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Section 2: Claim Liability risk margin

Section 3: Premium Liability risk margin

Section 4: Conclusions
What are risk margins?

Risk margins

**PRAD**
Provision of Risk Margin for Adverse Deviation

**PAD**
Provision for Adverse Deviation

**MAD**
Margin for Adverse Deviation

**MOCE**
Margin over the Current Estimate

**PRAD**
Provision of Risk Margin for Adverse Deviation

**MfAD**
Margin for Adverse Deviation

**Risk Margin**
Provision for Adverse Deviation
Why do we need them?

### Market Value Accounting

75\text{th} percentile is the common ground in determining the risk margin / margin to transact something at an arm’s length

### Consistency in Solvency

Many countries in the region are using the RBC approach for determining the capital requirements

### Properties

Increased uncertainty in the current estimate of liabilities and its trends

**Higher risk margins**
What are risk margins?

The uncertainties

**Claim Liability**
- Claims experience in the past
- Earned exposure

**Premium Liability**
- Prospective claims experience
- Unearned exposure

- **Variability in future trends**
- **Process error**
- **Model Specification error**
- **Data error**
- **Reinsurance risk**
- **Parameter error**

---

5
How are they determined? – Singapore

Methods used - Claim Liability risk margins

*Based on MAS 2013 stats
How are they determined? – Malaysia

**Methods used - Claim Liability risk margins**

- Mack Method: 30%
- Bootstrapping: 30%
- Stochastic Chain Ladder: 15%
- Industry Benchmark: 10%
- Judgement / bespoke solution: 5%
Claim Liability risk margin – the methods

**Judgement**
- Based on the actuary’s past experience or general reasoning
  + The actuary may take into account additional factors not captured within the data
    - Fairly subjective method and hence a risky process

**Industry Benchmark**
- Adoption of risk margins according to Industry Benchmark by line of business
  + Useful for **companies which lack historical claims data**
    - **May not be reflective of the Company’s true variability** of the liability estimates

**Mack Method**
- Measures the **Mean Square Error** of the overall claims reserve
  - Based on chain-ladder assumptions
  + Usually provide **stable results**, measuring parameter, process and total risk
    - Does not explicitly measure **tail variability**

**Bootstrapping Method**
- A resampling method used to consistently estimate the variability of parameters
  + **No assumptions about the underlying distribution** is required
  + Powerful and simple, using only a single data set
    - Variability limited to that in the underlying historical data
Claim Liability risk margin – the methods

- **Judgement**
  - Based on the actuary’s past experience or general reasoning
  - The actuary may take into account additional factors not captured within the data
  - Fairly subjective method and hence a risky process

- **Industry Benchmark by line of business**
  - Useful for companies which lack historical claims data
  - May not be reflective of the Company's true variability of the liability estimates

- **Mack Method**
  - Measures the Mean Square Error of the overall claims reserve
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  - A resampling method used to consistently estimate the variability of parameters
  - **No assumptions about the underlying distribution** is required
  - Powerful and simple, using only a single data set
  - Variability limited to that in the underlying historical data

The analysis performed in deriving the Central Estimate of the liabilities is disregarded!
Industry Benchmark

- Studies conducted are based on different:
  - regulatory environment
  - product features / tariff
  - economic environment
  - distribution channel

- Few reasons to justify why this is accurate and should be implemented in the local market

- Every company operates differently – benchmark risk margins may not reflect the true volatility of the liabilities

All companies are NOT the same
How are they determined? – Singapore

**Methods used - Claim Liability risk margins**

- **Industry Benchmark**
- **Bootstrapping**
- **Mack Method**
- **Judgement**
- **Stochastic Chain Ladder**
- **Other Methods**

*Based on MAS 2013 stats*
How are they determined? – Malaysia

Most insurers in Malaysia employ the more ‘traditional’ methods – Mack Method and Bootstrapping.

