Reserving with Simulation

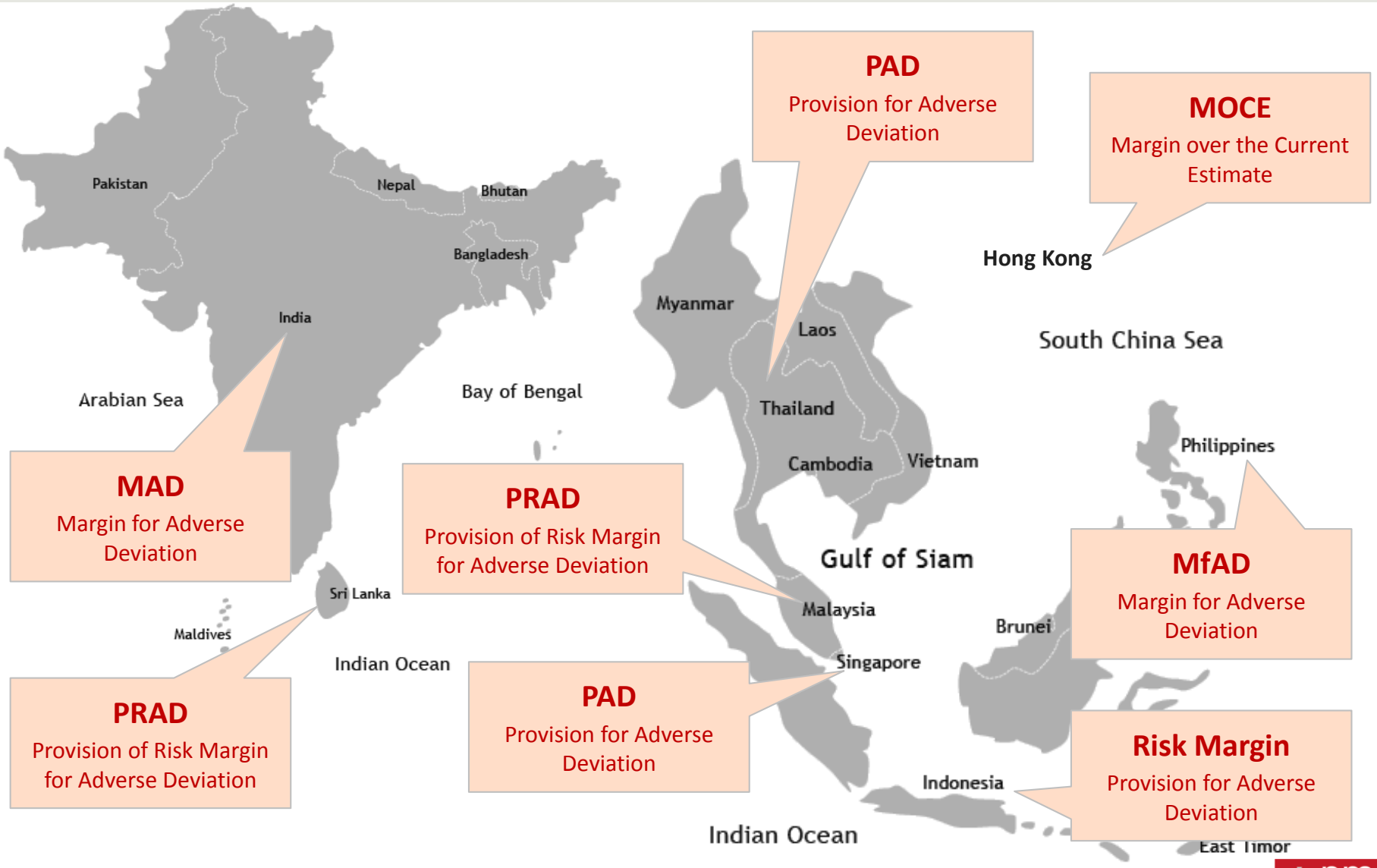
IFoA Asia Conference 2016

NMG Consulting

3 March 2016

Contents

Risk margins



Why do we need them?

Market Value Accounting

75th percentile is the common ground in determining the risk margin / margin to transact something at an arm's length

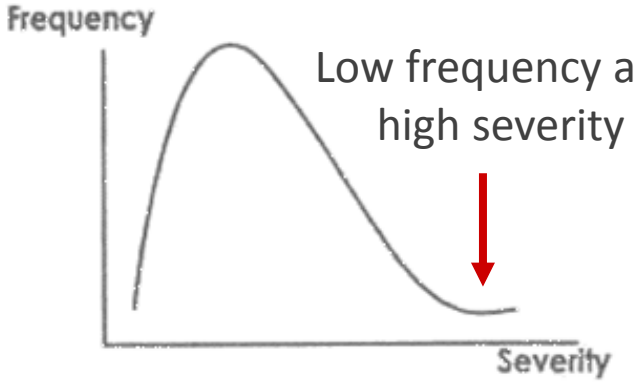
Consistency in Solvency

RISK BASED CAPITAL

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

The uncertainties

Claim Liability

- Claims experience in the past
- Earned exposure

Variability in future trends

Process error

Model Specification error

Premium Liability

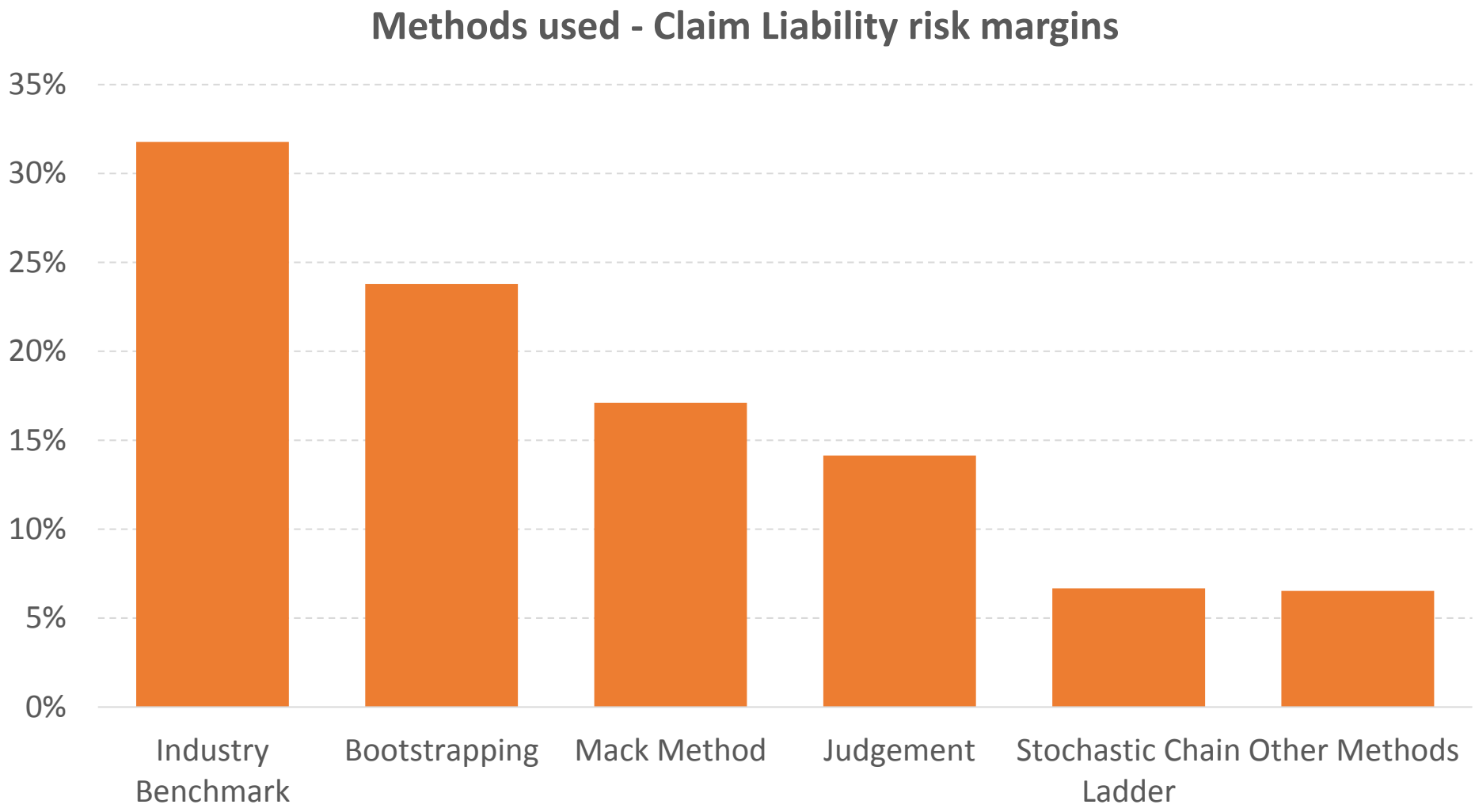
- Prospective claims experience
- Unearned exposure

Data error

Reinsurance risk

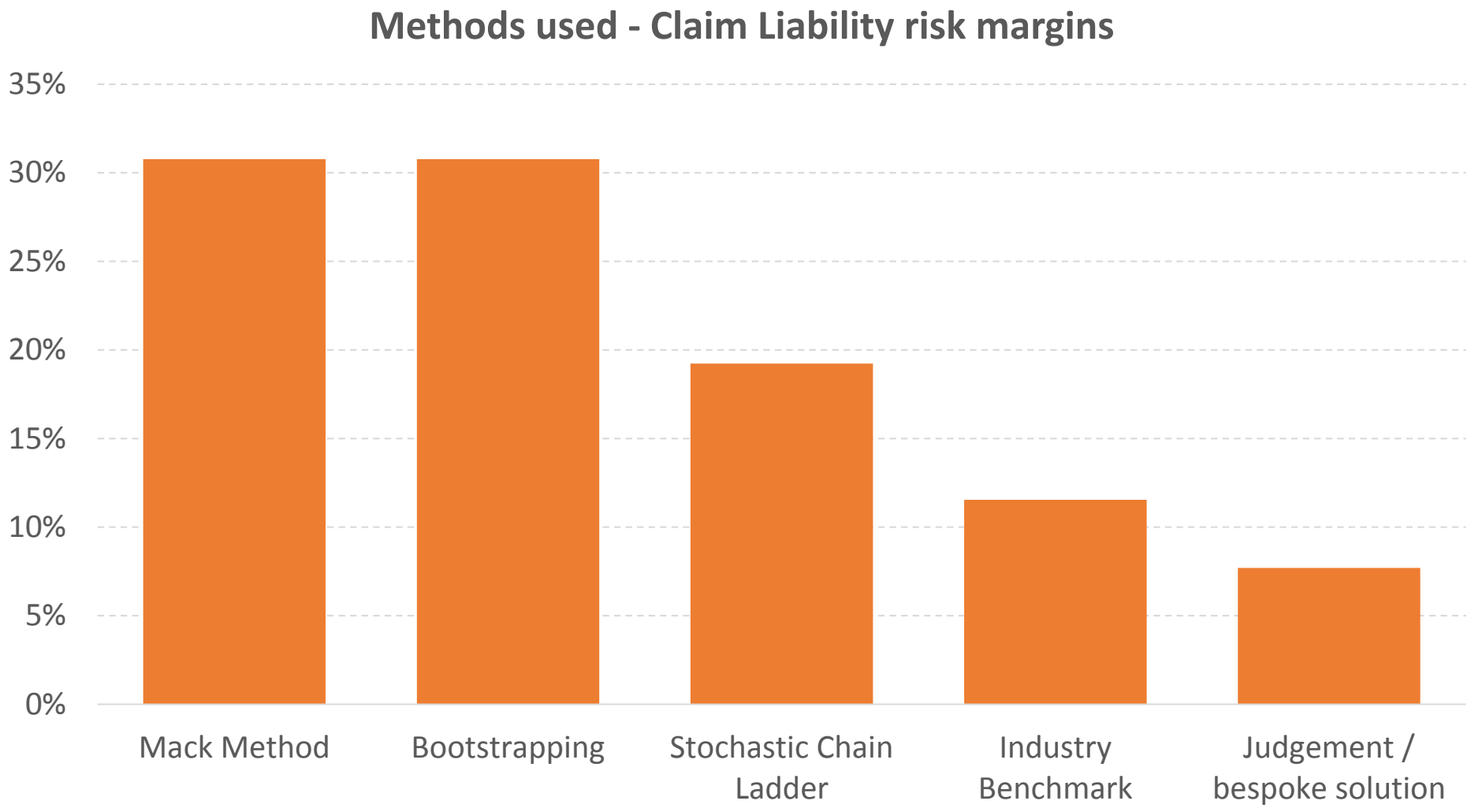
Parameter error

How are they determined? – Singapore



**Based on MAS 2013 stats*

How are they determined? – Malaysia



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 [illegible]eral reasoning
+ The actuary may take into account addi[illegible]factors not captured within the data
– Fairly subj[illegible]e method and hence [illegible]ocess

