

Credibility Theory

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Company Variability, Valuation, and Statistics

- Variability of Company Results around Industry-wide Mortality
- VM-20 - Determine Prudent Estimate Mortality. This is why you should care about this talk!
 - Selecting credibility method
 - Using credibility method to determine mortality from experience studies
- Examples using Preferred Mortality and Term Lapse rates

Variability of Company Results around Industry-wide Mortality

- Individual company data aggregated to determine industry -wide mortality tables
 - 2001 VBT
 - UCS
 - 2008 VBT
- Following slides - individual company mortality experience varies widely from these industry-wide standards

Variability of Company Results around Industry-wide Mortality: 2001 CSO

In the American Academy of Actuaries' CSO Task Force Report (dealing with the 2001 CSO), Appendix H – Loading Validation has the following statement:

“In the Academy Task Force’s work, we have assumed that the table should be sufficient to cover the experience of 71 percent of the companies that will use it”

Variability of Company Results around Industry-wide Mortality

UCS applied to Companies' NS Experience Varies
from Mortality Increasing with UCS Score

UCS 2006 Study		
UCS Score	A/E Ratio	Deaths
26	47.0%	6
41	63.1%	21
42	71.8%	78
95	65.3%	63
96	79.3%	174
119	65.9%	230
120	72.5%	9
141	95.8%	2,231

Variability of Company Results around Industry-wide Mortality: 2008 VBT

Out of 39 companies in the SOA 2005-07 study

2008 VBT A/E Ratio By Amount	Number of Companies
Above 100%	12
95% up to 100%	9
90% up to 95%	7
Below 90%	11

VM-20: For 30 or greater deaths in credibility set of mortality segments

Determine prudent estimate mortality by:

1. Selecting credibility method
2. Selecting industry basic table (UCS method)
3. Determine mortality from experience studies and credibility method
4. Determine margin
5. Use credibility mortality plus margin to select industry basic table with higher mortality

Selecting the Credibility Method

Two well-established credibility methods:

Limited Fluctuation Method – Uses policy level company data and aggregated industry-wide data
Can be done by a company on their business.

Bühlmann empirical Bayesian Method- Uses policy level company data for every company. Due to confidentiality of co data, done by statistical agent

Selecting Credibility Method

The total variance of an observation from the mean over all companies is the sum of two different sources of variation, which are:

- Within a company, the variation of the observation about that company's mean.
- The variation of each company's mean about the overall mean.

Naming the variances

- These variances encountered in Analysis of Variance where they are called the within and between variances.
- In credibility applications they are called
 - Process variance
 - Variance of the hypothetical means

How the variances are used

- Limited Fluctuation Credibility
 - Uses only the process variance
 - The smaller the process variance, the more accurate observations from that company are
 - Therefore, need only data from the company being analyzed.
 - By ignoring the other variance, the accuracy of the value that is multiplied by $1 - Z$ is not taken into account.

How the variances are used

- Buhlmann Credibility
 - Uses both variances
 - Estimation of the variance of hypothetical means requires data from many companies
 - As with Limited Fluctuation, small process variance implies more credibility for the company's data
 - Small variance of the hypothetical means implies more credibility for the overall mean

Estimating the variances

- For mortality or lapse data, the observations are Bernoulli trials and thus estimates of the variance are straightforward.
- Adjustments are needed when lives are not observed for a full year
- For Buhlmann Credibility, the average process variance over all companies is used for each company.

Estimating the variances

- Variance of the hypothetical means
 - It is tempting to use the sample variance of the individual companies mortality ratios
 - This overstates the variance (because the process variance also impacts these numbers)
 - No satisfactory solution (other than a true Bayesian approach) has been found
 - Correcting by subtraction implies negative estimates are possible (use zero in that case)

VM-20: For 30 or greater deaths in credibility set of mortality segments

Determine prudent estimate mortality by:

1. Selecting credibility method
2. **Selecting industry basic table (UCS method)**
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Selecting industry basic table (UCS method)

- For VM-20, use industry basic table selected by UCS method as expected mortality basis for the Limited Fluctuation and Bühlmann empirical Bayesian methods
- Examples in this talk use the 2001 VBT as expected mortality basis because 2008 VBT results were not available
- Credibility methods work with any expected mortality basis

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Determine Mortality from Experience Studies and Credibility Method

The following report will be on the SOA website:

‘Application of Credibility to Company Lapse and Mortality Experience’ by Klugman, Rhodes and Purushotham

