**INR 53,665,631**

10 – ILFs vs. Excess Factors

Common pitfalls

- Use different excess factors depending on underlying layer
- Use decreasing excess factors as % of underlying layer

Issues

- ILF curve should be consistent with loss distributions
- ILF curve should be ground up in order to be consistent

10 – ILFs vs. Excess Factors

Example

		Increased Limit Factors		Excess Market Factors	
Limit	Attachment	% of Primary $10MM	% of Underlying Layer	% of Primary $10MM	% of Underlying Layer
10,000,000	0	100.00%	100.00%	100%	100%
10,000,000	10,000,000	64.68%	64.68%	70.0%	70%
10,000,000	20,000,000	53.97%	83.44%	49.0%	70%
10,000,000	30,000,000	47.69%	88.38%	29.4%	60%
10,000,000	40,000,000	43.37%	90.94%	17.6%	60%
10,000,000	50,000,000	40.13%	92.53%	10.6%	60%
10,000,000	60,000,000	37.57%	93.62%	5.3%	50%
10,000,000	70,000,000	35.48%	94.42%	2.6%	50%
10,000,000	80,000,000	33.71%	95.04%	1.3%	50%
10,000,000	90,000,000	32.21%	95.52%	0.7%	50%

10 – ILFs vs. Excess Factors

Practical solution

- Actuaries should illustrate differences between ILFs and excess factors to underwriters
- Rating plans should work from ground up
  - Rate base limit
  - Use ILF to estimate excess premium
- Work with underwriters to determine ILFs at various points
- Fit a continuous curve to closely match those points

11 – Claims allowance and Rate Monitoring

Common pitfall

- Allow for claims experience when calculating rate change for individual risks

Issues

- Common underwriting considerations:
  - If rate increase but there are claims assume 0% rate change
  - If rate decrease but claims free offset rate change by claims discount
- Rate changes depend on market conditions not on claims experience of single risks

11 – Claims allowance and Rate Monitoring

Example – Hard market

Target rate change = 15%

	No Policies	Expiring Premium	Renewal Premium*	Rate Change with claims allowance	Actual Rate change
Claims free	80	1,000	1,188	18.75%	18.75%
With claims	20	1,000	1,300	0.00%	30.00%
Total	100			15.00%	21.00%

11 – Claims allowance and Rate Monitoring

Example – Soft market

Target rate change = -15%

	No Policies	Expiring Premium	Renewal Premium	Rate Change with claims allowance	Actual Rate change
Claims free	80	1,000	650	-18.75%	-35.00%
With claims	20	1,000	1,300	0.00%	30.00%
Total	100			-15.00%	-22.00%

11 – Claims allowance and Rate Monitoring

Practical solution

- Do not allow for claims loads or discounts in rate monitoring
- Understand what is or isn't accounted for in rate monitoring process in place
- Need to train underwriters to improve process
- Often rate change in soft market is underestimated

12 – Premium Size Discounts vs. Sliding Scale Premiums

Common pitfall

Use discrete size discounts to reduce premium for companies with large exposure base

Issues

- Size discounts are common when exposure base growth is not seen as proportional increase in loss cost
- Discrete size discounts could lead to premium reversals

12 – Premium Size Discounts vs. Sliding Scale Premiums

Example

Discrete size discounts

Min Revenue	Max Revenue	Discount
0	10,000,000	0%
10,000,001	20,000,000	10%
20,000,001	40,000,000	30%
40,000,001	100,000,000	50%
100,000,001	Unlimited	60%

Sliding Scale

Min Revenue	Max Revenue	Cum Premium	Load per million
0	10,000,000	250,000	25,000
10,000,001	20,000,000	450,000	20,000
20,000,001	40,000,000	700,000	12,500
40,000,001	100,000,000	1,250,000	9,167
100,000,001	Unlimited		7,000