SOCIETY OF ACTUARIES

Group LTD Credibility Study

Results from Stage 1

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Section 1: Introduction

In 2013, the Society of Actuaries Health Section published a report on credibility applications in group long term disability insurance (www.soa.org/resources/research-reports/2013/research-2013-iss-app-cred). The report discusses credibility applications in pricing, rate making, and valuation, and features results from a survey of group long-term disability (LTD) insurers on how they use credibility. It also includes a bibliography of papers, reports and other sources that specifically address credibility applications across all group insurance products. The report observed that the existing theory represented in the literature was based on independent variables, and there was little to guide applications for insurance benefits like group LTD that include non-independent variables. There was also little underlying theory or practical applications discussed in the existing literature to help evaluate whether a particular approach was "better" or "worse" for a given purpose. The survey results contained in the report are particularly interesting because they reveal that the methods for applying credibility vary widely across the LTD industry.

The primary objective of the Group Long-Term Disability Credibility Experience Study is to give actuaries practical information and guidance on LTD claim credibility for case level pricing and underwriting. It is not intended to support other credibility applications for LTD including the development of underlying base rates or the development of experience-based adjustments to industry tables for valuation purposes. As noted in the 2013 report, traditional credibility methods may not be applicable in the pricing of LTD insurance due to group dynamics (e.g. non-independent claims) and variable benefit payment patterns. Actuaries who work with LTD benefits often have to make special considerations for applying credibility in their work.

Furthermore, traditional approaches to credibility have concentrated largely on statistical variance—the degree to which historical experience differs from a hypothetical "true" expected value (which is unknown). However, credibility applications in LTD require additional considerations such as experience drift (changes in experience driven by the passage of time, such as changes in industry experience, changes in company practices, etc.) and modeling bias (degree to which the hypothetical "true" expected values differ from modeled expected values). Therefore, actuaries who work with LTD benefits should not only recognize the limitations of traditional credibility methods, but they should also recognize the multiple sources of variance that can impact credibility in LTD.

In this study, researchers tested the correlation of historical experience to future experience by modeling claim cost ratios calculated from industry data. Two different approaches were used for testing the predictive quality of LTD experience:

- Approach 1: Correlation Coefficients

  This approach involved an application of statistical methods discussed in the paper "On the Credibility of Group Insurance Claim Experience" by Myron Margolin[1]. Industry data was

[1] • Myron H. Margolin, On the Credibility of Group Insurance Claim Experience, Transactions of the Society of Actuaries, 1971, Vol. 23 Pt. 1 No. 67

used to compute correlation coefficients between experience from an initial period (e.g., three consecutive years) and a subsequent period (e.g., the next two consecutive years).

- Approach 2: Relative Errors

  This approach involved calculating the relative error between historical LTD experience and experience from a subsequent period. The relative errors were calculated at the policy level and then grouped by life years of exposure (LYE) to observe how the average relative error changes with increasing LYE.

The analyses were performed using experience from LTD policies inforce for at least five consecutive years between January 1, 2004 and December 31, 2011. This data was supplied by 14 disability insurers who participated in the study, and included 300,020 LTD claims incurred between January 1, 2004 and December 31, 2011. A list of the 14 study participants is provided in Section 2 of this report.

The correlation coefficients and relative errors are based on incurred claim cost ratios. Covered payroll was used as the exposure basis in the denominator of the claim cost ratio. In the numerator, claim costs were calculated as the present value of expected payments on each claim, as of the end of the elimination period, using the 2012 GLTD Basic Table, the gross benefit amount payable under the policy with no offsets, and a 3.5% interest rate assumption.

Any reader of this report should keep in mind that the results presented in this report do not give specific guidance on the level of credibility that should be assumed for pricing LTD cases. The results are more informative when interpreted as relativities as opposed to absolute values. For instance, the results in Section 4 of this report demonstrate that the correlation between LTD experience from two periods depends on several factors, such as life years of exposure, incidence rates, etc. While these results can be useful in forming an opinion of the type of experience and characteristics that are most predictive, they should not be translated directly into credibility estimates.

Readers should also keep in mind that this study focused primarily on measuring the predictive attributes of LTD experience in the absence of a prior estimate (i.e. manual rate). However, credibility applications in the pricing of LTD cases are designed to minimize the variance of future claim costs versus a prior estimate made up of blending a manual rate and observed experience. Therefore, as applied in practice, credibility is not only a function of the predictive power of past experience, but also a function of the quality and accuracy of the manual rate.

Finally, because claim costs were calculated based on expected future benefit payments and with no offsets, the correlation coefficients may be overstated because these claim cost estimates ignore the volatility associated with actual termination rates and LTD benefit patterns. In Section 4 of this report, the results of a waterfall analysis are provided which illustrate the impact of reflecting actual claim terminations in the claim cost calculations. The results also show the impact of assuming a $1 monthly benefit amount for all claims versus the actual gross monthly benefit amount.

Section 2: Acknowledgements and Resources

2.1 Participating Companies

The Society of Actuaries would like to thank the following 14 companies who contributed data to this study:

- AIG
- Anthem
- Cigna
- Guardian
- Liberty Mutual
- MetLife
- Mutual of Omaha
- Northwestern Mutual
- OneAmerica
- Prudential
- Reliance Standard
- Standard
- The Hartford
- Unum

2.2 Group LTD Credibility Study Committee

The SOA extends its gratitude to the Group LTD Credibility Study Committee for designing the project, overseeing the analyses, and authoring and peer reviewing this report. The Group LTD Credibility Study Committee members are:

- Avtar Singh, FSA, MAAA
- Bram Spector, FSA, MAAA
- Jiayu Guo, FSA, MAAA
- Jinn Lin, FSA, MAAA
- Julie Shuman, FSA, MAAA
- Kari Stokely, FSA, MAAA
- Mark Mortensen, FSA, MAAA
- Matthew Desfosses, ASA, MAAA
- Rick Leavitt, ASA, MAAA
- Scott Carter, FSA, MAAA
- Tom Corcoran, FSA, MAAA (Co-chair)
- Warren Cohen, FSA, MAAA (Co-chair)
- Zheng Bai, FSA, MAAA

2.3 Other Resources

The SOA contracted with MIB's Actuarial and Statistical Research Group to collect, validate, and compile the data for this report. Also Erika Schulty, SOA Research Associate, and Pete Miller, SOA Experience Studies Actuary, supplied project management support. Significant analytical support was provided by Adelina Koseva, an actuarial assistant at Milliman.

Section 3: Executive Summary

This section contains a summary of the key findings from the LTD Credibility Study, which are discussed in greater detail in other sections of this report. Unless specifically stated otherwise, the results below are based on life years exposed and claim costs that reflect gross benefit amounts and expected claim termination rates as of the end of the elimination period.

Correlation Coefficients

- Correlation coefficients measure the extent to which the cost of LTD claims in a "lookback period" (e.g., 3 years) is correlated to the cost of LTD claims in a "subsequent period" (e.g., 2 years). The correlation coefficients generally increase with life years of exposure (LYE) up to about 5,000 LYE. Beyond this point, the correlation coefficients increase at a much slower rate, or in some cases level off, reaching maximum values in the range of 80% to 90%. Note that this does not imply that experience which includes 5,000 LYE is 80% to 90% credible, as discussed in the introduction of this report.

- Higher correlation coefficients were observed when the experience in the lookback and subsequent periods was based on claim incidence only, versus total incurred claim costs. For example, for groups whose experience includes 5,000 to 7,499 LYE, the correlation coefficients were 80% when based on claim incidence only and 65% when based on total claim costs (see Table 1.c). In general, the coefficients follow a hierarchy that suggests LTD credibility is impacted by variable benefit amounts and actual claim terminations. Furthermore, in a separate test, higher correlations were observed from groups whose experience included higher incidence rates.

- The correlation coefficients vary by length of lookback period and by length of the gap between lookback and subsequent experience periods. In general, correlation coefficients are higher when the experience is based on a shorter lookback period and a shorter gap (or no gap) between the lookback and subsequent periods, suggesting that more recent experience is more credible for predicting future experience. For example, the results of Test 1.a imply that one year of experience for a 4,000 life group demonstrates higher correlation than four years of experience for a 1,000 life group. However, for a particular case size, results show greater correlations for longer lookback periods (which increase LYE) as shown in Table 1.b.

- The correlations are relatively low for groups in Finance, Insurance, and Real Estate industries relative to the other industries. However, when volatility from variable benefit amounts was eliminated (by restating claim costs using a $1 gross benefit amount for all claims), the correlation coefficients were more similar among different industries. This result suggests that credibility may be impacted by a greater variability in benefit amounts and/or a higher prevalence of large outlier claims from groups in the Finance, Insurance, and Real Estate industry segment.

- The correlation coefficients tend to be higher for LTD experience corresponding to coverage that is either partially or 100% employee-paid, which may be partly due to higher claim incidence rates often observed on contributory policies.