Lower reliance on benchmark and judgements.
Claim Liability risk margin – the methods

Stochastic Chain Ladder Method

- Development Factors are assumed to be Lognormal distributed
- Flexible, can incorporate the development period effect explicitly
  + Correlations across periods can be accommodated
  – Requires statistical software for faster simulation

- Project to Ultimate (using any approach)
- Analyse the implied development
- Run simulations of how the claims might run-off
Stochastic Chain Ladder Method

1. **Determine the implied paid / reported cumulative LDFs for each Accident Year and for each development period**

Paid Analysis

Reported Analysis

- **Motor class from a regional insurer**
Stochastic Chain Ladder Method

Stochastic Chain Ladder Method – Motor class from a regional insurer

2 Determine the parameters for simulating the cumulative LDFs

<table>
<thead>
<tr>
<th>Paid Example</th>
<th>Accident Year</th>
<th>2011</th>
<th>2012</th>
<th>2013</th>
<th>2014</th>
<th>2015</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Development Factor (Year 1 to Ultimate)</td>
<td>109%</td>
<td>117%</td>
<td>119%</td>
<td>101%</td>
<td>104%</td>
</tr>
</tbody>
</table>

(a) Average (2011 to 2015) = 110%
(b) Standard Deviation (2011 to 2015) = 8%
(c) = (b)/(a) Coefficient of Variation = 7%
Stochastic Chain Ladder Method

3. Simulate the cumulative LDFs and derive the revised Ultimate Loss

<table>
<thead>
<tr>
<th>Paid Example</th>
<th>Accident Year</th>
<th>2011</th>
<th>2012</th>
<th>2013</th>
<th>2014</th>
<th>2015</th>
</tr>
</thead>
<tbody>
<tr>
<td>Simulated Development Factor (Year 1 to Ultimate)</td>
<td></td>
<td>102%</td>
<td>102%</td>
<td>102%</td>
<td>103%</td>
<td>109%</td>
</tr>
<tr>
<td>Paid to Date</td>
<td></td>
<td>199</td>
<td>369</td>
<td>557</td>
<td>617</td>
<td>680</td>
</tr>
<tr>
<td>Ultimate Loss</td>
<td></td>
<td>202</td>
<td>374</td>
<td>567</td>
<td>635</td>
<td>742</td>
</tr>
</tbody>
</table>

- Assume a Lognormal distribution for the cumulative LDFs
- Sum the Ultimate Loss across Accident Years and determine the overall 75th percentile value
- Subtract the Central Estimate of the Ultimate Loss from this value to determine the risk margin
Stochastic Chain Ladder Method

Existing methodology:

- Lognormal distribution reflects the positively skewed nature of GI claims
- Simulations based on the calculated Central Estimate
- Outliers removed from original data
- Allows judgement for past experience

Issues:

- Model error
- Reality is one simulation only – results will differ if the sample is changed
- Need an objective approach to remove outliers
- Results are subject to individual judgements – need to automate to run simulations
Enhancements introduced:

Automation of outlier removal

– based on the number of points and mean & standard deviation of the lognormal distribution

Parameter uncertainty

– re-simulate the claim triangles
Enhanced Stochastic Chain Ladder Method

Stochastic Chain Ladder Method – Motor class from a regional insurer

CoV Movement – Paid Analysis
- Standard
- Standard with Outlier Automation
- Plus Parameter Uncertainty

CoV Movement – Reported Analysis

Development Year

Development Year
## Enhanced Stochastic Chain Ladder Method

### Stochastic Chain Ladder Method – Motor class from a regional insurer

#### Comparison of the risk margin:

<table>
<thead>
<tr>
<th></th>
<th>Industry Benchmark</th>
<th>Stochastic Chain Ladder</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>*APRA</td>
<td>^Tillinghast-Towers Perrin</td>
</tr>
<tr>
<td>75% Risk Margin</td>
<td>13.1%</td>
<td>8.0%</td>
</tr>
</tbody>
</table>


Summary

Industry Benchmark & Judgement

~50% of the insurers in Singapore

~20% of the insurers in Malaysia

Mack Method & Bootstrapping

~40% of the insurers in Singapore

~60% of the insurers in Malaysia

Relevance?

No relationship to the Central Estimate!
Summary

Industry Benchmark & Mack Method & Bootstrapping

~50% of the insurers in Singapore

~20% of the insurers in Malaysia

No relationship to the Central Estimate!

