

Credibility, Margins and Individual Life PBR Reserves

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Mortality for Individual Life PBR Reserves

Valuation Manual, VM-20 Section 9 C

Prudent Estimate Mortality Assumption

1. Credibility segment
2. Credibility theory combines credibility segment mortality experience and industry table for anticipated experience assumption
3. Apply margin to the anticipated experience assumption to create Prudent Estimate Mortality Assumption

Credibility Segment

- Select policies with similar
 - Underwriting characteristics
 - Mortality experience
- At least 30 deaths in credibility segment
 - Required if company is to use credibility theory
- Credibility segment boundaries
 - Data may have limited issue ages/durations

Given a Company's Experience ...

Policy	G	Smoking Status	Pricing Assumption	Issue Age	Duration	Alive or Dead
1	M	SM	150%	50	2	Alive
2	M	NS	70%	27	7	Dead
3	F	NS	100%	32	11	Alive
:						
10,000	M	NS	70%	60	3	Alive
:						
24,999	M	NS	70%	42	9	Alive
25,000	F	NS	90%	48	8	Alive

Credibility Segment with Similar Underwriting Characteristics and Mortality Experience (bounded by data's issue age and duration)

Policy	G	Smoking Status	Pricing Assumption	Issue Age	Duration	Alive or Dead
2	M	NS	70%	27	7	Dead
:						
10,000	M	NS	70%	60	3	Alive
:						
24,999	M	NS	70%	42	9	Alive

Credibility Theory and Credibility Segment Mortality Experience

- Credibility Theory
 - Credibility Formula
 - SOA Sponsored Paper on Credibility Approaches
 - Features of Credibility Formulas in Report
 - Actuarial Judgment Essential
- Margins
 - SOA Sponsored Paper on Margins
 - Overlap of Credibility Theory and Margins

Credibility Formula

- Credibility formulas use a credibility factor 'Z' which varies from 0 to 1.
- The standard form of credibility formula:

$$Z \times (\text{Company A/E Ratio}) + (1-Z) \times (\text{Base Estimate})$$

Credibility Methods in Report

- SOA supported MIB Solutions Credibility Theory Practices Report produced by Klugman, Rhodes, Purushotham and Gill
<http://www.soa.org/research/life/research-credibility-theory-pract.aspx>
- Two Well-Established Credibility Methods
 - Limited Fluctuation Method
 - Bühlmann Empirical Bayesian Method

Credibility Methods

- Total Variance = Process Variance + Variance of Hypothetical Means
- Limited Fluctuation uses Process Variance
 - Only requires own company data
 - Company can do in-house with own experience & Excel files from MIB Credibility Practices Report
- Bühlmann Empirical uses both Process Variance + Variance of Hypothetical Means
 - Requires all companies data for calculation
 - Statistical Agent required for confidentiality

Credibility Formula Development

Limited Fluctuation method's formula development see pp 8-10 of
MIB Credibility Theory Practices Report

For Bühlmann Empirical Bayesian method's formula development
see pp 15-19 of MIB Credibility Theory Practices Report

Features of Credibility Formulas in Paper

- Value of Q_x can be either small or large
- Separate formulas for count and amount
- Limited Fluctuation uses table as base estimate (RR table, Pricing Assumptions, ...)
- Bühlmann Empirical uses base estimate that is empirically adjusted by company experience
- Result is flat percentage of base estimate (Actuarial judgment required in implementation)

NS Preferred Class Structure of 2 (NS PCS 2)

Bühlmann Empirical Bayesian Method
Using base estimate of 100% of 2001 VBT

Empirically Adjusted by Co Exper A/E Ratio by Amount	Company	Company 2001 VBT A/E Ratio by Amount	Credibility Factor Z	Number Of Deaths	Credibility Estimate Buhlmann Empirical Bayesian
65.6%	B	66.4%	0.072	9	65.7%
65.6%	D	109.3%	0.068	17	68.6%
65.6%	E	46.2%	0.266	36	60.5%
65.6%	F	84.9%	0.231	65	70.1%
65.6%	H	65.3%	0.336	554	65.5%
65.6%	I	57.8%	0.511	153	61.7%
65.6%	J	112.4%	0.118	63	71.1%

NS Preferred Class Structure of 2 (NS PCS 2)

Limited Fluctuation Method

Using base estimate of 65.6% of 2001 VBT

Base Estimate		Company 2001 VBT	Credibility		Credibility Estimate
A/E Ratio		A/E Ratio	Factor	Number	Limited
by Amount	Company	by Amount	Z	of Deaths	Fluctuation
65.6%	B	66.4%	0.060	9	65.7%
65.6%	D	109.3%	0.075	17	68.9%
65.6%	E	46.2%	0.108	36	63.6%
65.6%	F	84.9%	0.134	65	68.2%
65.6%	H	65.3%	0.152	554	65.6%
65.6%	I	57.8%	0.205	153	64.0%
65.6%	J	112.4%	0.102	63	70.4%

Credibility Theory

Implementation Issues

- Outside of credibility segment boundaries, credibility results blended to base estimate
- Actuarial judgment essential for applying credibility estimate
- Implementation in VM-20, Section 9 C
- Overlap with Margins - Four Main Types of Uncertainties pp 15, 16 of PwC Report

<http://www.soa.org/files/pdf/research-analysis-life-annuity.pdf>

Actuarial Judgment Essential:

Do not blindly use credibility estimates

- Base estimate chosen for credibility method has significant effect on results (Exception if specified, e.g. RR tables determined in VM-20)
- Credibility estimate is % of base estimate—Can alter at older ages, after level term period, ...
- Lack of quality company experience studies
- New business has different risk factors from business used in company A/E Ratio

Credibility Important Due to VM-20 Section 9, C Mortality Assumptions

For 30 or greater deaths in credibility set of mortality segments, determine prudent estimate mortality by:

1. Select credibility method
2. Select base estimate for credibility method by using the UCS method to indicate industry basic table
3. Determine mortality from experience studies and credibility method
4. Determine margin
5. Use credibility mortality plus margin as your prudent estimate assumption

Overlap with Margins

Four Main Types of Uncertainties

1. Random fluctuation in the individual risks or losses arising from pooled insurance policies

Credibility Overlap with Margins

- Credibility formulas in the SOA Credibility Theory Practices report account for random fluctuation in company results in mean and variance calculations

Overlap with Margins

Four Main Types of Uncertainties

2. Uncertainties with regard to the mis-estimate of experience assumptions and the changes in those assumptions

Credibility Overlap with Margins

- Choice of base estimate has significant effect on the results (Exception if specified, e.g., RR tables)
- Quality of company experience studies vary significantly
- New business has different risk factors from business used in company A/E Ratio

Overlap with Margins

Four Main Types of Uncertainties

3. Uncertainties with regard to the use of inappropriate trend assumptions (e.g. mortality Improvement)

Not Addressed in Credibility

4. Uncertainties with regard to the assumed relationships between risk factors

Not Addressed in Credibility

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Questions?

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