Relative Error

- The relative error between experience from a lookback period and subsequent period generally decreases as LYE increases, which is consistent with the pattern seen in the correlation coefficients. A similar slope was also observed, where the relative error is decreasing rapidly up to 5,000 LYE and then decreases at a much slower rate.

- Even at the highest LYE groups, the relative error between historical experience and subsequent experience does not drop below 26%. This confirms that there is significant volatility in LTD claim experience, even when the group is large and where most carriers would currently assign full credibility. This may be an indication of volatility arising from experience drift or other issues beyond mere statistical fluctuation.

- An interesting result emerged when studying the relative error as a function of credibility and LYE group. These results are presented in Table 14. The results presented illustrate a process of minimizing the relative error between the case rate (i.e. credibility weighted average of manual and experience rates) and future experience for each LYE group. For this purpose we used a simplified approach to establish a manual rate, using industry experience from 2004 through 2011. For lower LYE groups, a lower credibility factor is found to minimize error, and the optimal credibility weighting increases with increasing LYE. This result reminds us that volatility and credibility are two separate concepts, and that assigning high levels of credibility to prior experience may still be optimal for larger groups, despite the underlying volatility of LTD claims experience.

Section 4: Correlation Coefficient Analysis

4.1 Analytical Methods

LTD underwriting typically includes experience rating methods in which the group's experience from a lookback period (usually three to five years) combined with a prior estimate (manual rate) is used to estimate future experience. The credibility assigned to the historical experience is a key factor in the experience rating process. However, because traditional credibility formulas may not be appropriate for group LTD insurance, actuaries are faced with the question of the degree to which experience from the lookback period is correlated to future experience.

This section of the report provides results from an analysis of correlation coefficients corresponding to LTD claim cost ratios from a lookback experience period and a subsequent period. Correlation coefficients are unitless measures of the linear association between two variables and they do not imply causation.

Specifically, the correlation coefficients were calculated as follows[2]:

$$Correlation\ Coefficient = \frac{Cov(CC1,CC2)}{\sigma(CC1)\cdot\sigma(CC2)}$$

In the above equation Covariance represents the expected value of the product of deviations of CC1 and CC2 from their respective population means. CC1 represents the claim cost ratio from the lookback experience period, and CC2 represents the claim cost ratio corresponding to a subsequent experience period, where claim cost ratios were calculated at the policy level. Expected values (population means of E(CC1) and E(CC2)) were calculated separately for each LYE segment based on the weighted average claim cost ratio for all policies included in that segment. The LYE segment was determined from life years in the lookback period for each policy.

Covariance was calculated as follows:

$$Cov(CC1,CC2) = \sum_{i=1}^{n} \frac{(CC1_i - E(CC1)) \times (CC2_i - E(CC2))}{n-1}$$

And standard deviations as follows:

$$\sigma(CC1) = \sqrt{\sum_{i=1}^{n} \frac{(CC1_i - E(CC1))^2}{n-1}}$$

$$\sigma(CC2) = \sqrt{\sum_{i=1}^{n} \frac{(CC2_i - E(CC2))^2}{n-1}}$$

[2] Various weighting methods were considered and tested for calculating the correlation coefficients reflected in this report. Results are implicitly weighted on covered payroll, which we determined to be a reasonable approach for this purpose.

Claim costs were calculated as the present value of expected payments on each claim, as of the end of the elimination period, using the 2012 GLTD Basic Table with no offsets and a 3.5% interest rate assumption. This approach ensures that claim costs are calculated consistently for every claim in the study, and are not biased by different approaches for calculating incurred claims among companies that participated in the study, nor by different claim management practices among those companies. We recognize, however, that the use of expected termination rates may overstate correlation coefficients by ignoring the volatility associated with actual termination rates. To assess the impact of this approach, we performed a test (Test 1.c described below) in which we reflected actual terminations in the claim cost calculations and then compared the corresponding correlation coefficients to those computed using expected terminations. Not surprisingly, the correlation coefficients were lower when claim costs reflected actual claim terminations. This is an important result to keep in mind when interpreting other results from this section.

We excluded data from groups whose plan design changed within the study period to ensure meaningful and unbiased comparisons between lookback and subsequent experience periods. Also, certain groups were excluded from the study if there were data quality issues that could impact study results, such as illogical exposure patterns or missing data.

The following tests were performed using the approaches described above (unless explicitly stated otherwise in the description):

- Test 1.a – Test whether longer lookback periods demonstrate higher correlation than shorter periods, or vice versa (lookback periods ranging from 1 to 5 years). Results summarized by LYE group.

- Test 1.b – Similar to Test 1.a (i.e. whether longer lookback periods demonstrate higher correlation than shorter periods), but results are summarized by case size.

- Test 1.c – Test the impact of claim incidence, variable benefit amounts, and duration on the correlation coefficients.

- Test 2 – Test the impact of including a gap between the lookback and subsequent periods (no gap, 1 year, 2 years, 3 years and 4 years).

- Test 3 – Test whether more recent experience demonstrates higher correlation than older experience, or vice versa.

- Test 4 – Test experience across different calendar periods using experience from 2004-2008 versus 2005-2009 versus 2006-2010 versus 2007-2011.

- Test 5 – Test whether shorter elimination periods demonstrate higher correlation than longer elimination periods, or vice versa.

- Test 6.a and 6.b – Test whether the experience from certain industries demonstrates higher correlation than other industries.

- Test 7 – Test whether the experience from certain geographical regions demonstrates higher correlation than other regions.

- Test 8.a and 8.b – Test whether experience from groups with higher incidence rates demonstrates higher correlation than experience from groups with lower incidence rates, or vice versa.

- Test 9 – Test whether the experience from employee-paid coverage demonstrates higher correlation than employer-paid.

- Test 10 – Test whether the experience from policies integrated with STD demonstrates higher correlation than non-integrated policies.

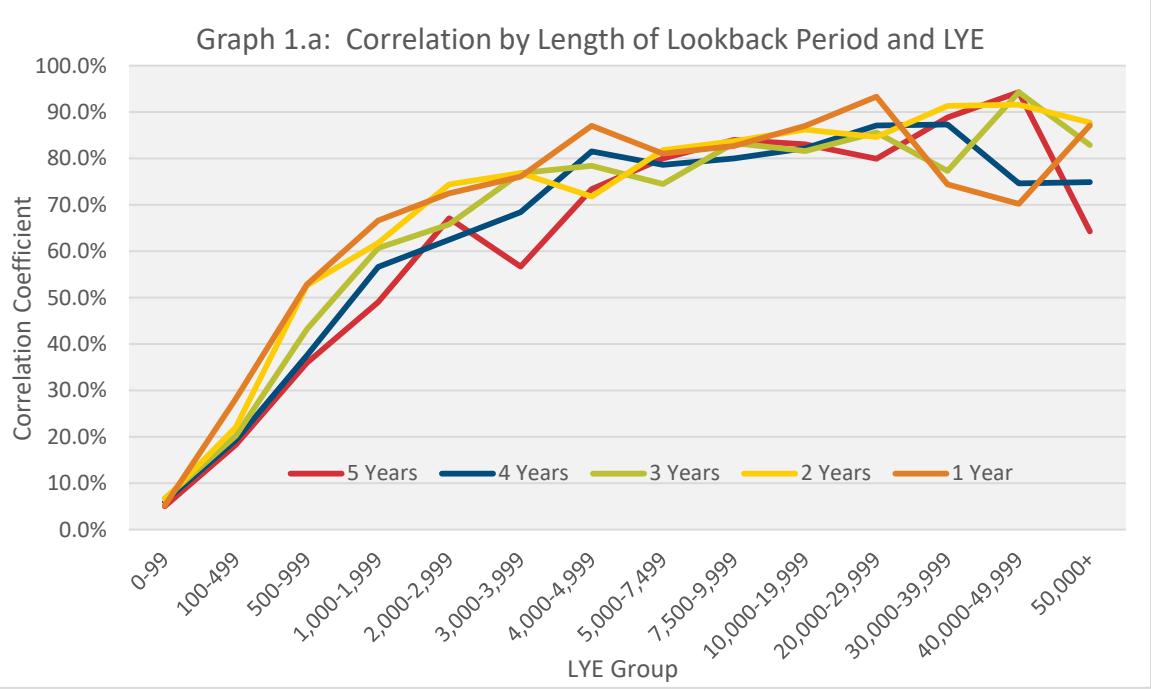
The results from these tests are shown below in Section 4.2. The results have also been provided in the Appendix (Group LTD Credibility Study Stage 1 – Appendix.xlsx) in greater detail, by including additional information such as exposures and confidence intervals with suggested upper and lower bounds for interpreting results. The confidence intervals are estimated using a Fisher transformation. Additional details of the calculation are included on the 'Formulas' tab of the Appendix.

4.2 Test Results

Test 1.a

The following table shows correlation coefficients based on LYE segment and length of lookback period, ranging from one to five years. The length of the subsequent period is two years in every case, and there is no gap between lookback and subsequent periods. Policies were grouped by LYE segment based on total exposure in the lookback period.

