Components of Basis Risk

Attachment 1

Valuation Table vs. Company Mortality

- Prescribed statutory valuation mortality may not be conservative enough for all business
- AAT Testing already covers this risk

Company Mortality Experience Assumption vs. True Company Mortality Basis

I. **Credibility Risk—**difference between the true underlying mortality basis and company experience due to the limited amount of experience data. Size of this risk declines as the quantity of experience increases

II. **Volatility of True Mortality**—true underlying mortality rates have volatility and change from year to year even with fully credible data

III. **Mortality Trend Adjustment—**mortality experience over a multi-year period must be translated to a base table year using a mortality improvement assumption. Basis risk will result to the extent this assumed improvement differs from actual underlying improvement.

I. Credibility Risk

- Full credibility is often defined as 95% confidence that an assumption is within 5% of the true value
- Some error margin always exists even with long experience from a fully credible block of business
- Figures below use Longley-Cook credibility formula to estimate this error margin
- Adjusted for credibility by amount of insurance in force using data underlying the 2012 IAM table development

	One-sided confidence interval for μ				
# of Deaths	85%	95%	99%		95th - 85th
250	14.0%	22.2%	31.4%		8.2%
500	9.9%	15.7%	22.2%		5.8%
1,082	6.7%	10.7%	15.1%		4.0%
3,000	4.0%	6.4%	9.1%		2.4%
10,000	2.2%	3.5%	5.0%		1.3%
100,000	0.7%	1.1%	1.6%		0.4%
200,000	0.5%	0.8%	1.1%		0.3%

II. Volatility of True Mortality

- This results from year-to-year volatility in true population mortality rates in the experience study period
- Using data and analysis from the LRTF's prior work on trend risk, the annual volatility of population mortality in the U.S. is 2.9% at 1 standard deviation
- This result is scaled to multi-year experience periods using the assumption that each years' volatility is independent
- Longer experience periods will reduce this risk component as the impact of volatility in any single year is diminished

Volatility of Underlying Population Mortalitiy Rate μ								
Annual volatility of mortality rate (improvement rate) from trend risk work:								2.9%
# of Exp Yrs	85%	95%	99%		95th - 85th			
1	3.0%	4.8%	6.7%		1.8%			
3	1.7%	2.8%	3.9%		1.0%			
5	1.3%	2.1%	3.0%		0.8%			
10	1.0%	1.5%	2.1%		0.6%			

III. Trend Adjustment

- Risk results from differences between actual and assumed mortality improvement during the experience period that is used to adjust mortality experience to the base table effective date
- Quantification uses mortality trend stress work previously completed by group (aggregate M/F results across all ages based on the normal model at 85th and 95th percentile relative to mean improvement)
- Trend stress is applied for ½ of the experience period—trending from the mid-point of the experience period to the end point
- Longer experience periods will increase this component as the possibility for error in trending older experience to the valuation date increases

Mortality Trend Adjustment							
Trend Stress:	0.38%	0.60%	(from Trend Stress work, normal model)				
# of Exp Yrs	85%	95%			95th - 85th		
1	0.2%	0.3%			0.1%		
3	0.6%	0.9%			0.3%		
5	1.0%	1.5%			0.6%		
10	1.9%	3.0%			1.1%		

Aggregate Basis Risk

Attachment 1

- The three components are independent, so aggregate basis risk measured as (A2 + B2 + C2) ½
- Overall risk is not that sensitive to the length of experience period given the trade-off between Annual Volatility and Trend Adjustment as the experience period lengthens.
- Credibility adjustment declines with experience, but aggregate basis risk quickly becomes dominated by components B and C for large blocks of business.
- Aggregate basis risk is independent of mortality trend risk

# of Exp Yrs:	3	3	3		5	5	5		10	10	10
# of Deaths	500	3,000	100,000		500	3,000	100,000		500	3,000	100,000
I. Credibility	5.8%	2.4%	0.4%		5.8%	2.4%	0.4%		5.8%	2.4%	0.4%
II. Volatility	1.0%	1.0%	1.0%		0.8%	0.8%	0.8%		0.6%	0.6%	0.6%
III. Trend Adjustment	0.3%	0.3%	0.3%		0.6%	0.6%	0.6%		1.1%	1.1%	1.1%
Total Basis	**5.9%**	**2.6%**	**1.1%**		**5.9%**	**2.6%**	**1.0%**		**5.9%**	**2.7%**	**1.3%**

Result is a qx aggregate basis risk stress event ranging from approximately 1% to 6% depending on block size

Field Study

- While we have performed simple testing in Excel, the LRTF suggests that the NAIC Longevity Risk Subgroup (LRSG) conduct a study to evaluate results of applying the agreed upon approach to actual company blocks of business
- LRTF has developed instructions and a template to be completed to enable LRSG to conduct a field study on individual and group annuities
- Request Dec. 31, 2016 statutory CARVM reserve amounts calculated on the 3 assumption bases, under a range of valuation interest rate, issue age, duration since issue, and gender combinations

Field Study Details (Initial Draft)