Industry Bench[illegible]

[illegible]ine of business

Mac[illegible]

[illegible]and total risk

Bootstrapping Method

- A resamp[illegible]od used to co[illegible] estimate the variabilit[illegible]f parameters
+ **No assun[illegible]about the underly[illegible]stribution** is required
+ Powerful a[illegible]mple, using only a singl[illegible] data set
– Variability [illegible]ted to that in the underlying historical data

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

Industry Benchmark

Tillinghast-Towers Perrin Risk Margin Study [2001]

APRA Risk Margin analysis: Collings and White – Trowbridge Consulting [2001]

Simple average of risk margins from other insurance companies

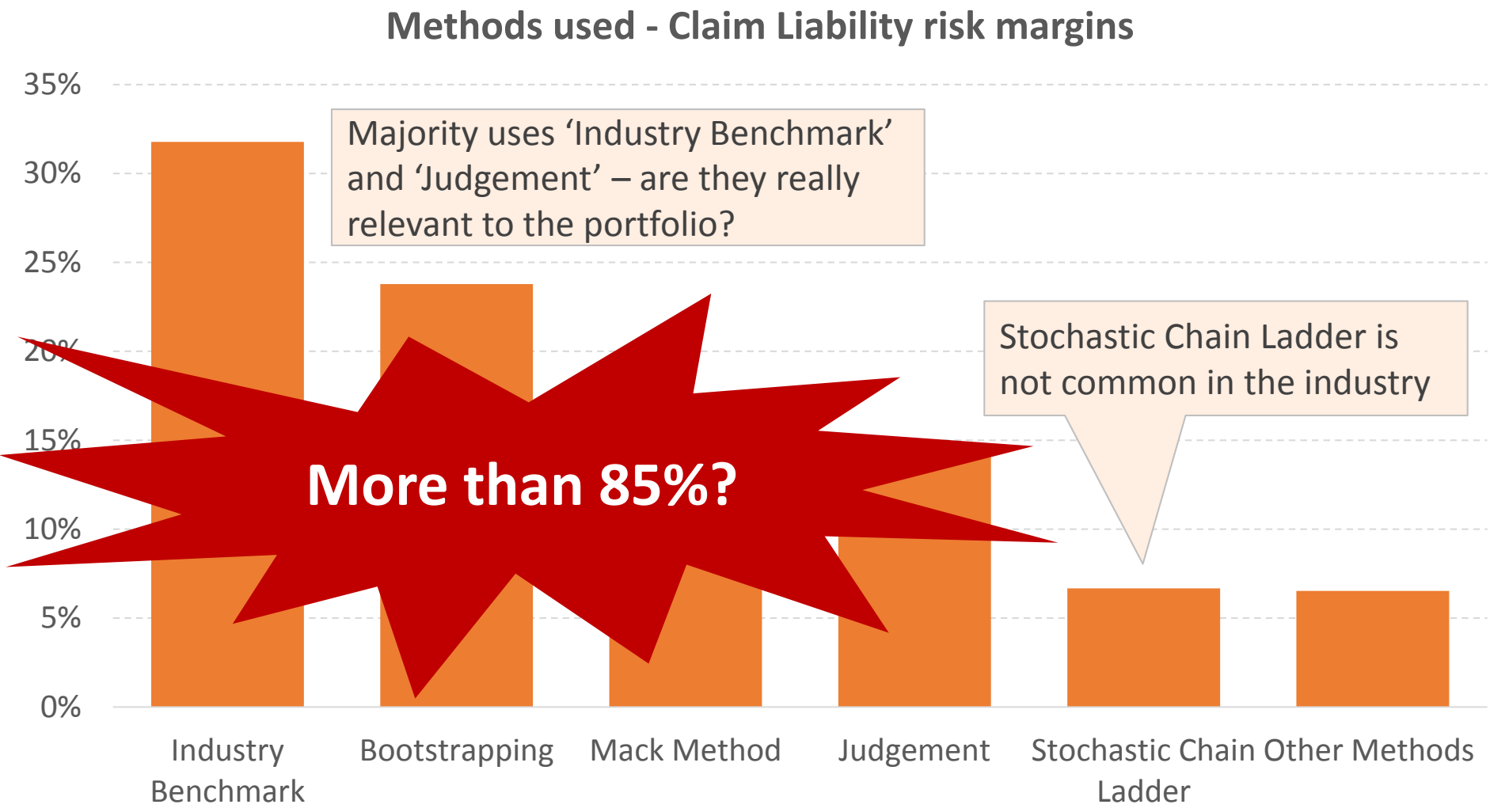
- Studies conducted are based on different:
  - regulatory environment
  - product features / tariff
  - economic environment
  - distribution channel

- 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

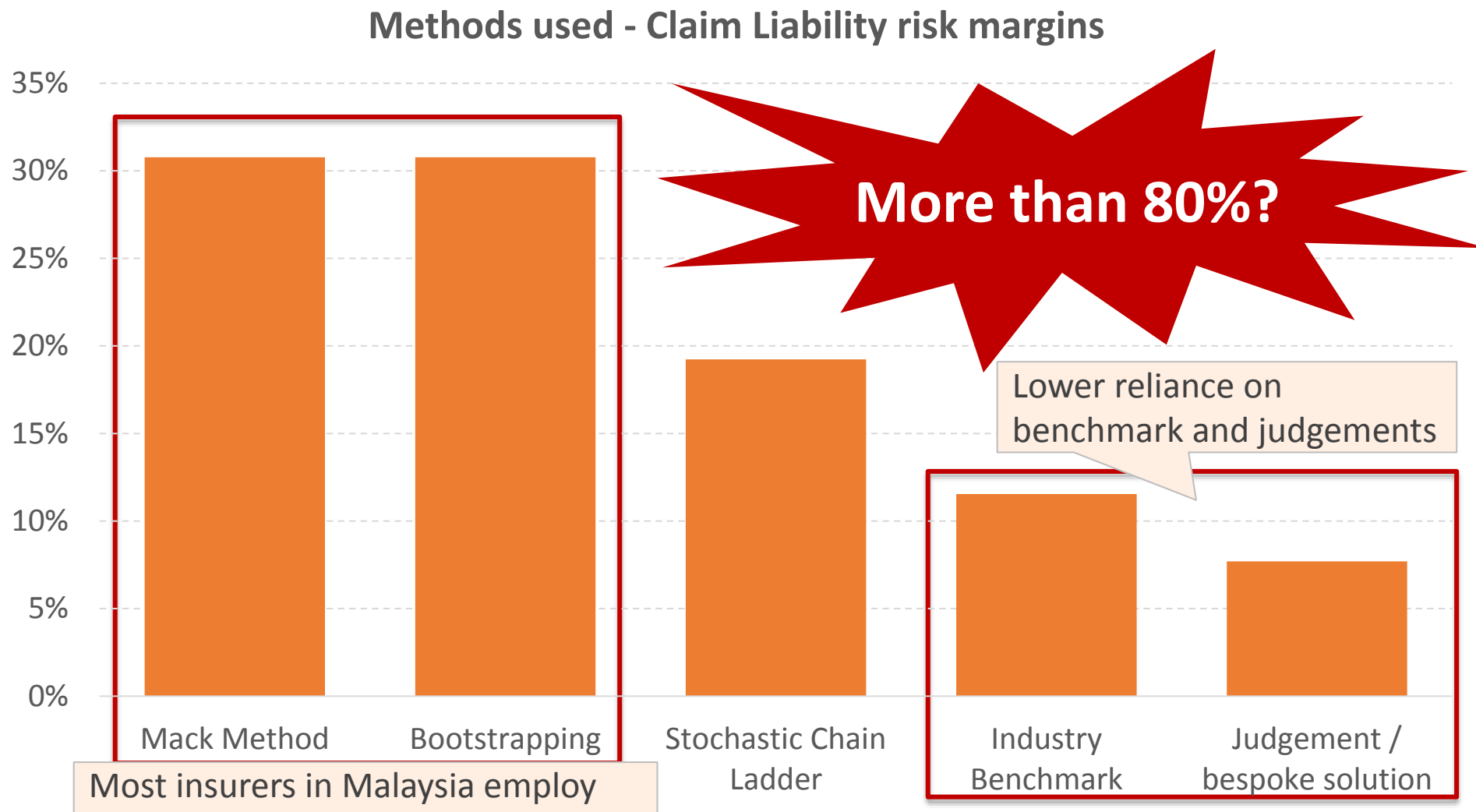
All companies are NOT the same

How are they determined? – Singapore



**Based on MAS 2013 stats*

How are they determined? – Malaysia



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

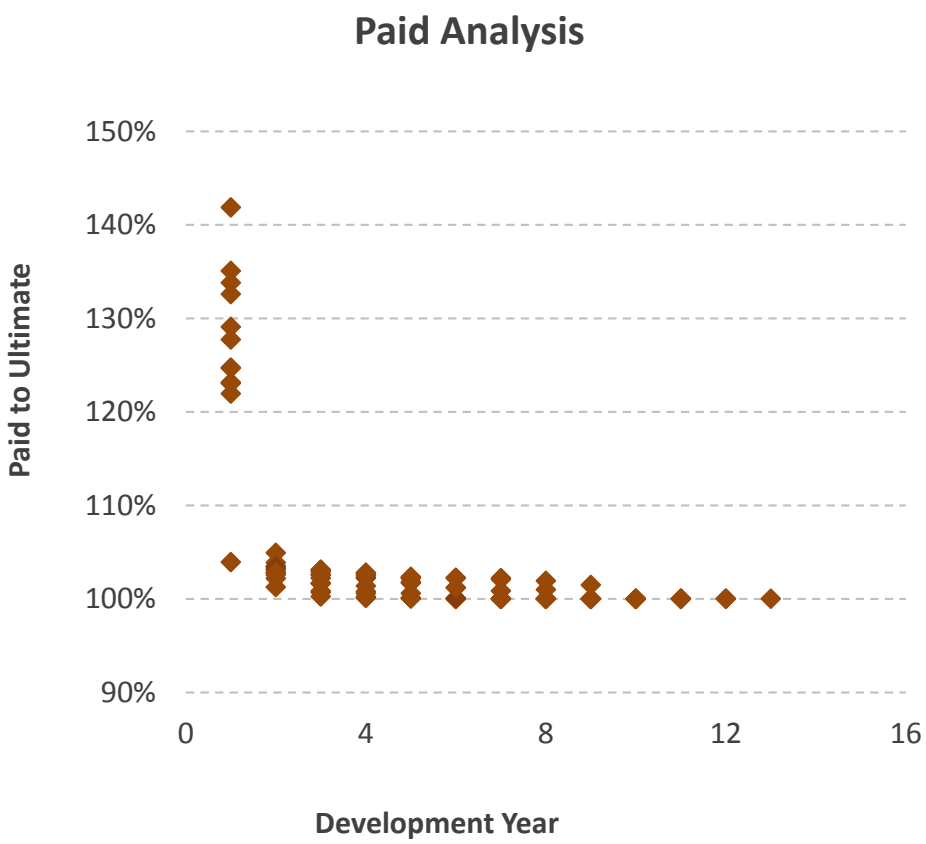
– Requires statistical software for faster simulation