The report contains:

- Derivation of Formulas

- Applied to overall mortality and lapse experience for 10 cos in SOA 2004-05 experience study

- Results in paper and Excel sheets

- Step by step process shown in appendices

Determine Mortality from Experience Studies and Credibility Method

Limited Fluctuation, Bühlmann empirical Bayesian methods applied to Nonsmoker Preferred Class Structure of 2 (NS PCS 2)

Experience from:

- 7 companies in SOA 2004-05 experience study
- Large, medium and small companies
- Only a portion of each company's data used to maintain individual company confidentiality

NS Preferred Class Structure of 2 (NS PCS 2)

Limited Fluctuation Method

Overall 2001 VBT A/E Ratio by Amount	Company	Company 2001 VBT A/E Ratio by Amount	Credibility Factor Z	Number of Deaths	Limited Fluctuation A/E Ratio by Amount
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%

NS Preferred Class Structure of 2 (NS PCS 2)

Bühlmann empirical Bayesian Method

Overall 2001 VBT A/E Ratio by Amount	Company	Company 2001 VBT A/E Ratio by Amount	Credibility Factor Z	Number Of Deaths	Buhlmann empirical Bayesian A/E Ratio by Amount
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%

Credibility methods – Limited Fluctuation & Bühlmann empirical Bayesian

- For the NS PCS 2 mortality data by amount studied, the Bühlmann empirical Bayesian method assigns to a company's results a level of credibility higher than assigned by the Limited Fluctuation method
- The same conclusion was reached when examining overall mortality data by amount.

VM-20: For 30 or greater deaths in credibility set of mortality segments

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Determine Margin

Refer to:

- VM-20 provisions
- Study on SOA website ‘Analysis of Methods for Determining Margins for Uncertainty under a Principle-Based Framework for Life Insurance and Annuity Products’

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Application of Credibility Methods to Lapse

- Used term policies in the NS PCS 2 for the 7 companies studied for mortality
- Recent LIMRA study is basis for expected lapse
- Principles-Based Valuation Considerations for lapse and other policyholder behavior items

Term Lapse for NS PCS 2

Limited Fluctuation Method

Overall LIMRA A/E Ratio by Amount	Company	Company LIMRA A/E Ratio by Amount	Credibility Factor Z	Number of Lapses	Limited Fluctuation A/E Ratio by Amount
150.1%	B	130.9%	0.822	1,069	134.3%
150.1%	D	123.8%	0.091	30	147.7%
150.1%	E	97.3%	1.000	1,221	97.3%
150.1%	F	112.1%	0.263	95	140.1%
150.1%	H	174.8%	1.000	15,540	174.8%
150.1%	I	142.8%	1.000	7,966	142.8%
150.1%	J	73.7%	1.000	994	73.7%

Term Lapse for NS PCS 2

Bühlmann empirical Bayesian Method

Overall LIMRA		Company LIMRA	Credibility		Bühlmann empirical Bayesian	
A/E Ratio		A/E Ratio	Factor	Number	A/E Ratio	
by Amount	Company	by Amount	Z	Of Lapses	by Amount	
150.1%	B	130.9%	0.982	1,069	131.3%	
150.1%	D	123.8%	0.390	30	139.8%	
150.1%	E	97.3%	0.985	1,221	98.1%	
150.1%	F	112.1%	0.826	95	118.7%	
150.1%	H	174.8%	0.998	15,540	174.8%	
150.1%	I	142.8%	0.997	7,966	142.8%	
150.1%	J	73.7%	0.988	994	74.7%	

Credibility methods – Limited Fluctuation & Bühlmann empirical Bayesian

- For the Term lapse data by amount for policies in the NS PCS 2, the Limited Fluctuation method assigns to a company's results a level of credibility similar to that assigned by the Bühlmann empirical Bayesian method.
- The same conclusion was reached when examining overall lapse data by amount.

Application of Credibility Methods to Lapse

Principles-Based Valuation Considerations for lapse and other policyholder behavior items

- No standard tables
- Taking into account factors:
 - Interest rate environment
 - Policy provisions
 - Other
- Need for more work on Policyholder Behavior data format in VM-51

Summary

- Variability of Co Results around Industry-wide Mortality
- VM-20 - Determine prudent estimate mortality :
 1. Selecting credibility method
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 5. Use credibility mortality plus margin to select industry basic table with higher mortality
- Examples using Preferred Mortality and Term Lapse rates

Questions?

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