Table 1.a: Correlation Coefficients by Length of Lookback Period and Life Years of Exposure					
Lookback period	5 Years	4 Years	3 Years	2 Years	1 Year
Subsequent period	2 Years	2 Years	2 Years	2 Years	2 Years
LYE					
0-99	5.0%	6.1%	6.7%	6.5%	5.2%
100-499	18.3%	19.3%	20.2%	22.1%	28.2%
500-999	35.9%	37.5%	43.2%	52.6%	52.8%
1,000-1,999	49.0%	56.6%	60.7%	61.8%	66.6%
2,000-2,999	67.1%	62.5%	65.8%	74.4%	72.5%
3,000-3,999	56.7%	68.4%	76.8%	76.8%	76.1%
4,000-4,999	73.4%	81.5%	78.4%	71.8%	87.0%
5,000-7,499	80.0%	78.6%	74.5%	81.8%	81.0%
7,500-9,999	84.0%	80.0%	83.3%	83.7%	82.7%
10,000-19,999	83.0%	82.2%	81.6%	86.2%	87.0%
20,000-29,999	79.9%	87.1%	85.6%	84.6%	93.3%
30,000-39,999	88.8%	87.3%	77.3%	91.3%	74.4%
40,000-49,999	94.3%	74.6%	94.3%	91.6%	70.2%
50,000+	64.3%	74.9%	82.9%	87.7%	87.1%

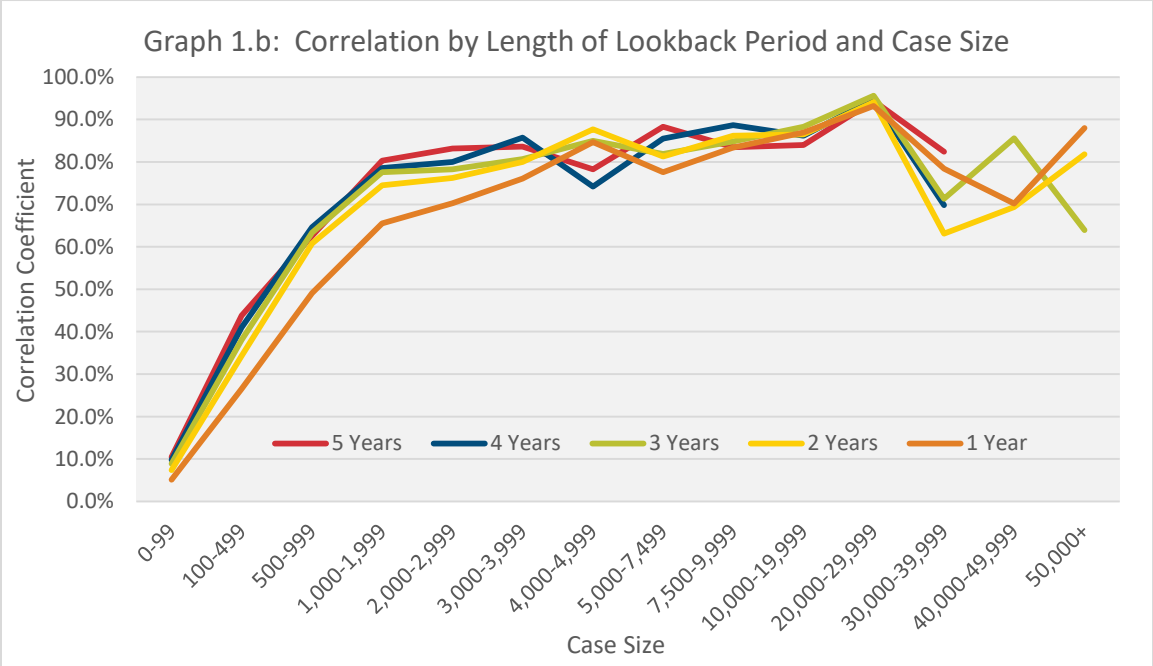


The correlation coefficients increase rapidly with increasing life years of exposure up to about 5,000 LYE, then they follow a less predictable pattern. Generally speaking, the correlations are higher for shorter lookback periods. Note that the LYE groups are recalculated for each column in Table 1.a based on the length of the lookback period. This test therefore implies that one year of experience for a 4,000 life group demonstrates higher correlation than four years of experience for a 1,000 life group. The results corresponding to the groups of 30,000 LYE and greater are more volatile because exposure (i.e., the number of policies represented) in these segments is relatively low (see Appendix for exposures and confidence intervals).

Test 1.b

To see how results vary when correlations are based on case size rather than LYE, Test 1.a was repeated and results were summarized by case size, which represents the number of covered employees reported in the last year of the lookback period. These results are shown below.

Table 1.b: Correlation Coefficients by Length of Lookback Period and Case Size					
Lookback period	5 Years	4 Years	3 Years	2 Years	1 Year
Subsequent period	2 Years	2 Years	2 Years	2 Years	2 Years
Case Size					
0-99	10.5%	9.8%	8.9%	7.4%	5.1%
100-499	43.8%	41.0%	38.1%	34.3%	26.5%
500-999	62.6%	64.6%	63.3%	60.8%	49.1%
1,000-1,999	80.3%	78.6%	77.6%	74.5%	65.5%
2,000-2,999	83.2%	80.0%	78.3%	76.2%	70.3%
3,000-3,999	83.6%	85.7%	80.7%	80.0%	76.1%
4,000-4,999	78.3%	74.2%	85.0%	87.7%	84.7%
5,000-7,499	88.3%	85.5%	81.9%	81.3%	77.6%
7,500-9,999	83.5%	88.7%	84.8%	86.2%	83.4%
10,000-19,999	84.0%	86.2%	88.3%	86.5%	86.9%
20,000-29,999	94.4%	94.8%	95.6%	94.1%	93.2%
30,000-39,999	82.4%	69.8%	71.3%	63.1%	78.4%
40,000-49,999	N/A	N/A	85.6%	69.4%	70.2%
50,000+	15.9%	25.3%	63.9%	81.8%	88.0%



The patterns seen in Graph 1.a are reversed in Graph 1.b. When we switch to groupings by case size, the 4,000 case size group now represents 4,000 LYE for the one-year lookback period, and 16,000 LYE for the four-year lookback period. In general, correlation coefficients in this test are higher for smaller case sizes when the experience is based on a longer lookback period, which

corresponds to higher LYE. Note that the exposure for larger case size segments is very low, and the results for these groups are volatile.

Test 1.c

To explore the impact of separate components of variability in clam experience (such as claim incidence and duration), we began Test 1.c by calculating correlation coefficients based only on claim incidence. We then layered on additional components of variability in a waterfall analysis. Each layer of this waterfall analysis is described below:

1. Incidence Rate: Correlation of incidence rates from lookback and subsequent periods;

2. $1 Gross Benefit and Expected Terminations: Correlation of claim cost ratios from lookback and subsequent periods, in which claim costs were calculated using a $1 benefit amount and expected claim termination rates from the 2012 GLTD Basic Table for all claims;

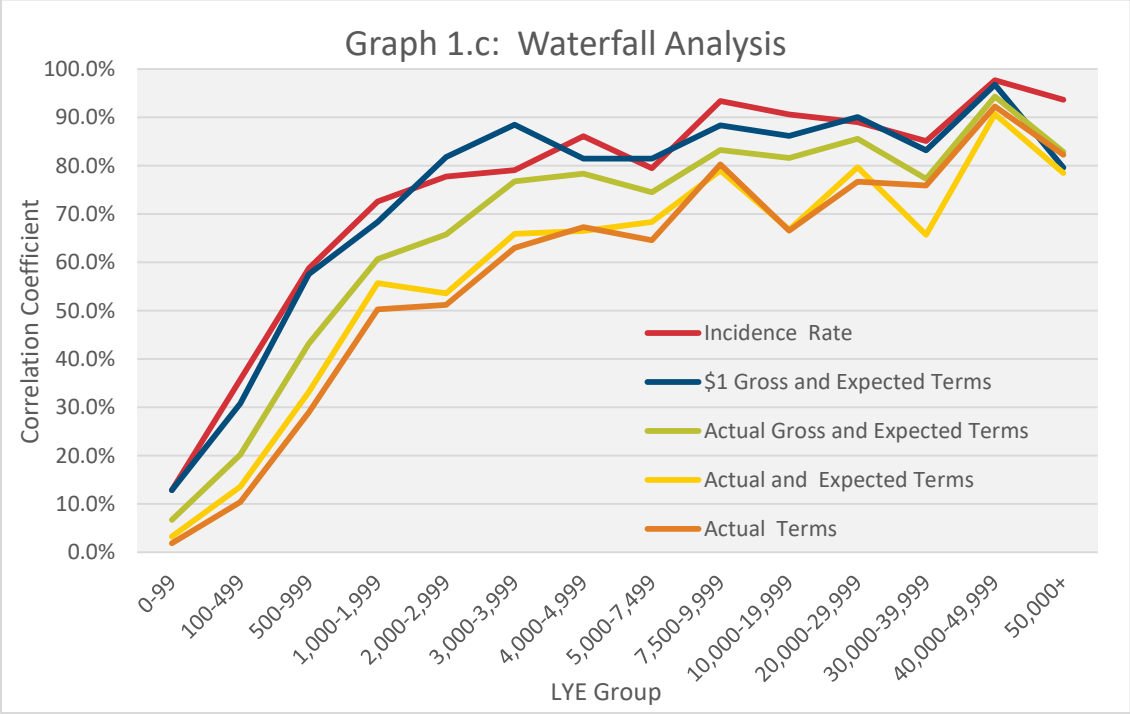
3. Actual Gross Benefit and Expected Terminations: Correlation of claim cost ratios from lookback and subsequent periods, in which claim costs were calculated using actual monthly benefit amounts and expected claim termination rates for all claims;