Relevance? Time for a change?
Question 15:
In terms of percentage, the volatility of the URR should be greater than the volatility of the Claim Liability. We observe in terms of Net liabilities for all lines excluding Marine, the loadings for CL liability are greater than Premium Liability. If we were to look into volatility by each accident quarter the recent quarter would be expected to be most volatile, given we assume the selected payment/reporting patterns will follow.

Question 2:
What is the rationale for allowing a lower PRAD in premium liabilities compared to the PRAD in OSC for these classes given that there is typically greater uncertainty in estimating premium liabilities?

5) Could you share with us how the PRAD loading for premium liability are selected after comparing with results from previous analyses, including APRA study?
Common myth

Quotes from APRA Risk Margin Analysis 2001

“It is generally recognised that the volatility of the premium liabilities of a class will be greater than that for outstanding claims.”

“This is because the exposure period for these liabilities has not yet occurred and events such as future catastrophes need to be allowed for.”

“Premium liabilities should contain a slightly greater degree of variability to that of the most recent accident year”

*Source: APRA Risk Margin analysis by Trowbridge Consulting 2001*
Methods used - Premium Liability risk margins

If this is based on ‘Industry Benchmark’ or ‘Judgement’, Multiplier method is effectively industry experience and judgement.

About 60%?

How is this relevant to the business?

*Based on MAS 2013 stats
How are they determined? – Malaysia

**Methods used - Premium Liability risk margins**

- **Multiplier**: More than 80%?
- **Stochastic Chain Ladder**: Multiplier is popular!
- **Time Series**: More than 80%?
- **Judgement / bespoke solution**: More than 80%?
Debunking the myth: Part 1

APRA has moved on from 2001!

<table>
<thead>
<tr>
<th>Direct Classes</th>
<th>1&lt;sup&gt;st&lt;/sup&gt;</th>
<th>2&lt;sup&gt;nd&lt;/sup&gt;</th>
<th>3&lt;sup&gt;rd&lt;/sup&gt;</th>
<th>Tillinghast</th>
<th>Trowbridge</th>
</tr>
</thead>
<tbody>
<tr>
<td>Householders</td>
<td>1.19</td>
<td>1.40</td>
<td>1.75</td>
<td>1.48</td>
<td>1.50</td>
</tr>
<tr>
<td>Domestic Motor</td>
<td>0.88</td>
<td>1.26</td>
<td>1.61</td>
<td>1.13</td>
<td>1.20</td>
</tr>
<tr>
<td>Commercial Motor</td>
<td>1.01</td>
<td>1.45</td>
<td>1.67</td>
<td>1.33</td>
<td>1.30</td>
</tr>
<tr>
<td>Other direct - category A</td>
<td>1.27</td>
<td>1.61</td>
<td>2.10</td>
<td>1.32</td>
<td>1.40</td>
</tr>
<tr>
<td>Travel</td>
<td>1.10</td>
<td>1.34</td>
<td>1.70</td>
<td>1.81</td>
<td>1.40</td>
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<tr>
<td>Fire and ISR</td>
<td>1.27</td>
<td>1.52</td>
<td>1.76</td>
<td>1.64</td>
<td>1.60</td>
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<tr>
<td>Marine</td>
<td>0.88</td>
<td>1.22</td>
<td>1.51</td>
<td>2.07</td>
<td>1.40</td>
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<tr>
<td>Consumer Credit</td>
<td>0.78</td>
<td>1.29</td>
<td>2.06</td>
<td>1.12</td>
<td>1.40</td>
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<tr>
<td>Other Accident</td>
<td>1.30</td>
<td>1.44</td>
<td>1.77</td>
<td>1.69</td>
<td>1.40</td>
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<tr>
<td>Other direct - category B</td>
<td>1.12</td>
<td>1.41</td>
<td>1.75</td>
<td>0.99</td>
<td>1.40</td>
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<tr>
<td>Mortgage</td>
<td>1.66</td>
<td>1.90</td>
<td>2.00</td>
<td>1.17</td>
<td>1.40</td>
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<tr>
<td>CTP</td>
<td>0.67</td>
<td>1.44</td>
<td>1.60</td>
<td>1.40</td>
<td>1.80</td>
</tr>
<tr>
<td>Public and Product Liability</td>
<td>1.18</td>
<td>1.27</td>
<td>1.42</td>
<td>1.81</td>
<td>1.60</td>
</tr>
<tr>
<td>Professional Indemnity</td>
<td>1.10</td>
<td>1.26</td>
<td>1.49</td>
<td>1.69</td>
<td>2.00</td>
</tr>
<tr>
<td>Employers Liability</td>
<td>0.86</td>
<td>1.22</td>
<td>1.40</td>
<td>1.47</td>
<td>1.60</td>
</tr>
<tr>
<td>Other direct - category C</td>
<td>0.64</td>
<td>0.93</td>
<td>1.43</td>
<td>1.45</td>
<td>1.45</td>
</tr>
</tbody>
</table>