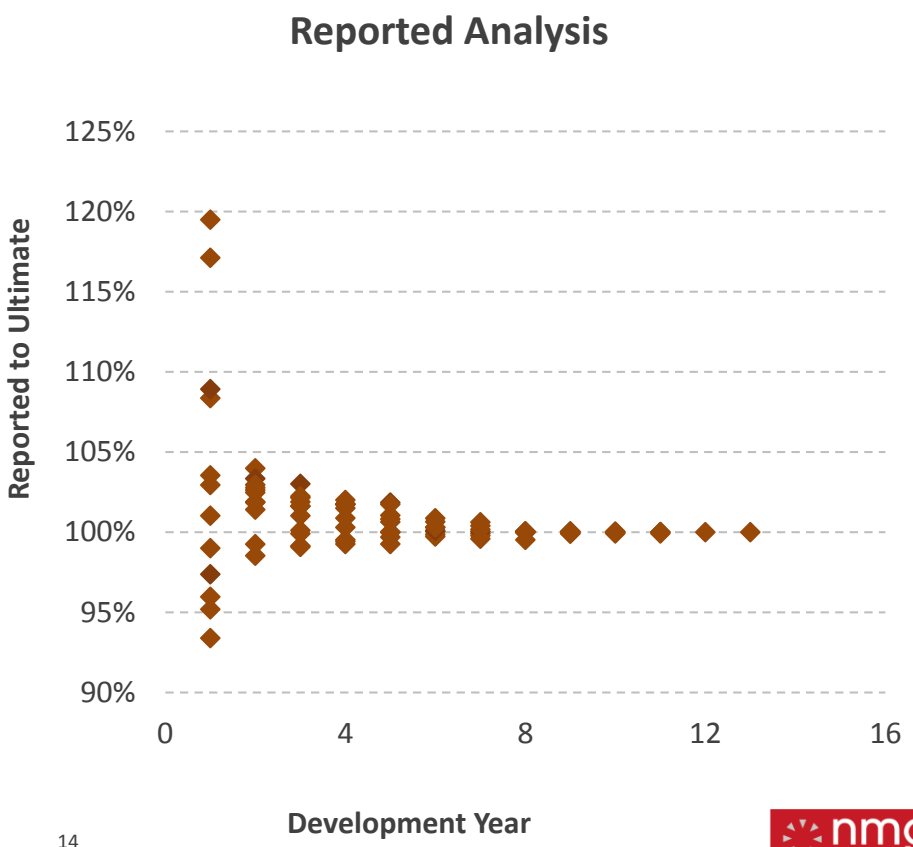
Project to Ultimate (using any approach) → **Analyse the implied development** → **Run simulations of how the claims might run-off**

Stochastic Chain Ladder Method

Stochastic Chain Ladder Method – Motor class from a regional insurer

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





Stochastic Chain Ladder Method

Stochastic Chain Ladder Method – Motor class from a regional insurer

2 **Determine the parameters for simulating the cumulative LDFs**

Paid Example	Accident Year	2011	2012	2013	2014	2015
	Development Factor (Year 1 to Ultimate)	109%	117%	119%	101%	104%

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

Stochastic Chain Ladder Method

Stochastic Chain Ladder Method – Motor class from a regional insurer

3 Simulate the cumulative LDFs and derive the revised Ultimate Loss

	Accident Year	2011	2012	2013	2014	2015
Paid Example	Simulated Development Factor (Year 1 to Ultimate)	102%	102%	102%	103%	109%
	Paid to Date	199	369	557	617	680
	Ultimate Loss	202	374	567	635	742

- 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

Stochastic Chain Ladder Method

Enhancements introduced:

Automation of outlier removal

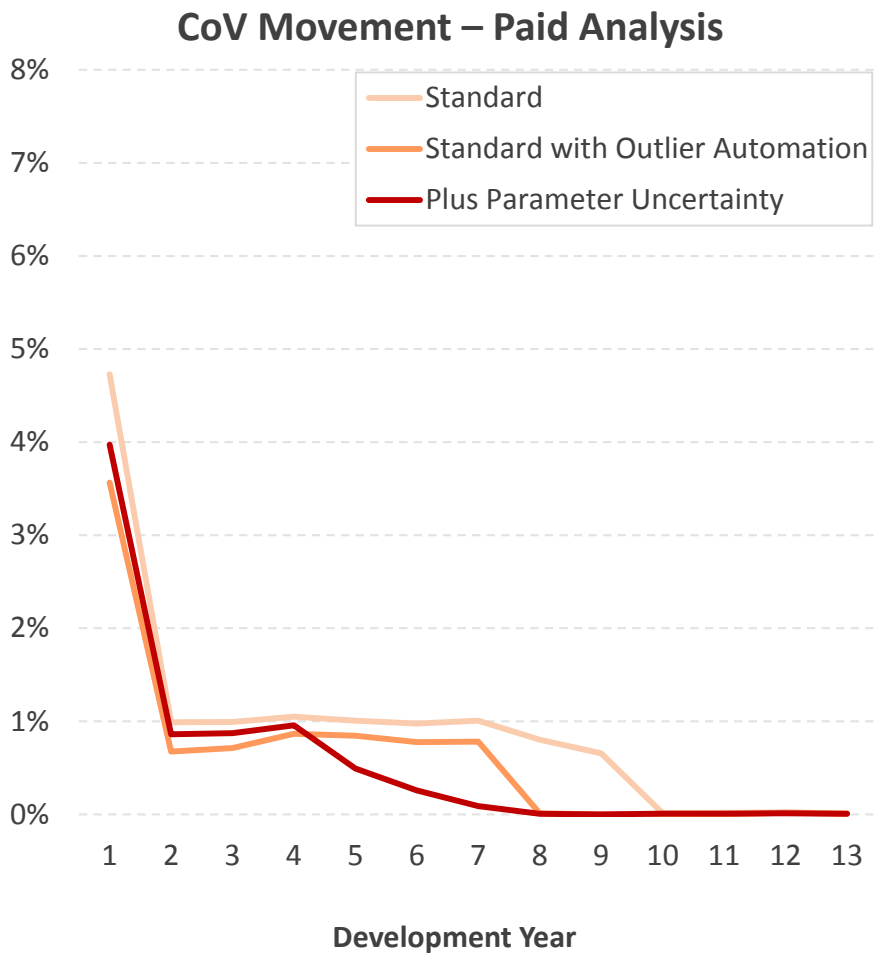
– based on the number of points and mean & standard deviation of the lognormal distribution

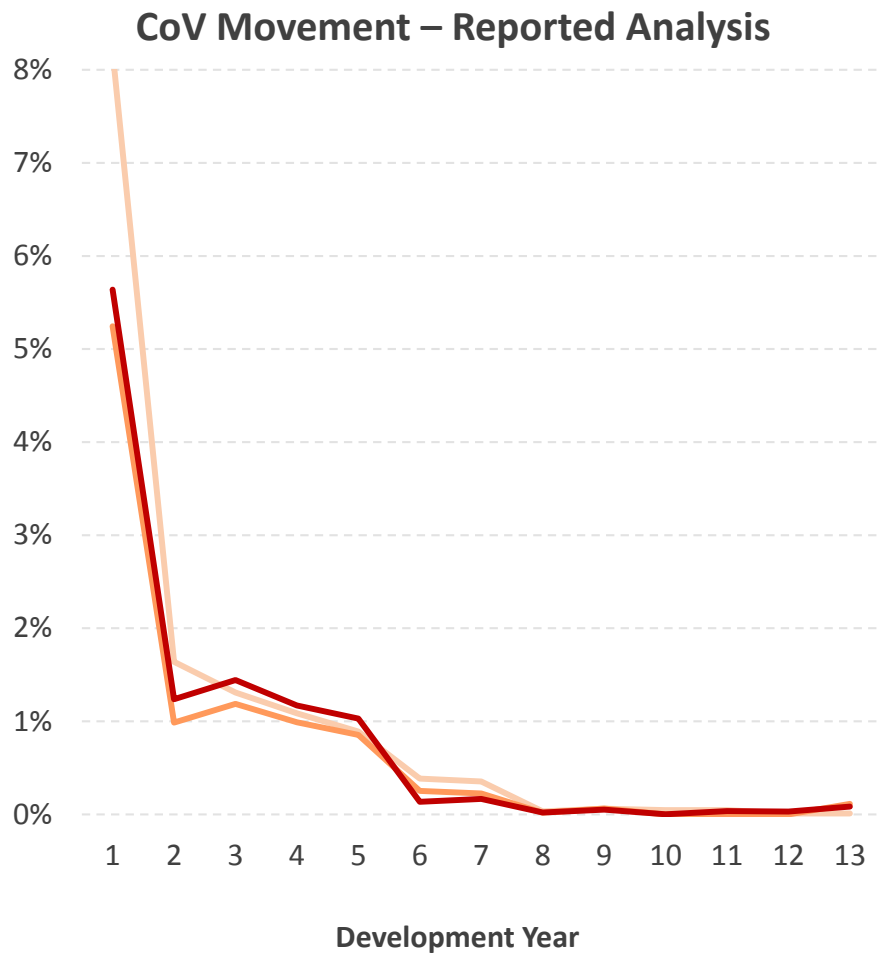
Parameter uncertainty

– re-simulate the claim triangles

Enhanced Stochastic Chain Ladder Method

Stochastic Chain Ladder Method – Motor class from a regional insurer





Enhanced Stochastic Chain Ladder Method

Stochastic Chain Ladder Method – Motor class from a regional insurer

Comparison of the risk margin:

	Industry Benchmark		Stochastic Chain Ladder	
	*APRA	^Tillinghast-Towers Perrin	Standard with Outlier Automation	Plus Parameter Uncertainty
75% Risk Margin	13.1%	8.0%	16.3%	**22.0%**

** APRA General Insurance Risk Margins Industry Review report as at 30 September 2013, published 17 February 2015*

^ Tillinghast-Towers Perrin Risk Margin Study – Research and Data Analysis Relevant to the Development of Standards and Guidelines on Liability Valuation for General Insurance, published 20 November 2001

Summary

Industry Benchmark & Judgement

~**50%** of the insurers in Singapore

~**20%** of the insurers in Malaysia

Relevance?

Mack Method & Bootstrapping

~**40%** of the insurers in Singapore

~**60%** of the insurers in Malaysia

No relationship to the Central Estimate!

Summary

Industry B **k Method** &
& **Ju** **trapping**

~50% e insurers
in S gapore

~20% of t of the insurers
in Malaysi in Malaysia

Time for a change?

Relevance? elationship to the Central Estimate!