4. Actual Terminations (Lookback) and Expected Terminations (Subsequent): Correlation of claim cost ratios from lookback and subsequent periods, in which claim costs were calculated using actual monthly benefit amounts for all claims, and based on actual claim terminations from the lookback experience period and expected terminations for the subsequent period; and

5. Actual Terminations for Lookback and Subsequent Periods: Correlation of claim cost ratios from lookback and subsequent periods, in which claim costs were calculated using actual monthly benefit amounts and actual claim termination rates for all claims.

Each scenario was tested using a 3-year lookback experience period and 2-year subsequent experience period with no gaps in between. The same data were used in each of the tests to ensure meaningful comparisons. The results from this waterfall analysis are shown below in Table 1.c and Graph 1.c.

Table 1.c: Waterfall Analysis Correlation Coefficients Vary by Experience Basis and LYE Group					
LYE Group	Experience Basis				
	Incidence Rate	$1 Gross and Expected Terms	Actual Gross and Expected Terms	Actual and Expected Terms	Actual Terms
0-99	12.9%	12.9%	6.7%	3.3%	1.9%
100-499	35.8%	30.8%	20.2%	13.6%	10.4%
500-999	58.8%	57.6%	43.2%	33.2%	29.0%
1,000-1,999	72.6%	68.4%	60.7%	55.7%	50.3%
2,000-2,999	77.8%	81.8%	65.8%	53.6%	51.2%
3,000-3,999	79.1%	88.5%	76.8%	65.9%	63.0%
4,000-4,999	86.1%	81.5%	78.4%	66.5%	67.3%
5,000-7,499	79.5%	81.5%	74.5%	68.4%	64.6%
7,500-9,999	93.4%	88.4%	83.3%	79.0%	80.3%
10,000-19,999	90.6%	86.2%	81.6%	66.8%	66.6%
20,000-29,999	89.0%	90.1%	85.6%	79.7%	76.7%
30,000-39,999	85.1%	83.2%	77.3%	65.7%	75.9%
40,000-49,999	97.7%	96.8%	94.3%	90.7%	92.3%
50,000+	93.7%	79.6%	82.9%	78.5%	82.3%



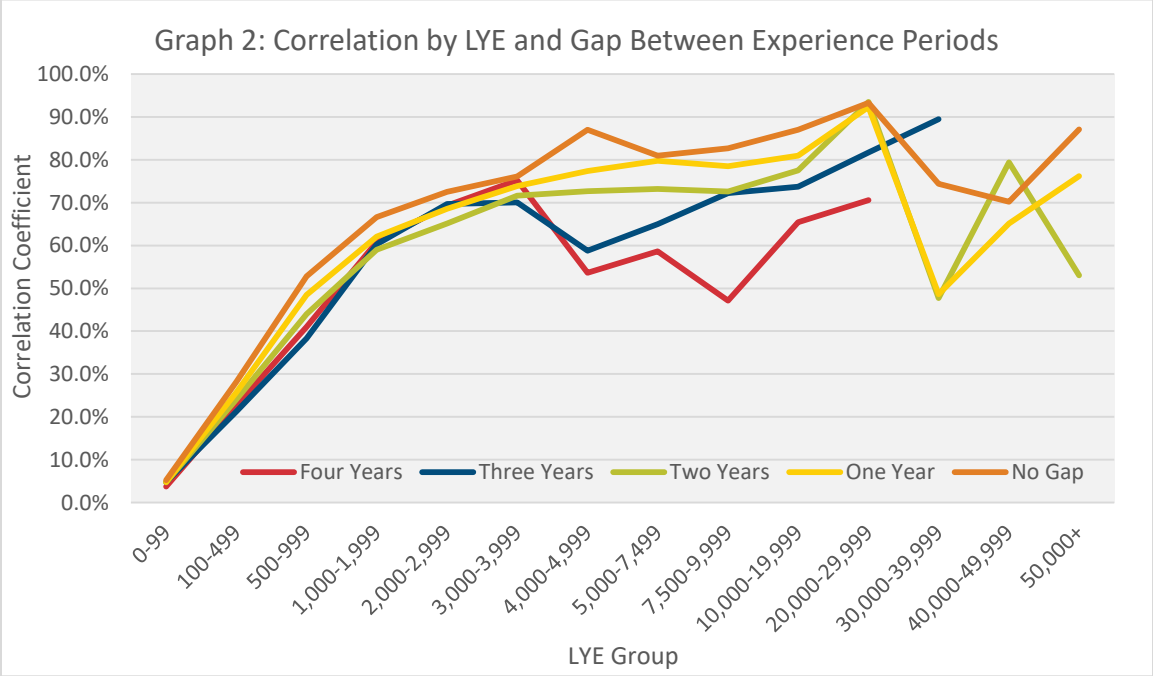
When we look at the correlation coefficients calculated using incidence rates only, we see coefficients in excess of 90% for many of the larger LYE groups. Adding expected terminations in the "$1 Gross and Expected Terms" scenario decreases the correlation coefficients slightly for many LYE groups, but does not appear to produce a significant drop, as the red and blue lines in the table above are close to overlapping for many LYE groups. Including actual gross benefit

amounts drops the correlation coefficients more significantly, generally producing coefficients between 75% and 85% for most of the higher LYE groups. This suggests that variations in benefit amounts among members of a group add volatility and reduce the credibility of LTD claim experience. We observe another significant drop when we include the impact of actual claim terminations in the lookback period, further suggesting that actual claim termination experience also adds volatility and reduces credibility for LTD. In this scenario the correlation coefficients are generally between 65% and 80% for most of the higher LYE groups. Finally, including actual claim terminations in the subsequent period produces a relatively small change in the correlation coefficients.

Test 2

Test 2 is aimed at evaluating whether a gap between the lookback and subsequent periods has an impact on credibility. The correlation coefficients are shown below by LYE segment and length of gap (i.e. no gap, 1 year, 2 years, 3 years and 4 years). Note that the length of the lookback period is one year and the length of the subsequent period is two years in every case (in order to normalize results).

Table 2: Variable Length of Time Between Lookback Period and Subsequent Period					
Gap b/w Lookback Period and Subsequent Period	Four Years	Three Years	Two Years	One Year	No Gap
LYE					
0-99	3.7%	4.8%	4.7%	4.8%	5.2%
100-499	22.7%	21.3%	24.1%	25.8%	28.2%
500-999	41.0%	38.3%	44.0%	48.5%	52.8%
1,000-1,999	60.8%	60.3%	59.0%	62.1%	66.6%
2,000-2,999	69.3%	69.7%	65.1%	68.6%	72.5%
3,000-3,999	75.2%	70.1%	71.6%	73.9%	76.1%
4,000-4,999	53.6%	58.8%	72.7%	77.4%	87.0%
5,000-7,499	58.6%	65.0%	73.2%	79.8%	81.0%
7,500-9,999	47.1%	72.2%	72.6%	78.5%	82.7%
10,000-19,999	65.4%	73.7%	77.5%	81.0%	87.0%
20,000-29,999	70.6%	81.7%	93.5%	92.3%	93.3%
30,000-39,999	N/A	89.5%	47.7%	48.6%	74.4%
40,000-49,999	-99.3%	-16.4%	79.4%	65.1%	70.2%
50,000+	-48.9%	12.4%	53.0%	76.2%	87.1%