Attachment 1

Run A – 2016 CARVM Valuation Basis (assumed to be 85th percentile)

- 2012 IAM Table (1994 GAR for Group business)
- Projection Scale G2 (Projection Scale AA for Group business)

Run B – 95th Percentile Stress – basis risk

- 2012 IAM Table (1994 GAR for Group business), all rates adjusted for our defined basis risk stress event (99%, 97%, or 94%, depending on block size)
- Projection Scale G2 (Projection Scale AA for Group business)

Run C – 95th Percentile Stress – trend risk

- 2012 IAM Table (1994 GAR for Group business)
- Projection Scale G2 (Projection Scale AA for Group business), all improvement factors adjusted for our defined trend stress event (0.25%/0.50% stress)

$$\text{Capital} = [(\text{Run B} - \text{Run A})^2 + (\text{Run C} - \text{Run A})^2]^{1/2}$$

Next Steps

- Questions for LRSG
  - Does approach for basis risk make sense?
  - Should the charge vary by block size?
- Conduct field study and evaluate results
- Determine approach to correlation with other risks (most significantly, C2)
- Continue to evaluate approach for a potential RBC charge for lifetime income benefits

Appendix

Prior Update provided to Life Risk Based Capital Committee (NAIC Summer Meeting)

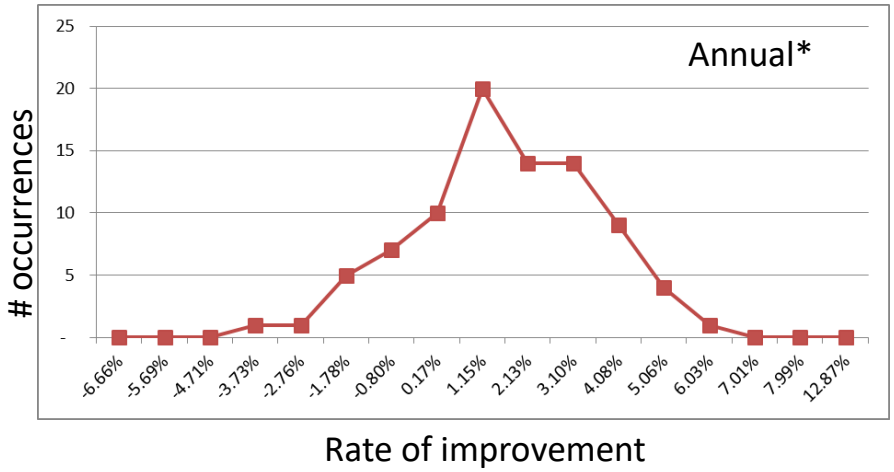
Determining Trend Risk Tail Event

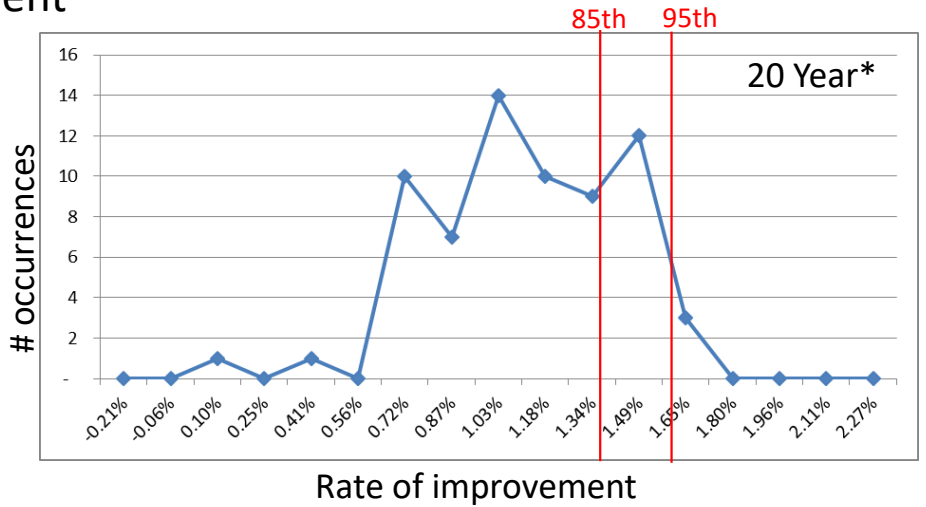
- LRTF analyzed historical population data over the period 1900-2013 using Social Security population data
- Calculated 1-, 5-, 10-, 20-, and 40-year rates of improvement by age bucket and gender
- Fit historical improvement data to a normal distribution to evaluate use of a normal model
- Developed a 95th percentile improvement event, focused on the 20-year historical period (which is conservative vs. current RBC's typical 5-10 year horizon)
- Evaluated difference between 95th percentile and 85th percentile for use in RBC

Distribution of Mortality Improvement Data

Attachment 1

Below is the distribution of annual and 20-year mortality improvement data from 1940-2013 used to develop the shock event





*Annual is improvement over historical one-year periods

*20 year is improvement over historical 20-year periods, converted to an annual rate

For more information

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