Common myth

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

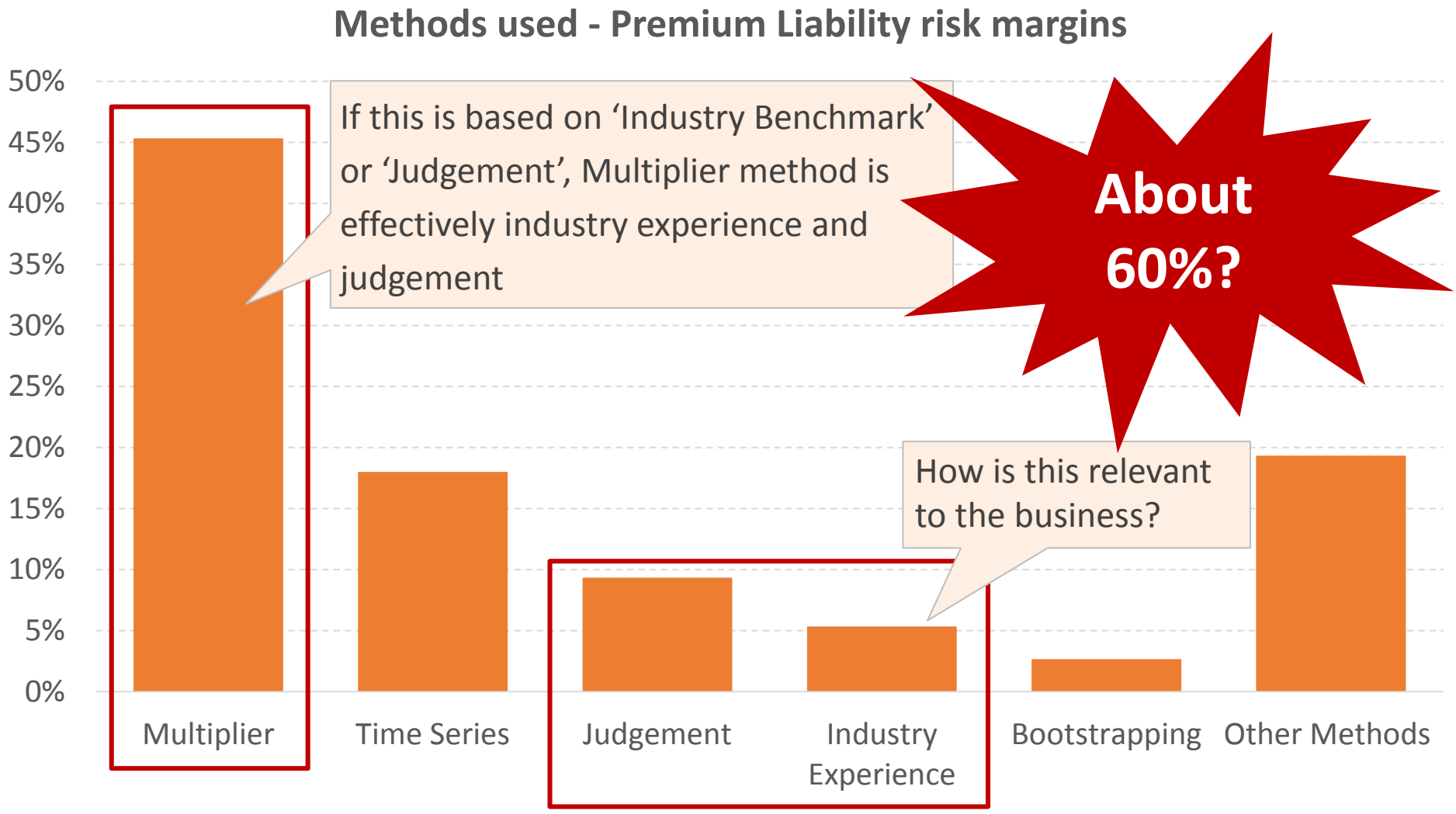
"It is generally recognised that the volatility of the premium liabilities of a class will be **greater than that for outstanding claims."**

"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"

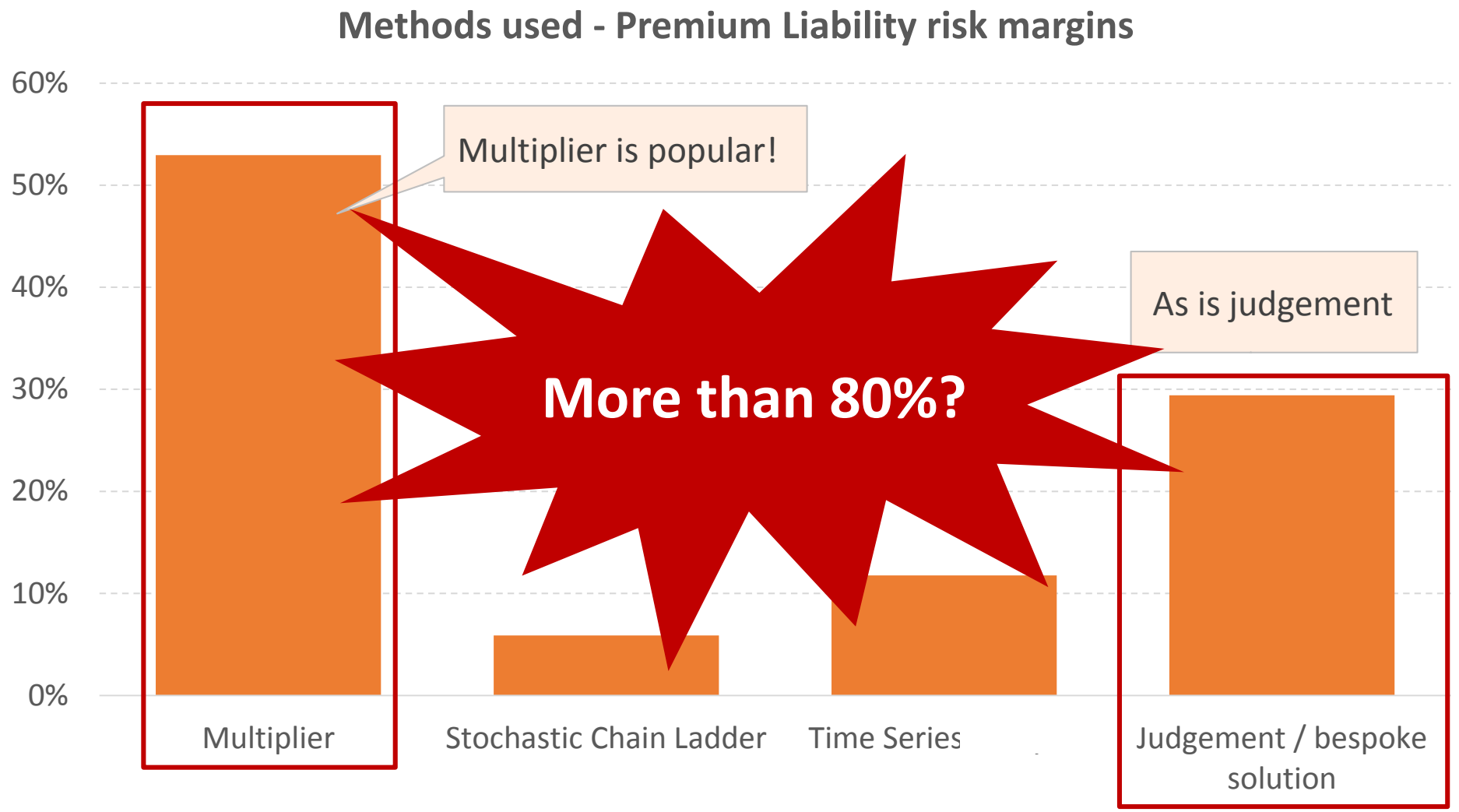
**Source: APRA Risk Margin analysis by Trowbridge Consulting 2001*

How are they determined? – Singapore



**Based on MAS 2013 stats*

How are they determined? – Malaysia



Debunking the myth: Part 1

APRA has moved on from 2001!

Ratio of PL to OCL risk margins

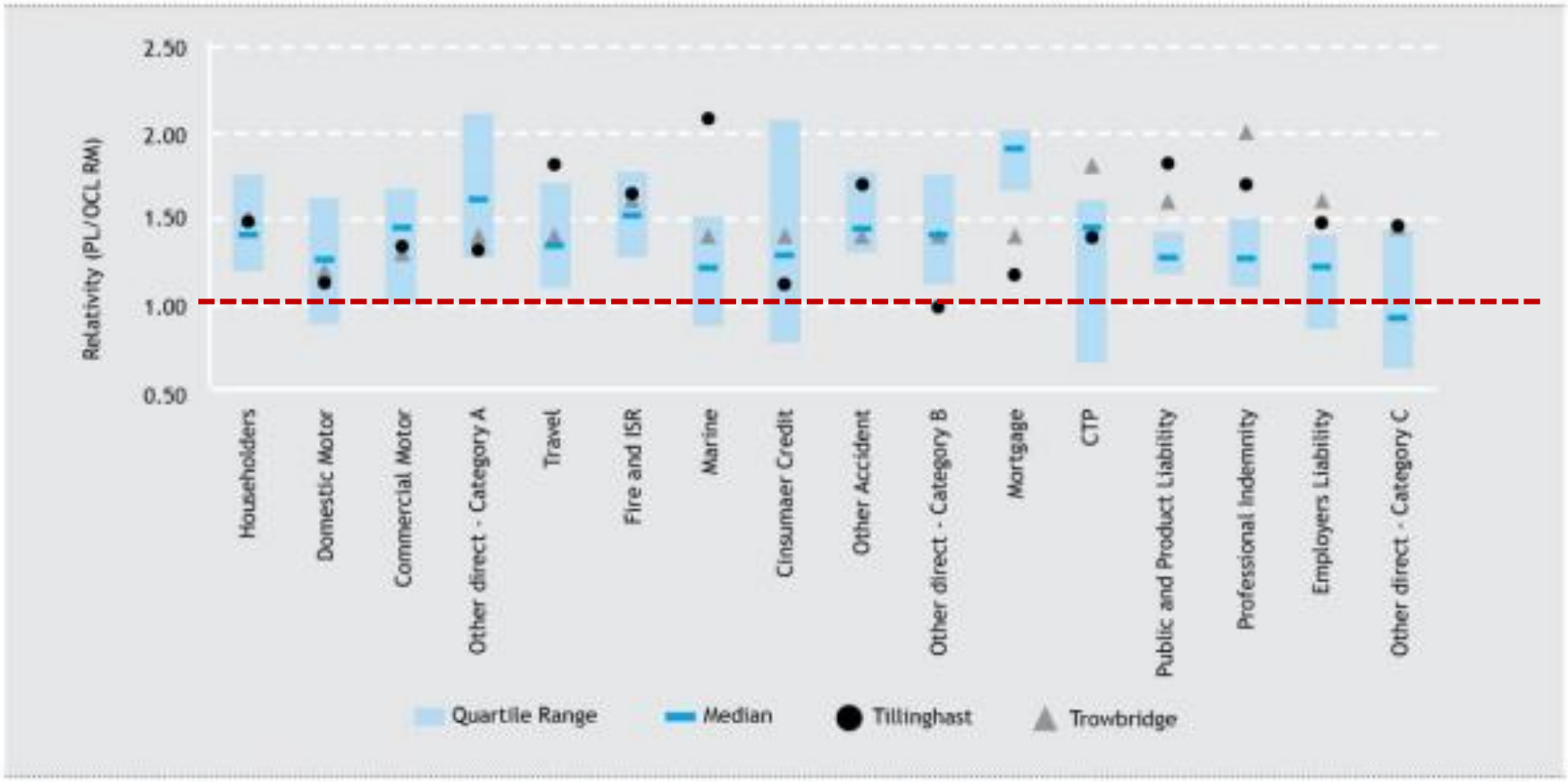
Direct Classes	PL Scale Up Factor Quartiles 1st	2nd	3rd	Tillinghast	Trowbridge
Householders	1.19	1.40	1.75	1.48	1.50
Domestic Motor	0.88	1.26	1.61	1.13	1.20
Commercial Motor	1.01	1.45	1.67	1.33	1.30
Other direct - category A	1.27	1.61	2.10	1.32	1.40
Travel	1.10	1.34	1.70	1.81	1.40
Fire and ISR	1.27	1.52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

**APRA General Insurance Risk Margins – Industry Review report as at 30 September 2013, issued 17 February 2015*

Debunking the myth: Part 1

APRA has moved on from 2001!