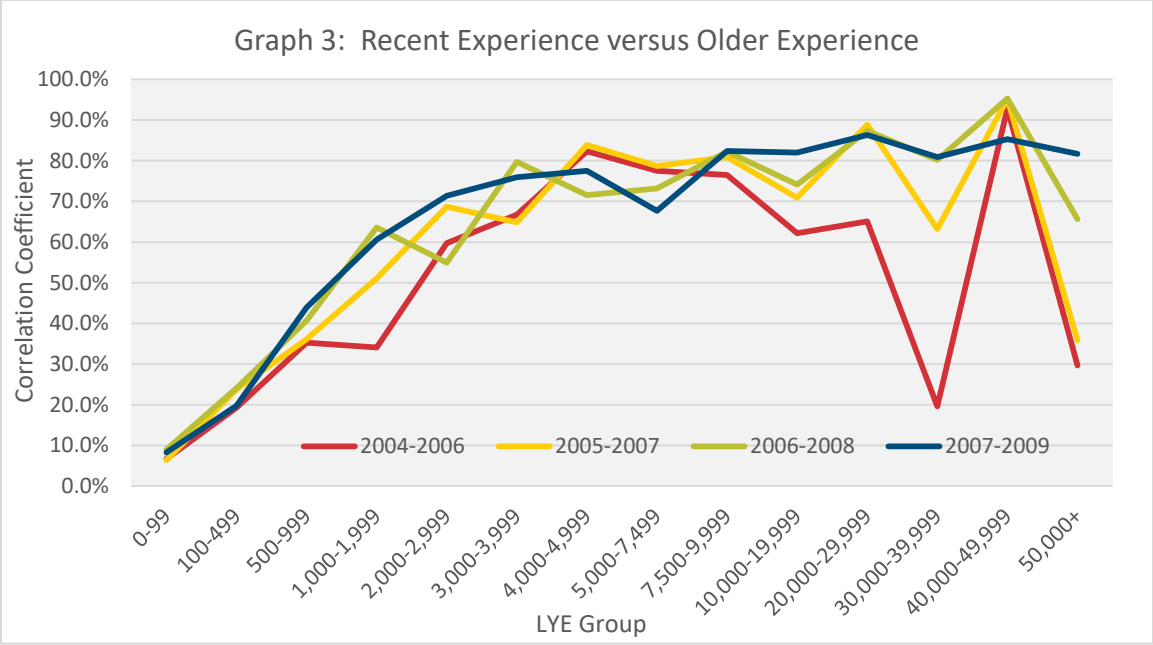


The correlation coefficients are higher and less volatile when there is either no gap or a 1-year gap between the lookback and subsequent periods, suggesting that more recent experience may be more credible than older experience. It is worth noting that exposure decreases significantly as the length of the gap increases (see 'Test 2' tab of the Appendix) which contributes, in part, to the volatility in results corresponding to 3-year and 4-year gaps.

Test 3

A similar test was performed to evaluate whether recent experience demonstrates higher correlation than older experience, in which the lookback period varies by calendar year (2004-2006 versus 2005-2007 versus 2006-2008 versus 2007-2009) and the subsequent period is always based on experience from 2010-2011. The results from this test are shown below.

Table 3: Recent Experience versus Older Experience Subsequent Period = 2010–2011 in All Scenarios				
Lookback period	2004-2006	2005-2007	2006-2008	2007-2009
Subsequent period	2010-2011	2010-2011	2010-2011	2010-2011
LYE				
0-99	6.7%	6.4%	9.0%	8.3%
100-499	19.3%	23.8%	24.1%	19.8%
500-999	35.3%	36.1%	40.7%	43.9%
1,000-1,999	34.1%	51.1%	63.6%	60.6%
2,000-2,999	59.7%	68.7%	54.9%	71.4%
3,000-3,999	66.7%	64.8%	79.7%	75.9%
4,000-4,999	82.3%	83.9%	71.5%	77.5%
5,000-7,499	77.5%	78.7%	73.2%	67.7%
7,500-9,999	76.5%	80.9%	82.2%	82.4%
10,000-19,999	62.2%	70.9%	74.1%	82.0%
20,000-29,999	65.1%	88.8%	87.3%	86.3%
30,000-39,999	19.6%	63.2%	80.2%	80.9%
40,000-49,999	92.8%	95.2%	95.3%	85.3%
50,000+	29.7%	35.9%	65.6%	81.7%

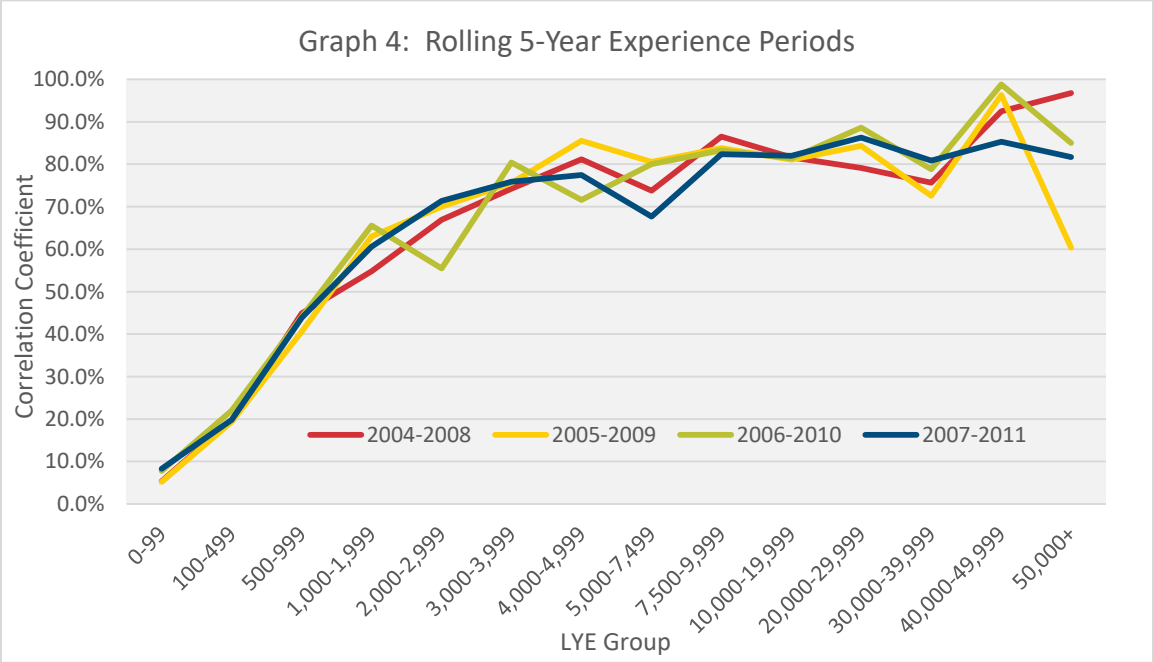


Once again, the results suggest that recent periods are more highly correlated with subsequent experience than are older periods.

Test 4

Test 4 was performed to evaluate differences in correlation coefficients by calendar period, using experience from 2004 through 2011. Rolling 5-year periods were used in every case, with no gaps between the 3-year lookback period and 2-year subsequent period.

Table 4: Rolling Five Year Experience Periods (Lookback Period = First Three Years, Subsequent Period = Next Two Years)				
Lookback period	2004-2006	2005-2007	2006-2008	2007-2009
Subsequent period	2007-2008	2008-2009	2009-2010	2010-2011
LYE				
0-99	5.4%	5.2%	7.8%	8.3%
100-499	19.7%	19.4%	22.0%	19.8%
500-999	44.9%	40.6%	44.1%	43.9%
1,000-1,999	54.8%	63.0%	65.6%	60.6%
2,000-2,999	66.9%	70.0%	55.5%	71.4%
3,000-3,999	74.2%	75.6%	80.4%	75.9%
4,000-4,999	81.2%	85.5%	71.6%	77.5%
5,000-7,499	73.8%	80.6%	80.0%	67.7%
7,500-9,999	86.5%	83.8%	83.3%	82.4%
10,000-19,999	81.6%	81.1%	81.4%	82.0%
20,000-29,999	79.1%	84.3%	88.6%	86.3%
30,000-39,999	75.7%	72.6%	78.8%	80.9%
40,000-49,999	92.5%	96.3%	98.8%	85.3%
50,000+	96.8%	60.4%	85.0%	81.7%

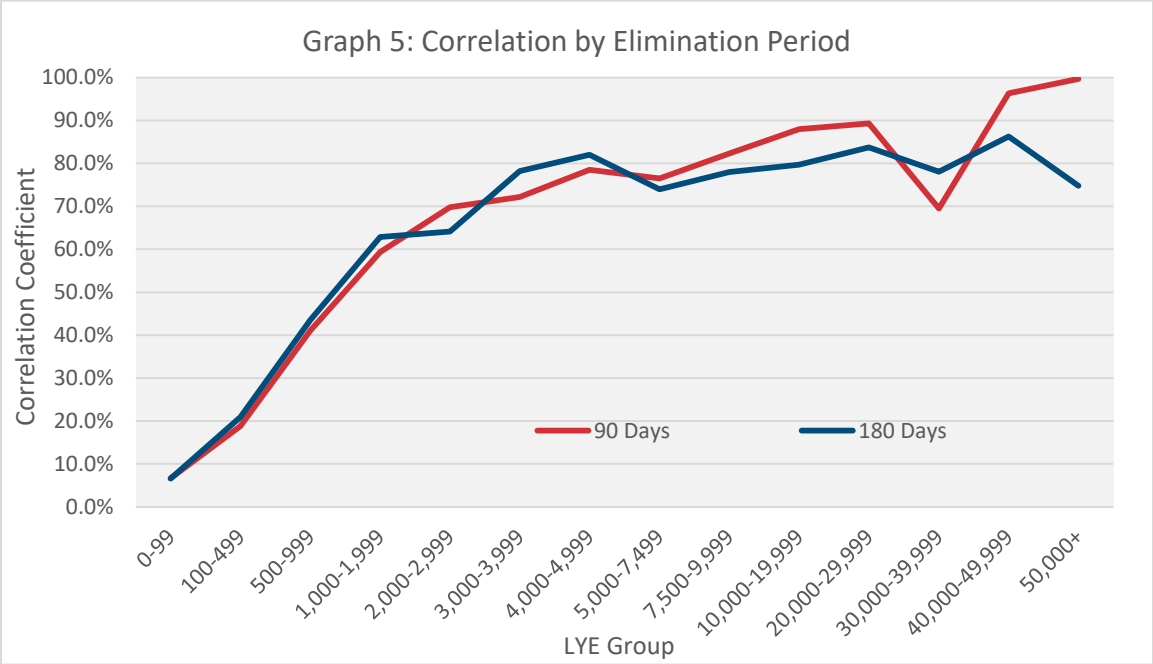


Despite the economic recession in the U.S. which began in 2007, there do not appear to be material differences in correlation coefficients by calendar period.