Debunking the myth: Part 1

APRA has moved on from 2001!

Debunking the myth: Part 2

Suggested CV Multipliers from APRA Risk Margin Analysis 2001

<table>
<thead>
<tr>
<th>Class of Business</th>
<th>CV Multiplier Range</th>
</tr>
</thead>
<tbody>
<tr>
<td>Long Tail</td>
<td>1.6 – 2.0</td>
</tr>
<tr>
<td>Short Tail</td>
<td>1.2 – 1.6</td>
</tr>
</tbody>
</table>
Debunking the myth: Part 2

<table>
<thead>
<tr>
<th>Long-Tail</th>
<th>Claim Liability</th>
<th>Premium Liability</th>
</tr>
</thead>
<tbody>
<tr>
<td>Premium</td>
<td>1,000</td>
<td>1,000</td>
</tr>
<tr>
<td>Expected ULR</td>
<td>80%</td>
<td>80%</td>
</tr>
<tr>
<td>Paid</td>
<td>100</td>
<td>0</td>
</tr>
<tr>
<td>Outstanding</td>
<td>700</td>
<td>800</td>
</tr>
<tr>
<td>CV Multiplier</td>
<td></td>
<td>1.8</td>
</tr>
<tr>
<td>Risk Margin (75%)</td>
<td>10%</td>
<td>18%</td>
</tr>
<tr>
<td>75% ULR</td>
<td>87%</td>
<td>94%</td>
</tr>
<tr>
<td>ULR Increase</td>
<td><strong>8.75%</strong></td>
<td><strong>18.00%</strong></td>
</tr>
</tbody>
</table>

2.06
Debunking the myth: Part 2

<table>
<thead>
<tr>
<th>Short-Tail</th>
<th>Claim Liability</th>
<th>Premium Liability</th>
</tr>
</thead>
<tbody>
<tr>
<td>Premium</td>
<td>1,000</td>
<td>1,000</td>
</tr>
<tr>
<td>Expected ULR</td>
<td>80%</td>
<td>80%</td>
</tr>
<tr>
<td>Paid</td>
<td>600</td>
<td>0</td>
</tr>
<tr>
<td>Outstanding</td>
<td>200</td>
<td>800</td>
</tr>
<tr>
<td>CV Multiplier</td>
<td></td>
<td>1.4</td>
</tr>
<tr>
<td>Risk Margin (75%)</td>
<td>10%</td>
<td>14%</td>
</tr>
<tr>
<td>75% ULR</td>
<td>82%</td>
<td>91%</td>
</tr>
<tr>
<td>ULR Increase</td>
<td>2.50%</td>
<td>14.00%</td>
</tr>
</tbody>
</table>
Debunking the myth: Part 3

Premium Liability risk margin

Year 1

Paid in Year 1 (80%)

Claim Liability (20%)


PLR at Year 1

Reported Analysis

- 75% load based on a Stochastic Chain Ladder = 10%
- 75% load based on a Lognormal distribution = 8%
Debunking the myth: Part 3

Premium Liability risk margin

Results

Volatility of Premium Liability, at 75% confidence level
= 80% * 8% + 20% * 10%
= **8.4%**

Comments

- Volatility of URR and volatility of Claim Liability are based on very different processes
- URR includes a large body of claims that are reported and paid in the first development year that are relatively stable, and so do not get included in the claim liability figures

75% load = **8%**

75% load = **10%**
Common myth

Quotes from APRA Risk Margin Analysis 2001

“It is generally recognised that the volatility of the premium liabilities of a class will be greater than that for outstanding claims.”