Figure 6: PL Scale up Factors by Class of Business



**APRA General Insurance Risk Margins – Industry Review report as at 30 September 2013, issued 17 February 2015*

Debunking the myth: Part 2

Suggested CV Multipliers from APRA Risk Margin Analysis 2001

Class of Business	CV Multiplier Range
Long Tail	1.6 – 2.0
Short Tail	1.2 – 1.6

Debunking the myth: Part 2

Long-Tail	Claim Liability	Premium Liability
Premium	1,000	1,000
Expected ULR	80%	80%
Paid	100	0
Outstanding	700	800
CV Multiplier		1.8
Risk Margin (75%)	10%	18%
75% ULR	87%	94%
ULR Increase	8.75%	18.00%

2.06

Debunking the myth: Part 2

Short-Tail	Claim Liability	Premium Liability
Premium	1,000	1,000
Expected ULR	80%	80%
Paid	600	0
Outstanding	200	800
CV Multiplier		1.4
Risk Margin (75%)	10%	14%
75% ULR	82%	91%
ULR Increase	2.50%	14.00%

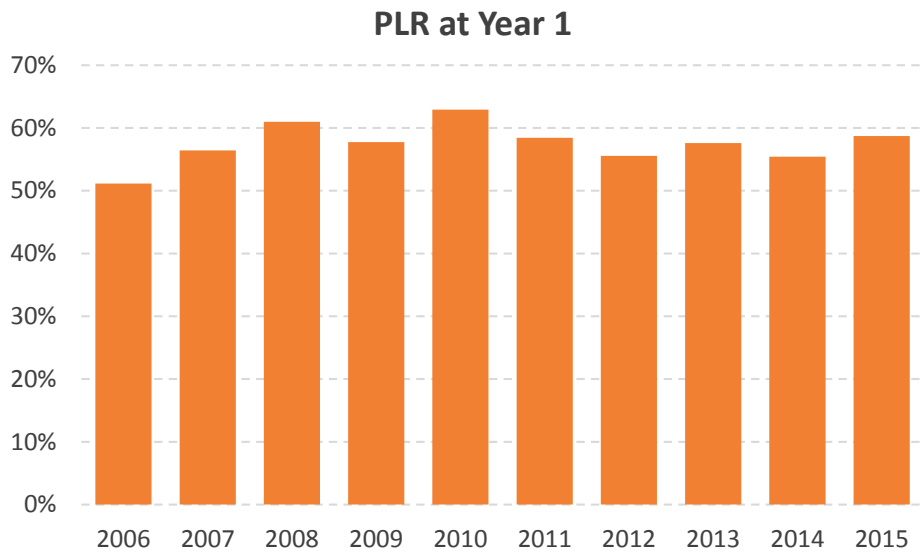
5.60

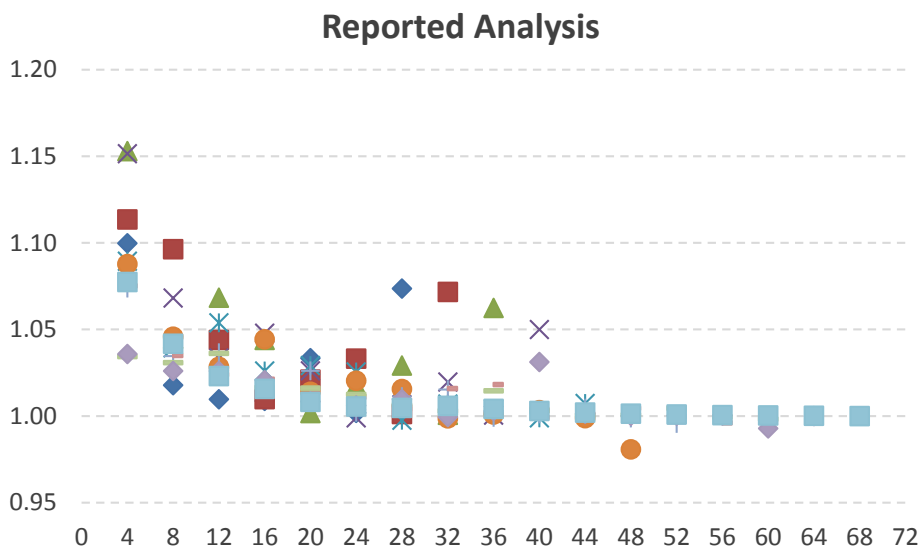
Debunking the myth: Part 3

Year 1

Paid in Year 1 (80%)

Claim Liability (20%)





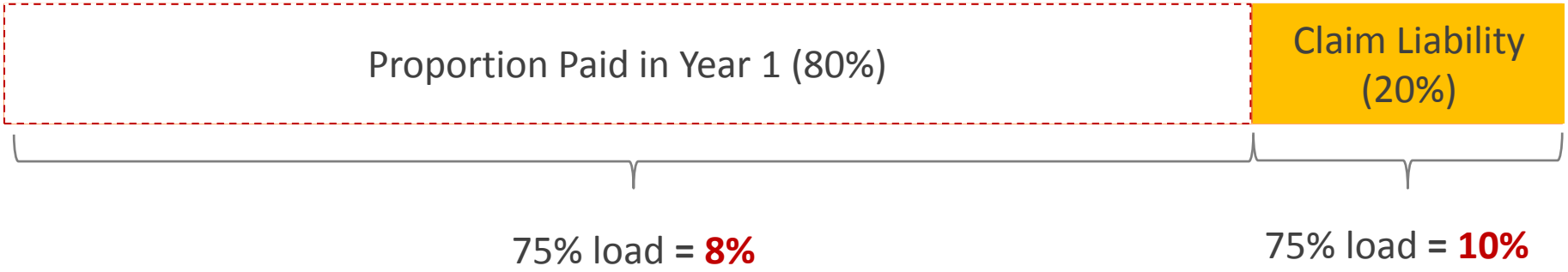
Average	57.5%

St Dev	3.1%

- 75% load based on a Lognormal distribution = 8%

- 75% load based on a Stochastic Chain Ladder = 10%

Debunking the myth: Part 3



Results

Volatility of Premium Liability, at 75% confidence level

= 80% * 8% + 20% * 10%

= **8.4%**

Less than the Claim Liability risk margin of **10%**

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

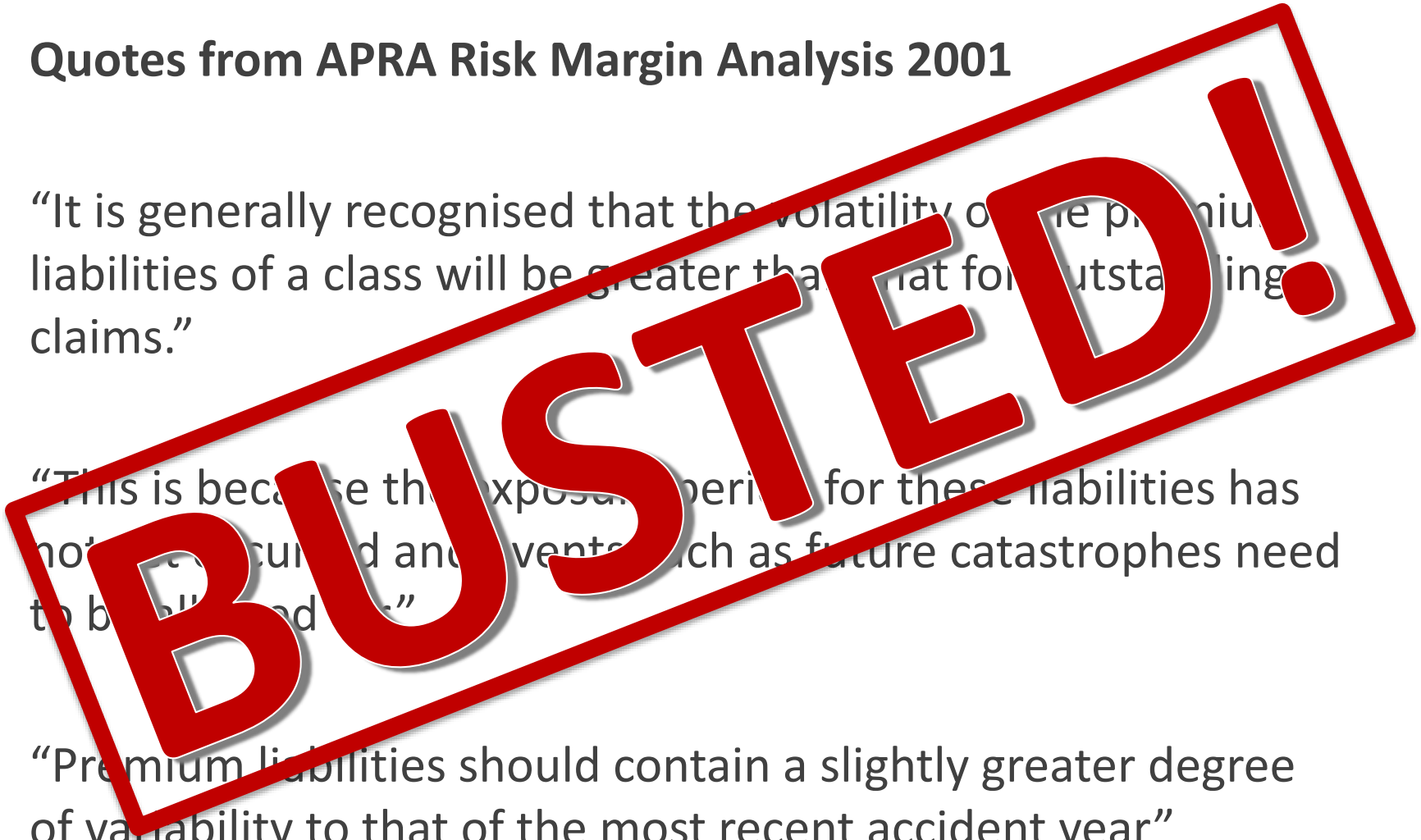
Common myth

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

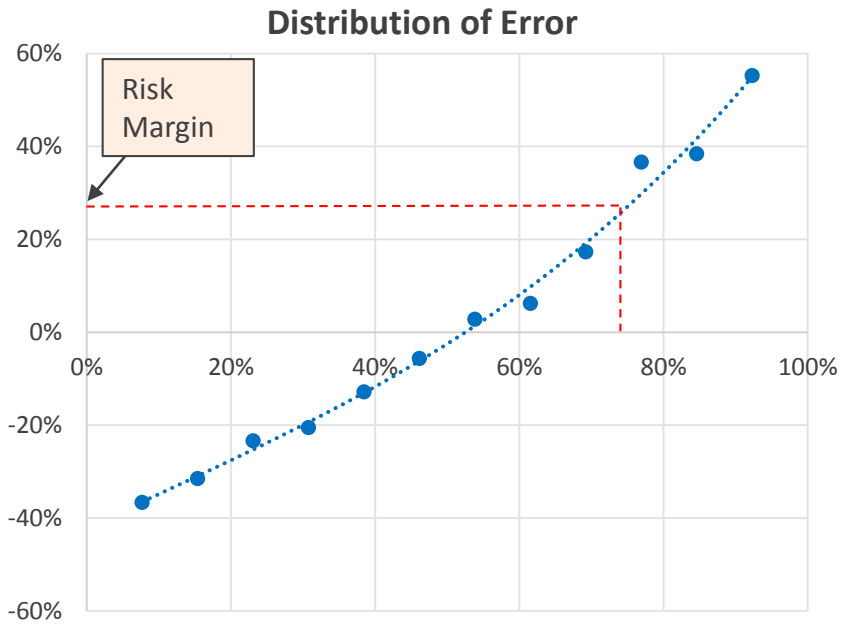
- Comparison of the historical projections of URR with the latest estimates
- Determines distribution of the standard errors and select the appropriate confidence level