Test 5

Test 5 captures differences in correlation coefficients by elimination period (EP). Policies were grouped into short EP, 90-day, 180-day and long EP segments. Rolling 5-year experience periods were used to compute the correlation coefficients, using a 3-year lookback period and 2-year subsequent period with no gap between the two. Note that exposure in the short and long EP segments was significantly lower than in the 90-day and 180-day segments.

Table 5: Correlation Coefficients by Elimination Period and Life Years of Exposure				
LYE	Elimination Period			
	Short EPs	90 Days	180 Days	Long EPs
0-99	11.8%	6.7%	6.6%	7.3%
100-499	26.9%	18.8%	20.9%	8.5%
500-999	41.6%	41.1%	43.6%	67.6%
1,000-1,999	58.8%	59.4%	62.9%	51.3%
2,000-2,999	18.2%	69.8%	64.1%	61.3%
3,000-3,999	81.7%	72.2%	78.2%	76.4%
4,000-4,999	91.1%	78.5%	82.0%	7.3%
5,000-7,499	56.2%	76.5%	74.0%	75.3%
7,500-9,999	95.0%	82.3%	78.0%	68.2%
10,000-19,999	17.4%	88.0%	79.7%	76.6%
20,000-29,999	N/A	89.3%	83.7%	81.0%
30,000-39,999	N/A	69.5%	78.1%	99.5%
40,000-49,999	-77.1%	96.3%	86.3%	-99.9%
50,000+	N/A	99.7%	74.8%	98.8%



The correlation coefficients are relatively close between 90-day and 180-day EP segments. For LYE groups of 5,000 and up, the correlations are generally higher for 90-day EPs than for 180-day EPs. For lower LYE groups, however, the correlation coefficients for 180-day EPs are often slightly higher

than those for 90-day EPs. In general, we would have expected to see higher correlation coefficients for groups with 90-day EPs versus groups with 180-day EPs because, all else being equal, the number of expected claims is higher for shorter EPs. It may be that other plan design differences within each EP segment are confounding the results, or that the differences in claim incidence by EP are not large enough among the LYE groups to produce significantly different expected claims to affect the correlation coefficients.

Test 6.a

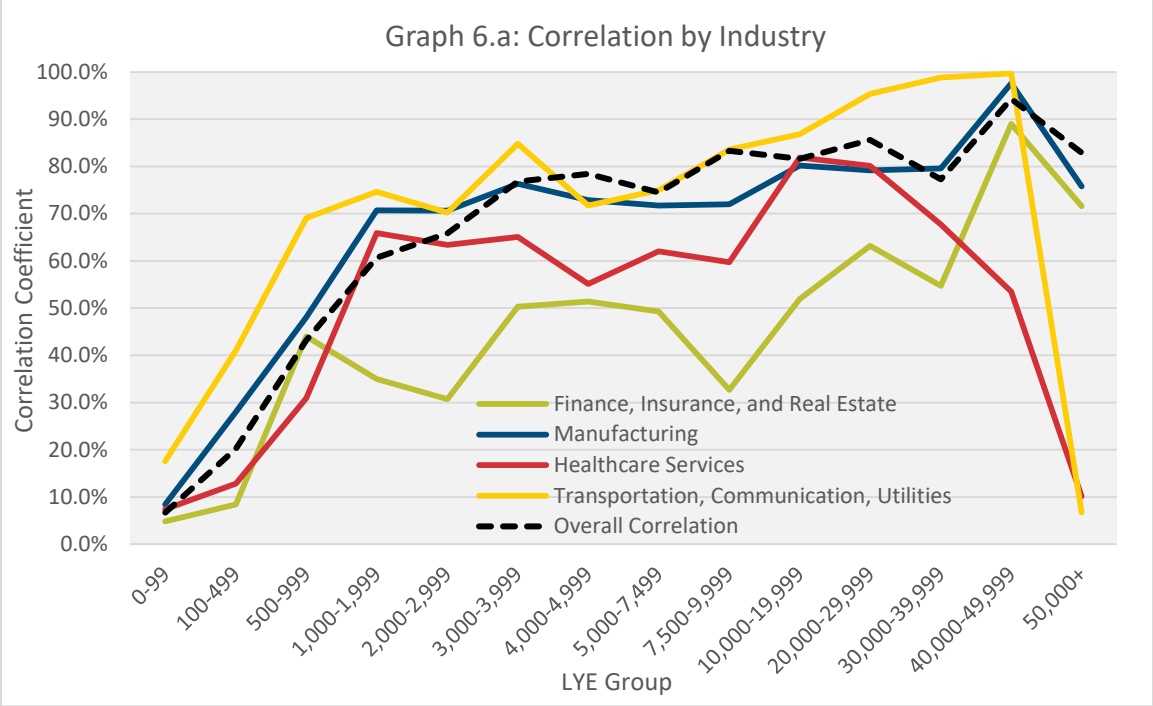
For Test 6.a, the correlation coefficients are summarized below by industry group. Rolling 5-year experience periods were used to compute the coefficients, using a 3-year lookback period and 2-year subsequent period with no gap between the two. Note that certain industries have significantly lower exposure than others (e.g. legal services—see tab 'Test 6.a' of the Appendix).

Table 6.a.1 Correlation Coefficients by Industry and Life Years of Exposure

LYE	Industry				
	Finance, Insurance, and Real Estate	Manufacturing	Other Services	Retail and Wholesale Trade	Legal Services
0-99	4.8%	8.4%	7.6%	6.8%	-1.0%
100-499	8.4%	28.0%	12.4%	14.9%	7.4%
500-999	44.0%	48.1%	33.3%	34.4%	-2.4%
1,000-1,999	35.0%	70.7%	36.2%	53.0%	8.2%
2,000-2,999	30.7%	70.6%	58.1%	41.9%	14.8%
3,000-3,999	50.3%	76.3%	68.7%	78.2%	43.9%
4,000-4,999	51.4%	72.9%	74.4%	87.9%	37.6%
5,000-7,499	49.3%	71.7%	81.7%	79.4%	64.9%
7,500-9,999	32.7%	72.0%	79.8%	86.3%	-6.1%
10,000-19,999	51.9%	80.2%	84.3%	92.7%	N/A
20,000-29,999	63.2%	79.2%	91.9%	77.1%	N/A
30,000-39,999	54.7%	79.6%	-37.2%	99.3%	N/A
40,000-49,999	89.0%	97.6%	96.7%	N/A	N/A
50,000+	71.6%	75.8%	94.8%	88.8%	N/A

Table 6.a.2 Correlation Coefficients by Industry and Life Years of Exposure

LYE	Industry					
	Agriculture, Forestry, Fishing, Mining, Construction	Healthcare Services	Transportation, Communication, Utilities	Educational Services	Public Administration	Overall
0-99	6.8%	7.4%	17.6%	11.8%	-0.7%	6.7%
100-499	23.9%	12.8%	41.0%	20.4%	28.8%	20.2%
500-999	48.5%	30.9%	69.1%	29.8%	35.4%	43.2%
1,000-1,999	73.6%	65.9%	74.6%	49.8%	72.3%	60.7%
2,000-2,999	61.1%	63.4%	70.2%	71.4%	79.0%	65.8%
3,000-3,999	69.8%	65.1%	84.8%	64.4%	67.4%	76.8%
4,000-4,999	91.3%	55.1%	71.7%	61.2%	93.7%	78.4%
5,000-7,499	53.3%	62.0%	75.0%	51.9%	85.4%	74.5%
7,500-9,999	82.2%	59.7%	83.6%	90.6%	78.1%	83.3%
10,000-19,999	86.0%	81.9%	86.8%	93.1%	84.6%	81.6%
20,000-29,999	N/A	80.1%	95.4%	-67.3%	-95.7%	85.6%
30,000-39,999	-49.3%	67.7%	98.8%	98.3%	N/A	77.3%
40,000-49,999	N/A	53.5%	99.7%	52.5%	100.0%	94.3%
50,000+	N/A	10.1%	6.7%	N/A	97.2%	82.9%