“This is because the exposure period for these liabilities has not yet occurred and events such as future catastrophes need to be allowed for.”

“Premium liabilities should contain a slightly greater degree of variability to that of the most recent accident year”
Time series method

- Comparison of the historical projections of URR with the latest estimates
- Determines distribution of the standard errors and select the appropriate confidence level

**Pros**

- Utilises data of many prior years
- Able to determine the most appropriate method to project URR for different classes
- **Does not rely on any assumptions on distribution** of claims

**Cons**

- Complex and difficult to understand
- **Outliers** can distort results
Time series – how does it work?

**Step 1:** Obtain the selected ULR from Claim Liability analysis

**Motor class from a regional insurer**

![Graph showing the trend of Premium Liability risk margin over years from 1999 to 2016. The ULR values range from 40% to 90%.](image-url)
Step 2: Calculate the two years rolling average ULR

Motor class from a regional insurer
Step 3: Calculate the error between the selected ULR and rolling average ULR

Motor class from a regional insurer

- ULR
- Rolling average
- Error
Time series – how does it work?

**Step 4:** Rank the errors and fit a trendline

**Motor class from a regional insurer**
Step 4: Rank the errors and fit a trendline

Motor class from a regional insurer
Time series – how does it work?

Step 5: Determine the 75th percentile

Motor class from a regional insurer
Time series – how does it work?

**Step 6:** Calculate the 75% risk margin from the trendline

Motor class from a regional insurer
Time series – how does it work?

**Step 7:** Calculate the 75% URR loss ratio

**Motor class from a regional insurer**
Comparison of methods – Time series vs Multiplier

Stochastic Chain Ladder suggests the Claim Liability risk margin to be 11%

<table>
<thead>
<tr>
<th>Loadings</th>
<th>Time Series</th>
<th>Multiplier @ 1.5</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>10%</td>
<td>16.5%</td>
</tr>
</tbody>
</table>

Motor class from a regional insurer

Historical CE ULR exceeds the 75% URR LR projection 4/15 times (~25%)
Comparison of methods – Time series vs Multiplier

Stochastic Chain Ladder suggests the Claim Liability risk margin to be 11%

<table>
<thead>
<tr>
<th></th>
<th>Time Series</th>
<th>Multiplier @ 1.5</th>
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</thead>
<tbody>
<tr>
<td>Loadings</td>
<td>10%</td>
<td>16.5%</td>
</tr>
</tbody>
</table>

Motor class from a regional insurer

Historical CE ULR exceeds the 75% URR LR projection 2/15 times (~13%)
Variations of Time series

Other considerations

- Underwriting cycle
- Change in premium rates
- Detailed regression?
- Amount of data

Other structures

- Reducing weights to older values
- Linear extrapolation of prior values
- Long-Term Average
- Moving Average with Mean Reversion
- Linear extrapolation with Mean Reversion
- Adjustments for changes in historical average premium

Goodness of Fit
### Summary

<table>
<thead>
<tr>
<th>Volatility drivers</th>
<th>Claim Liability</th>
<th>Premium Liability</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Claims settlement process</td>
<td>Claims experience</td>
</tr>
<tr>
<td>Industry benchmark and Judgement are regulators’ and auditors’ least favourite</td>
<td></td>
<td>Adding a loading to the Claim Liability risk margin to determine the Premium Liability’s is too simplistic</td>
</tr>
<tr>
<td>Mack and Bootstrap have no relationship to the Central Estimate selected</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

| Current methodologies employed | | |
| Stochastic Chain Ladder | Time Series |

| Recommended approach | | |
| | |

| Comments | | |
| Continuous enhancements are required | Loadings for Premium Liability can be lower than Claim Liability |
What’s next?

“We never finish our App, we just release it”
“Shape your thinking on the decisions that matter. Our specialist focus, global insights programmes and unique network give us the inside track in insurance and investment markets. We translate insights into opportunities.”

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