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

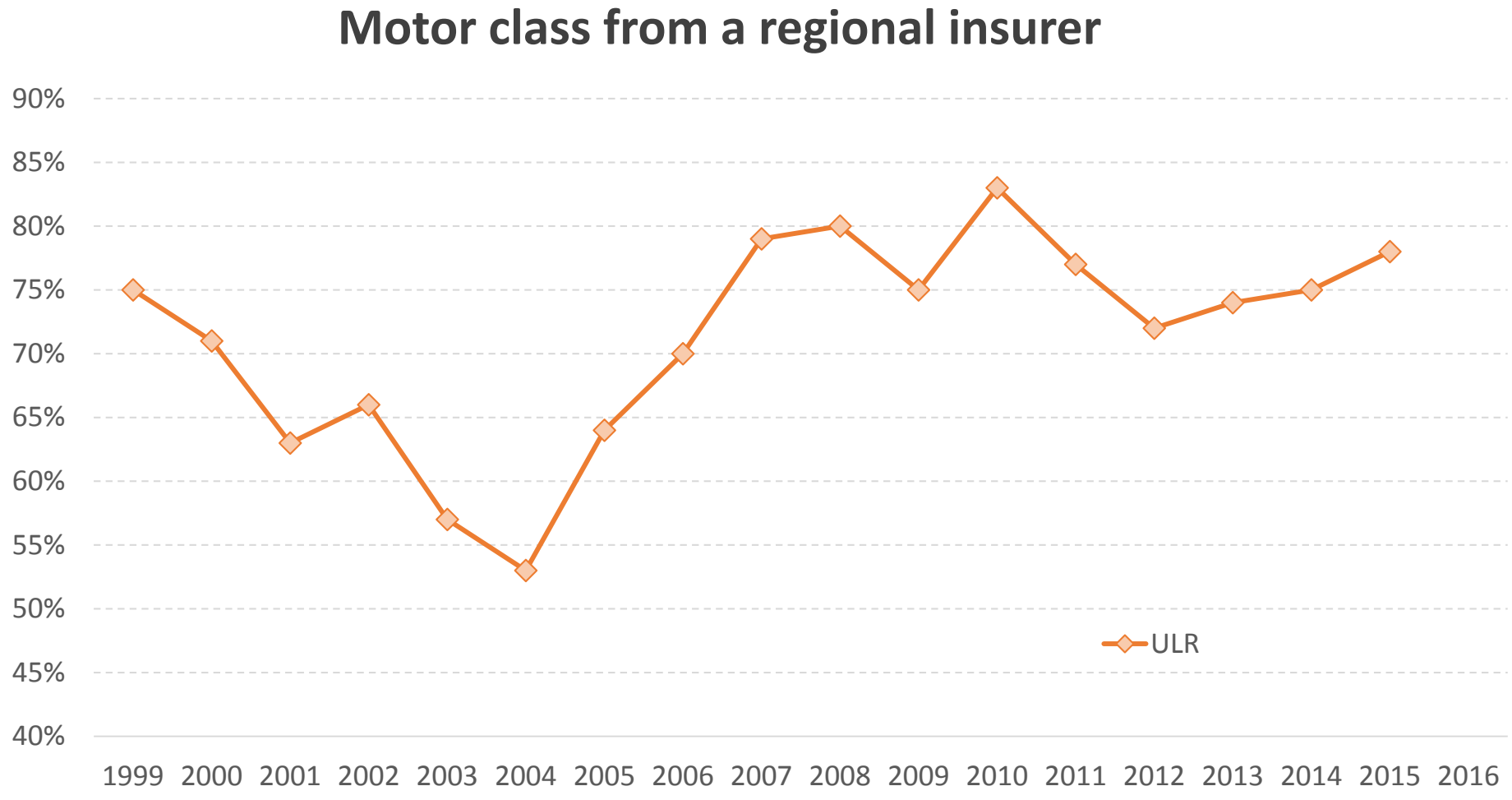
Cons

- Complex and difficult to understand
- **Outliers** can distort results



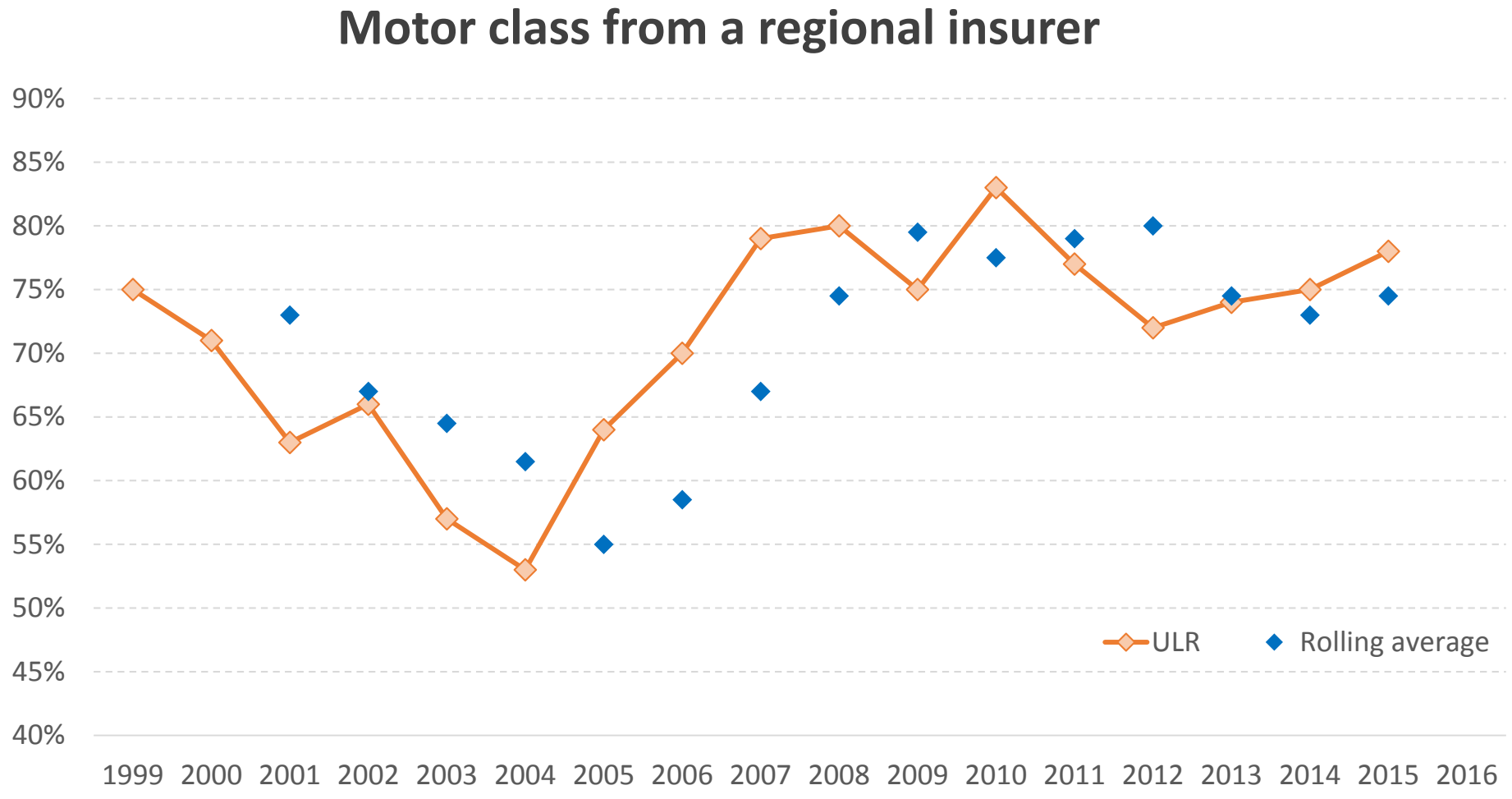
Time series – how does it work?

Step 1: Obtain the selected ULR from Claim Liability analysis



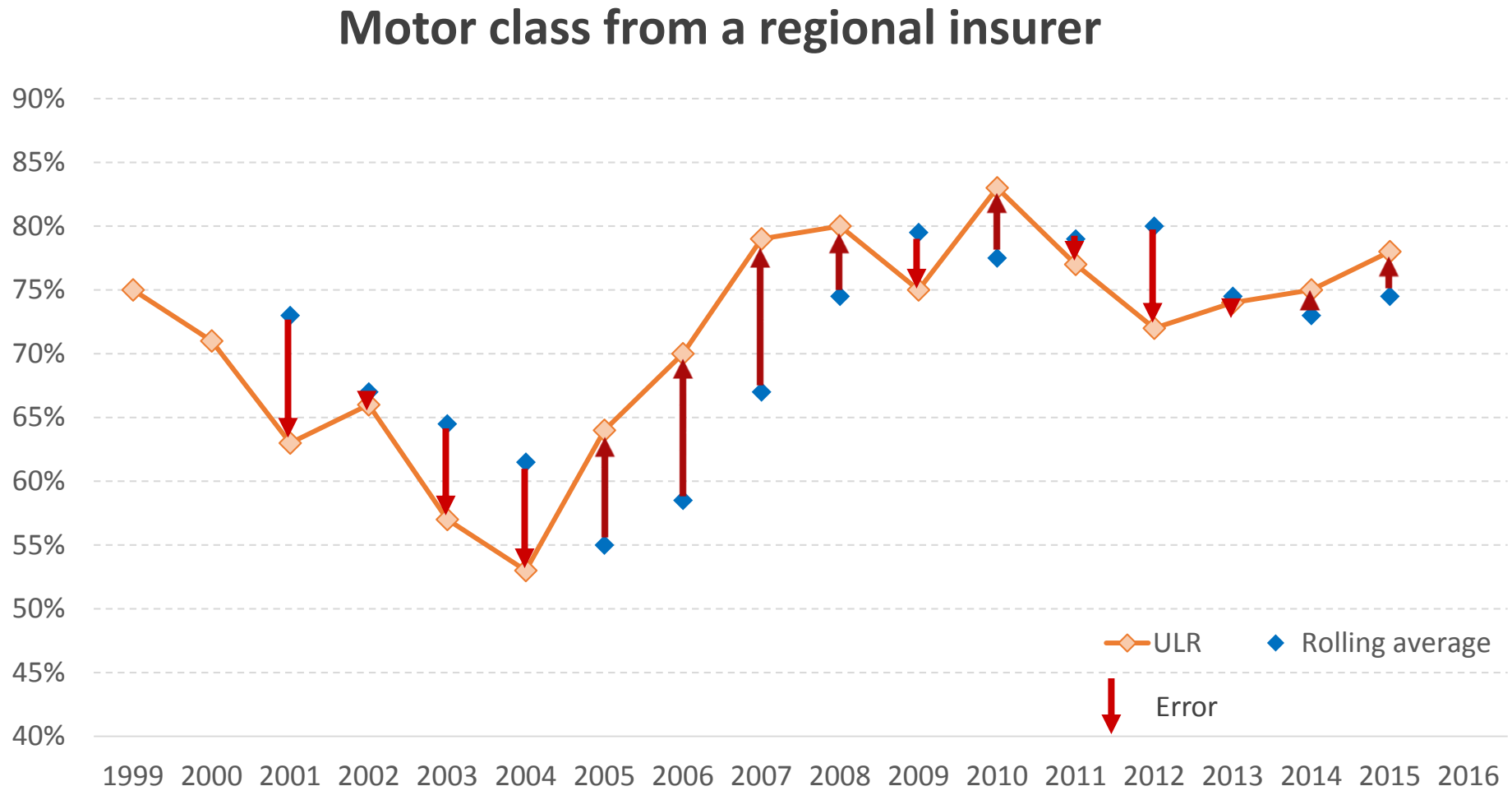
Time series – how does it work?

Step 2: Calculate the two years rolling average ULR



Time series – how does it work?