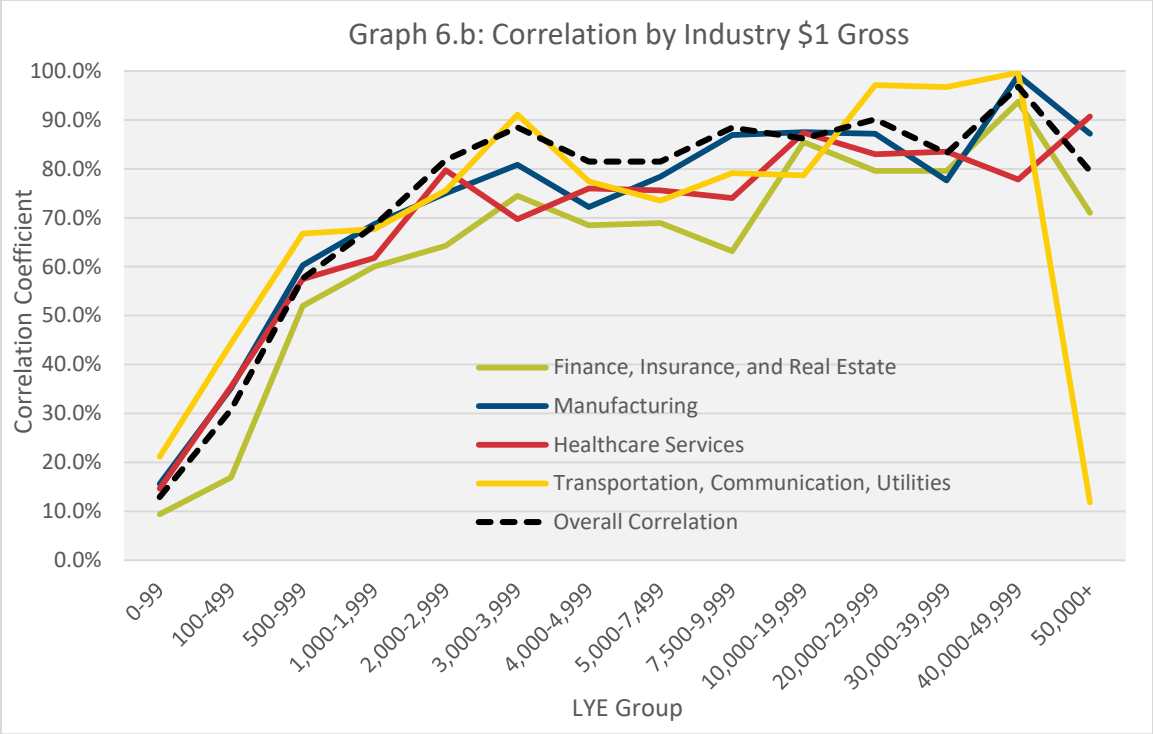
The correlations are relatively low for policies in the Finance, Insurance, and Real Estate segment relative to the other industries. On the other hand, correlation coefficients are relatively high for groups in the Transportation, Communication, and Utilities segment, especially for smaller sized cases.

Test 6.b

The results corresponding to the Finance, Insurance, and Real Estate segment may be driven, in part, by greater variability in benefit amounts and/or a higher prevalence of large outlier claims, since these industries tend to exhibit greater disparity among employee wages. When the claim costs were restated in Test 6.b using a $1 gross benefit amount for all claims in every industry—thereby neutralizing the impact of variable benefit amounts—the correlation coefficients are generally higher and more uniform across the industry segments. For example, results corresponding to the Finance, Insurance, and Real Estate segment are more similar to other industries when based on uniform benefit amounts, as shown in the following tables.

Table 6.b.1 Correlation Coefficients by Industry and Life Years of Exposure					
LYE	Industry $1 Gross				
	Finance, Insurance, and Real Estate	Manufacturing	Other Services	Retail and Wholesale Trade	Legal Services
0-99	9.4%	15.6%	12.9%	12.9%	3.7%
100-499	16.9%	35.2%	24.5%	23.0%	10.8%
500-999	52.0%	60.3%	50.6%	49.2%	20.2%
1,000-1,999	60.0%	68.7%	64.2%	69.8%	31.7%
2,000-2,999	64.3%	75.0%	67.8%	64.5%	42.3%
3,000-3,999	74.5%	80.8%	78.9%	84.3%	86.3%
4,000-4,999	68.5%	72.2%	84.4%	89.8%	90.5%
5,000-7,499	68.9%	78.4%	85.5%	87.2%	80.0%
7,500-9,999	63.2%	86.9%	92.2%	87.3%	46.5%
10,000-19,999	85.5%	87.5%	92.7%	90.8%	N/A
20,000-29,999	79.6%	87.2%	91.5%	87.6%	N/A
30,000-39,999	79.6%	77.6%	-74.1%	99.3%	N/A
40,000-49,999	93.7%	99.1%	97.3%	N/A	N/A
50,000+	71.0%	87.2%	96.7%	84.9%	N/A

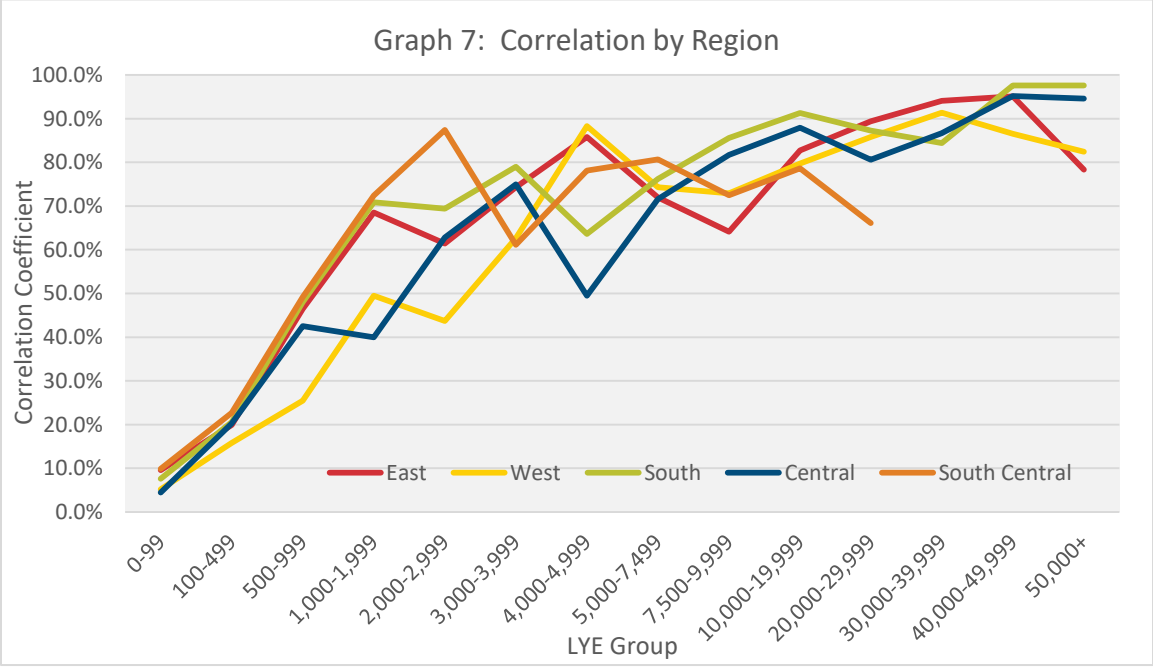
Table 6.b.2 Correlation Coefficients by Industry and Life Years of Exposure						
LYE	Industry $1 Gross					
	Agriculture, Forestry, Fishing, Mining, Construction	Healthcare Services	Transportation, Communication, Utilities	Educational Services	Public Administration	Overall
0-99	10.5%	14.6%	21.2%	13.7%	3.7%	12.9%
100-499	30.3%	35.5%	44.3%	30.9%	38.0%	30.8%
500-999	66.2%	57.5%	66.8%	39.9%	45.0%	57.6%
1,000-1,999	75.9%	61.8%	67.7%	71.2%	71.0%	68.4%
2,000-2,999	84.6%	79.7%	75.6%	84.7%	77.4%	81.8%
3,000-3,999	86.5%	69.7%	91.1%	65.6%	71.7%	88.5%
4,000-4,999	84.2%	76.0%	77.4%	60.6%	88.7%	81.5%
5,000-7,499	73.6%	75.6%	73.5%	65.4%	90.4%	81.5%
7,500-9,999	89.7%	74.0%	79.1%	92.8%	91.1%	88.4%
10,000-19,999	91.2%	87.4%	78.7%	96.6%	74.4%	86.2%
20,000-29,999	N/A	83.0%	97.1%	-17.7%	-97.9%	90.1%
30,000-39,999	-80.9%	83.5%	96.7%	89.8%	N/A	83.2%
40,000-49,999	N/A	77.8%	99.7%	75.7%	100.0%	96.8%
50,000+	N/A	90.7%	11.8%	N/A	96.1%	79.6%



Test 7

Test 7 captures differences across geographical region, based on the situs state of the policyholder. Rolling 5-year experience periods were used to compute the coefficients, using a 3-year lookback period and 2-year subsequent period with no gap between the two. The results are shown below.