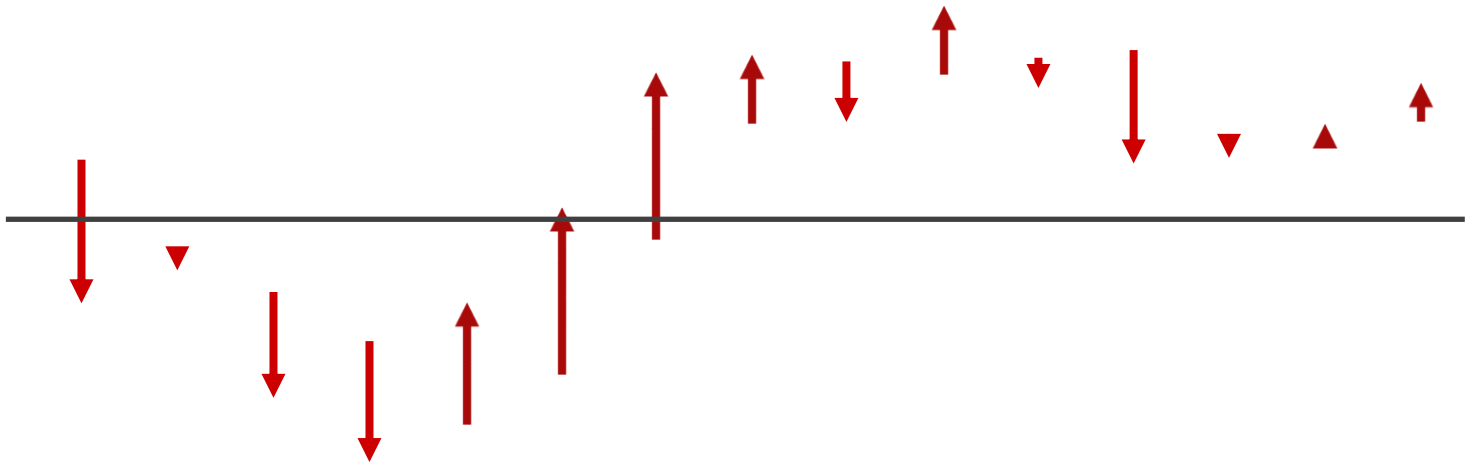
Step 3: Calculate the error between the selected ULR and rolling average ULR



Time series – how does it work?

Step 4: Rank the errors and fit a trendline

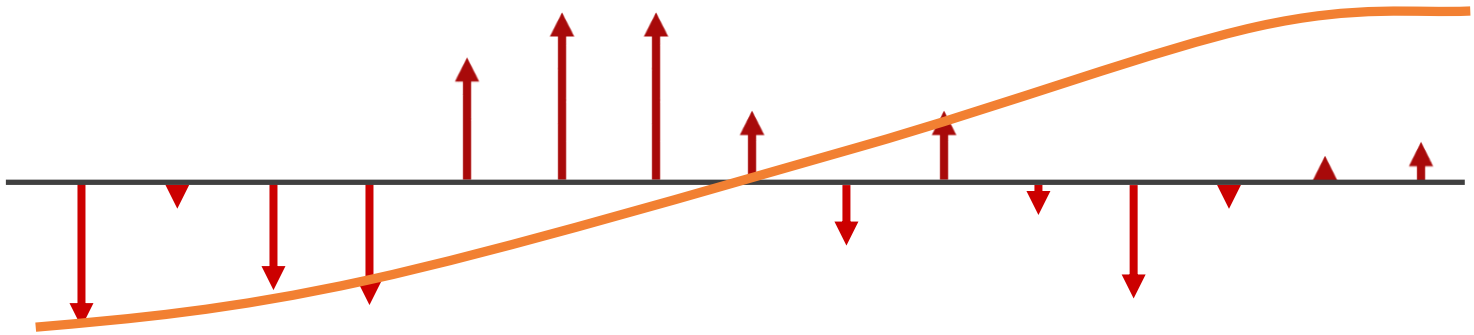
Motor class from a regional insurer



Time series – how does it work?

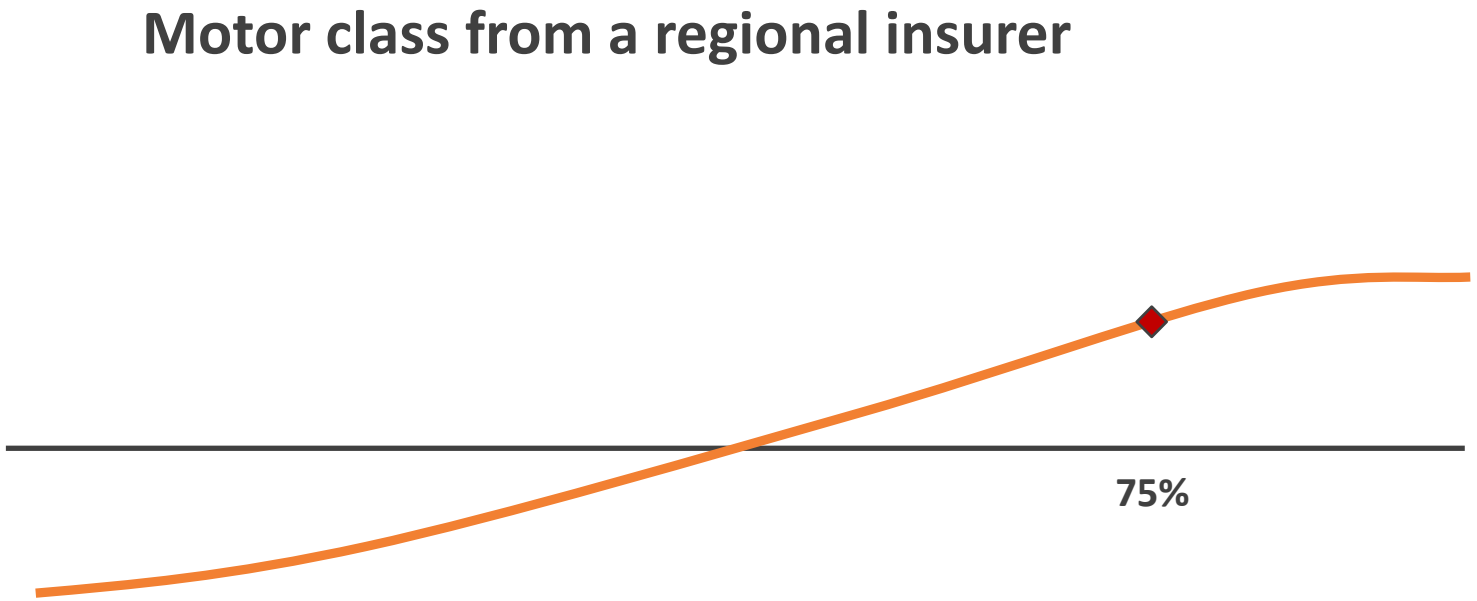
Step 4: Rank the errors and fit a trendline

Motor class from a regional insurer



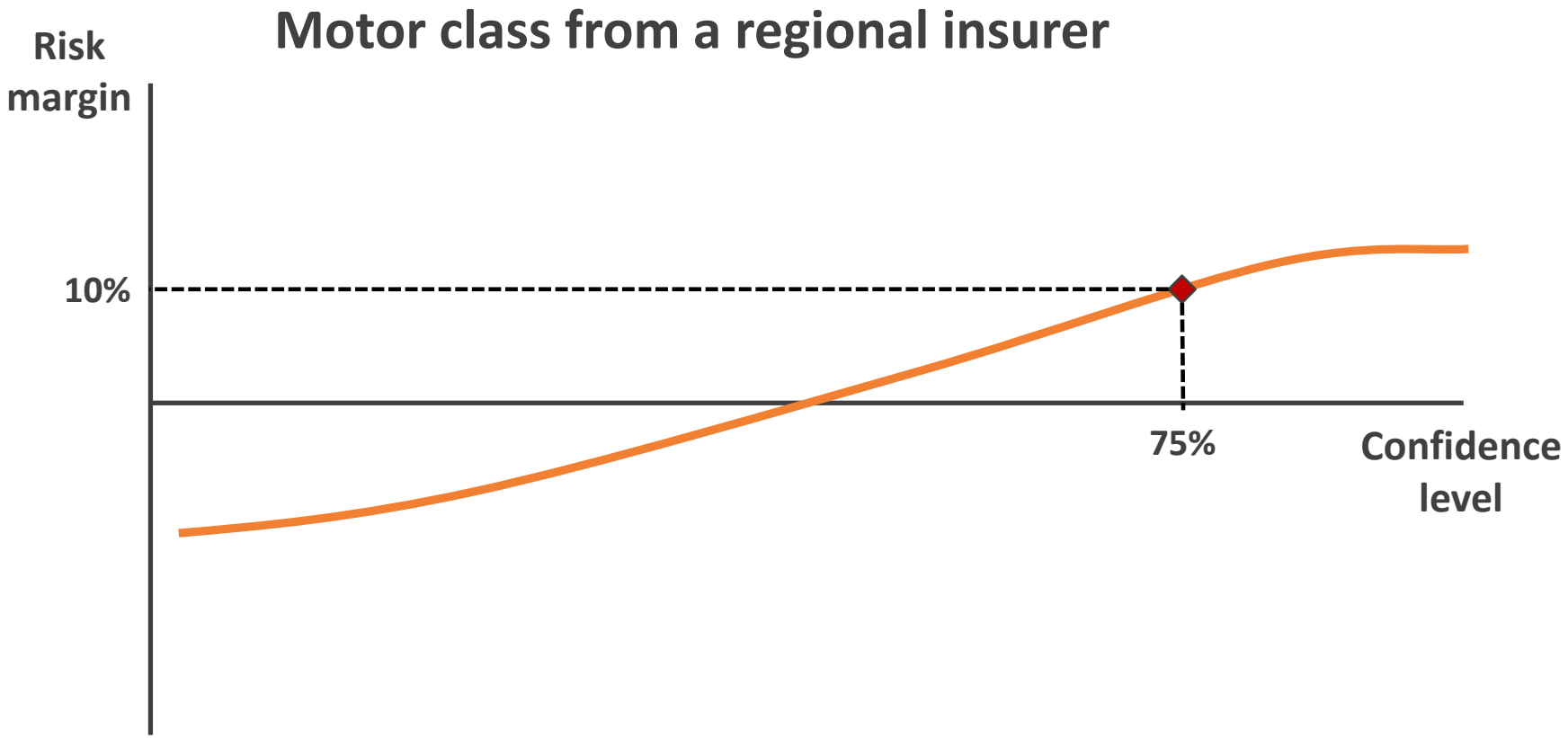
Time series – how does it work?

Step 5: Determine the 75th percentile



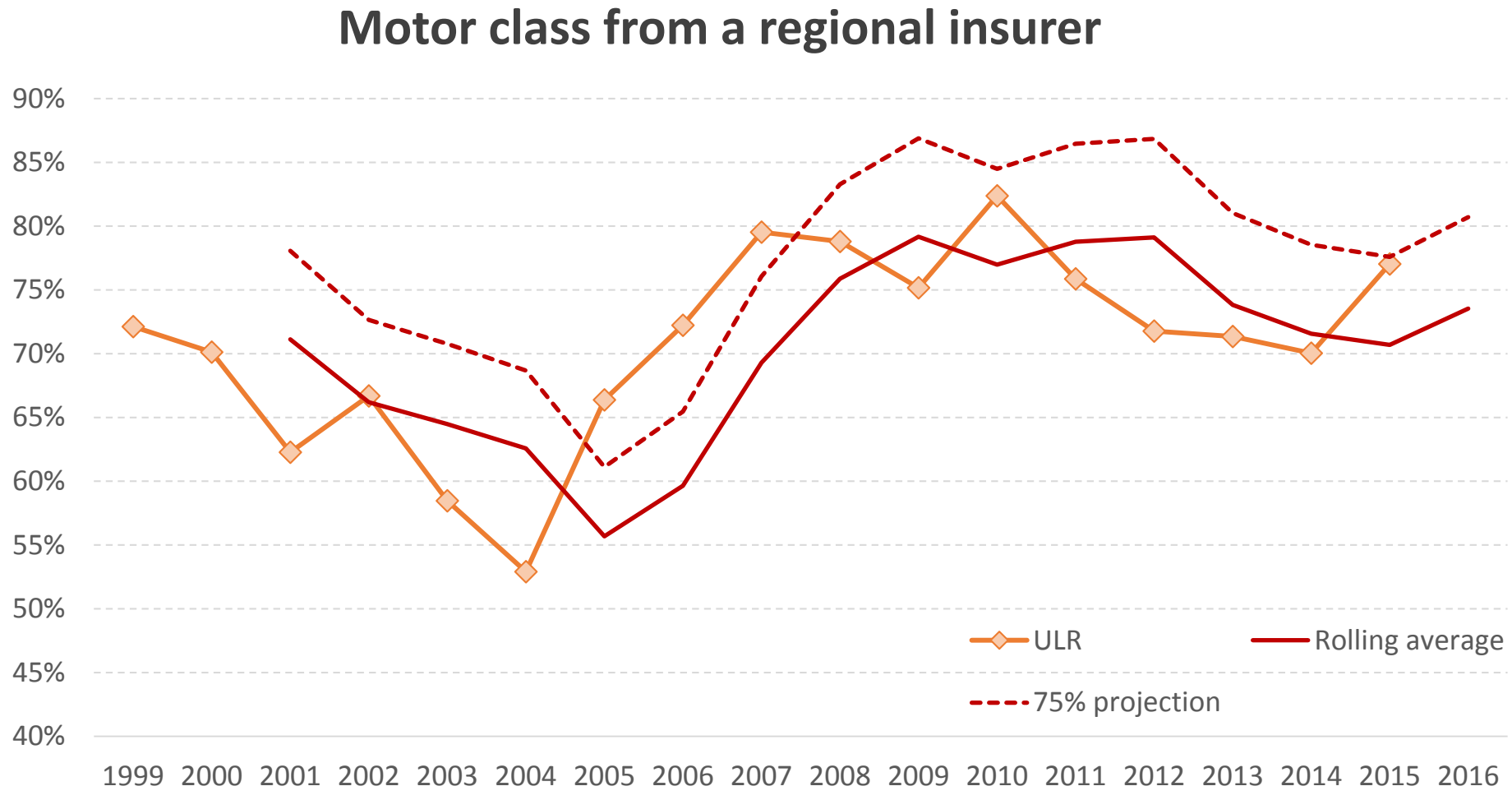
Time series – how does it work?

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



Time series – how does it work?

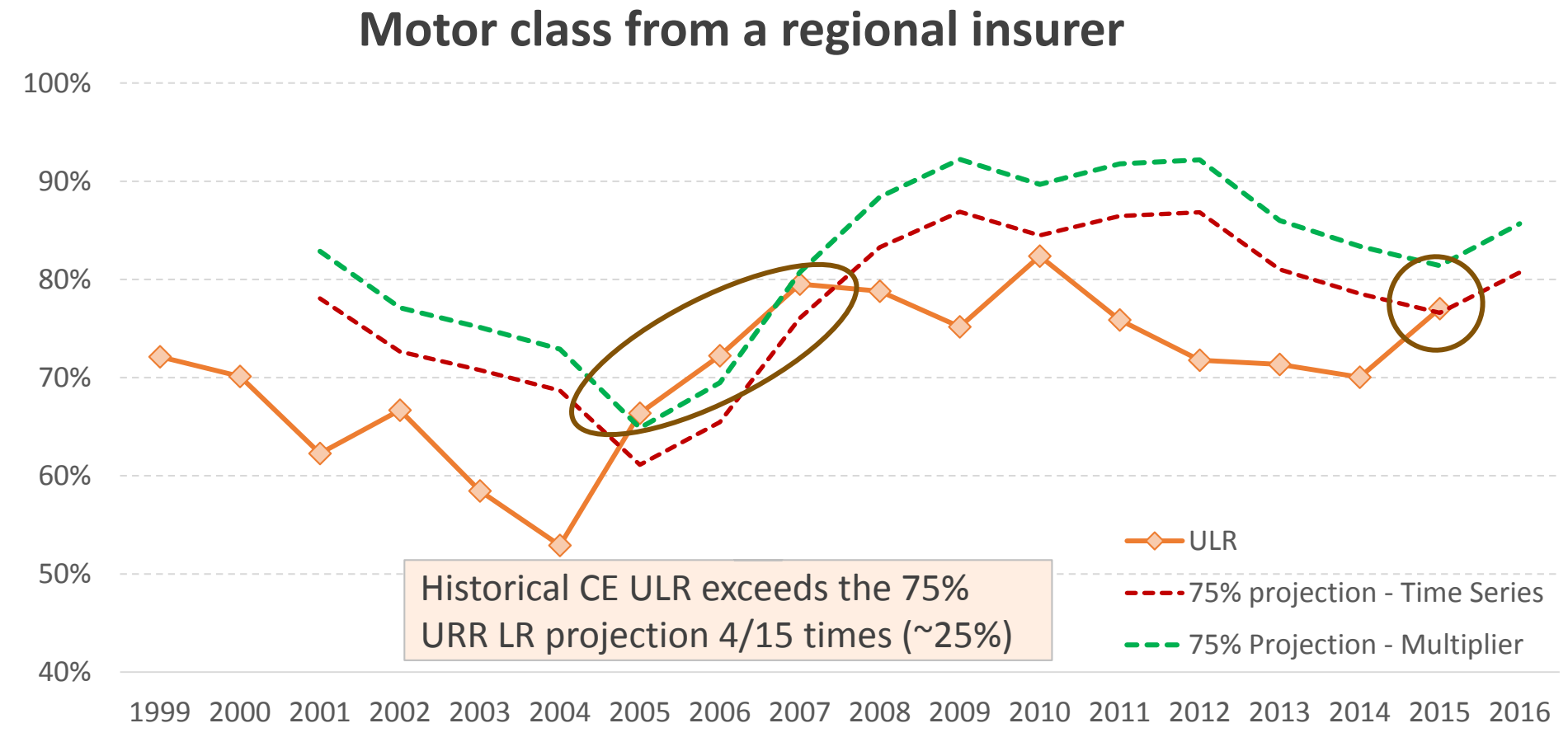
Step 7: Calculate the 75% URR loss ratio



Comparison of methods – Time series vs Multiplier

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

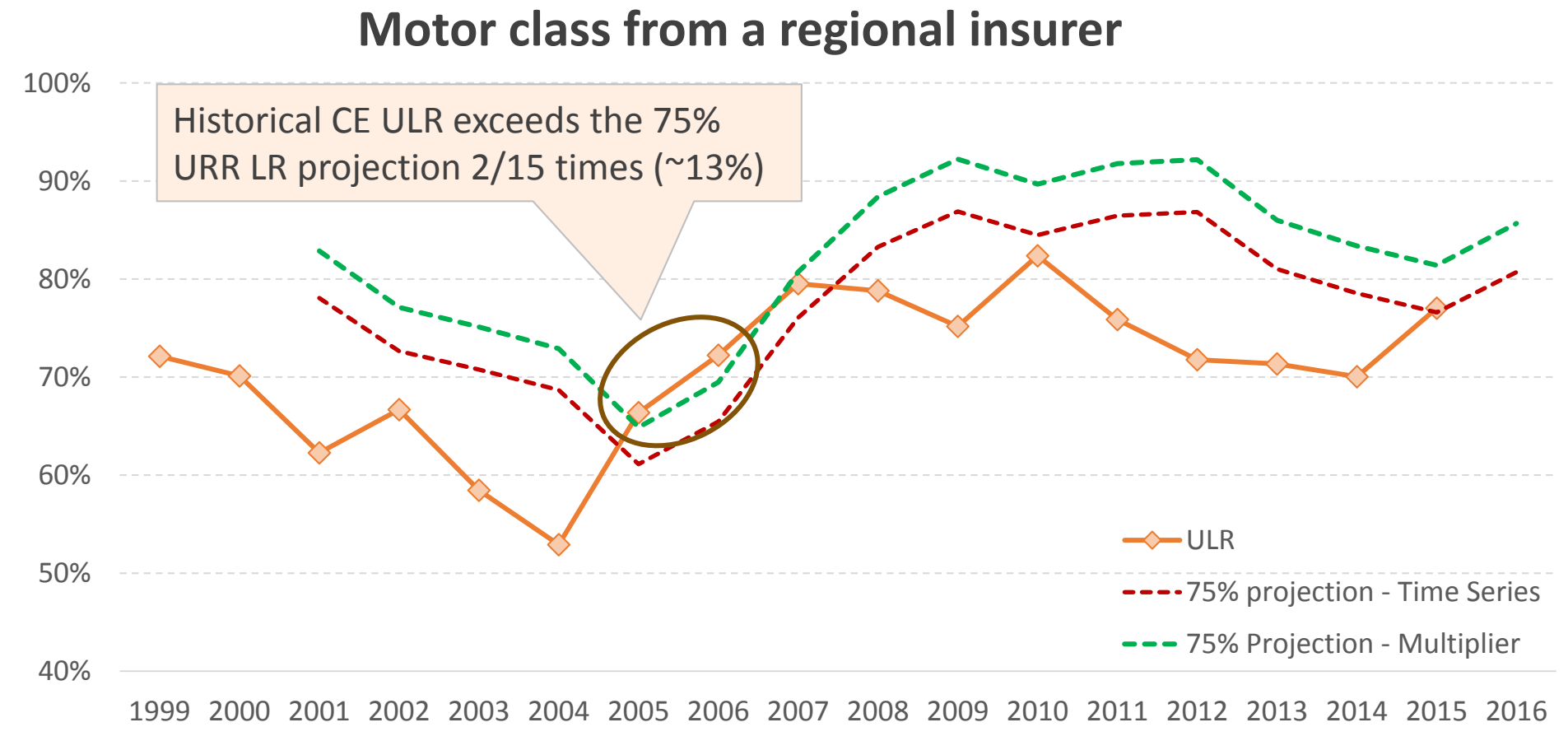
	Time Series	Multiplier @ 1.5
Loadings	10%	16.5%



Comparison of methods – Time series vs Multiplier

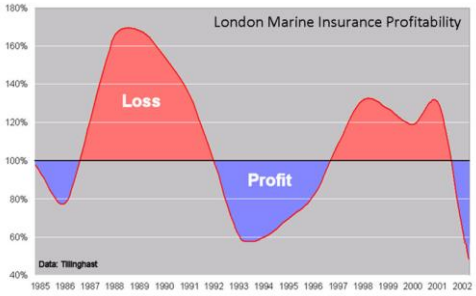
Stochastic Chain Ladder suggests the Claim Liability risk margin to be 11%

	Time Series	Multiplier @ 1.5
Loadings	10%	16.5%

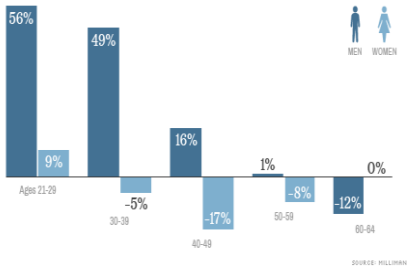


Variations of Time series

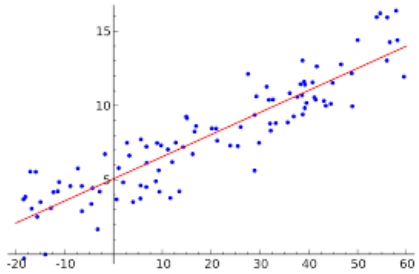
Other considerations



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

	Claim Liability	Premium Liability
Volatility drivers	▪ Claims settlement process	▪ Claims experience
Current methodologies employed	▪ Industry benchmark and Judgement are regulators' and auditors' least favourite ▪ Mack and Bootstrap have no relationship to the Central Estimate selected	▪ Adding a loading to the Claim Liability risk margin to determine the Premium Liability's is too simplistic
Recommended approach	▪ Stochastic Chain Ladder	▪ Time Series
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"

Thank you

"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."

Matthew Maguire
Partner, NMG Actuarial
Tel: +65 6325 9842
Matthew.Maguire@NMG-Group.com

Yuen Leng Chin
Principal Consultant, NMG Actuarial
Tel: +60 3 2283 6405
YuenLeng.Chin@NMG-Group.com


nmg
CONSULTING
shape your thinking