Table 7: Correlation Coefficients by Region and Life Years of Exposure					
LYE	Region				
	East	West	South	Central	South Central
0-99	9.6%	5.2%	7.6%	4.5%	9.9%
100-499	19.9%	15.8%	20.6%	20.3%	22.7%
500-999	46.5%	25.5%	48.0%	42.5%	49.2%
1,000-1,999	68.5%	49.5%	70.9%	40.0%	72.4%
2,000-2,999	61.4%	43.7%	69.4%	62.8%	87.4%
3,000-3,999	74.3%	62.7%	79.0%	75.0%	61.1%
4,000-4,999	85.8%	88.3%	63.6%	49.5%	78.1%
5,000-7,499	72.0%	74.3%	76.2%	71.6%	80.7%
7,500-9,999	64.1%	72.9%	85.6%	81.7%	72.5%
10,000-19,999	82.7%	79.7%	91.3%	87.9%	78.6%
20,000-29,999	89.4%	85.8%	87.3%	80.6%	66.1%
30,000-39,999	94.1%	91.4%	84.4%	86.7%	N/A
40,000-49,999	95.1%	86.5%	97.6%	95.2%	N/A
50,000+	78.3%	82.4%	97.6%	94.6%	82.7%



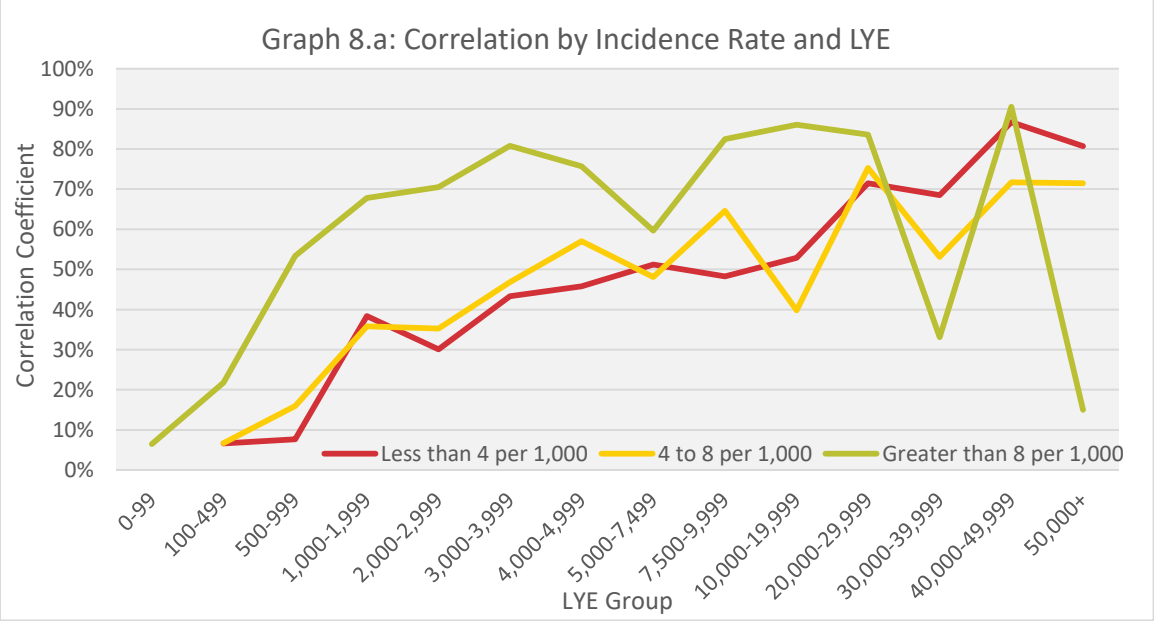
The correlation coefficients are much lower for groups located in the West region with lower LYE (less than 4,000 LYE). Note that we have not attempted to normalize for industry or other mixes, which could be potential contributors to the observed differences by region.

Test 8.a

For Test 8, policies were grouped based on LTD claim incidence rates in the lookback period—i.e. less than 4 per 1,000; 4 to 8 per 1,000; and greater than 8 per 1,000. The results from this test are shown below.

Table 8.a Correlation Coefficients by Incidence Rate per 1,000

Incidence Rate	Less than 4 per 1,000		4 to 8 per 1,000		Greater than 8 per 1,000	
Life Years of Exposure	Sample Size	Correlation Coefficient	Sample Size	Correlation Coefficient	Sample Size	Correlation Coefficient
0-99	0	N/A	0	N/A	11,362	6.5%
100-499	3,339	6.6%	7,795	6.7%	7,470	21.8%
500-999	3,218	7.7%	1,690	16.0%	874	53.4%
1,000-1,999	2,431	38.4%	1,106	35.8%	453	67.8%
2,000-2,999	992	30.1%	427	35.3%	149	70.5%
3,000-3,999	496	43.3%	294	46.8%	95	80.8%
4,000-4,999	348	45.8%	178	57.0%	61	75.7%
5,000-7,499	463	51.2%	274	48.1%	80	59.7%
7,500-9,999	240	48.3%	146	64.6%	52	82.5%
10,000-19,999	318	52.9%	199	39.8%	78	86.1%
20,000-29,999	111	71.5%	64	75.3%	9	83.6%
30,000-39,999	43	68.5%	33	53.1%	5	33.1%
40,000-49,999	25	86.7%	11	71.7%	6	90.5%
50,000+	59	80.7%	34	71.5%	6	15.0%

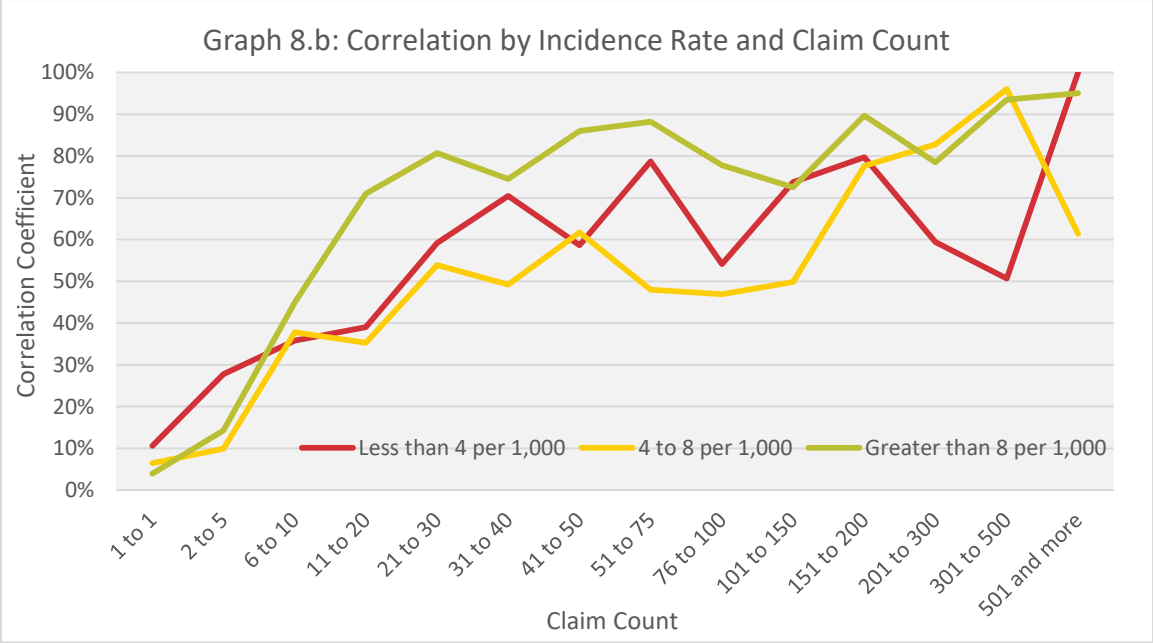


Correlation coefficients are significantly higher for groups whose experience included higher incidence rates (greater than 8 per 1,000), suggesting that LTD claim incidence may be an important driver of credibility. This result illustrates the relationship we expected to see reflected in the comparison by EP (Test 5), though the results by EP were less striking due to the possible reasons discussed earlier.

Test 8.b

The results from the prior test were summarized by claim count rather than LYE segment in the following table and graph.

Table 8.b Correlation Coefficients by Incidence Rate per 1,000						
Incidence Rate	Less than 4 per 1,000		4 to 8 per 1,000		Greater than 8 per 1,000	
Claim Count	Sample Size	Correlation Coefficient	Sample Size	Correlation Coefficient	Sample Size	Correlation Coefficient
1	5,447	10.6%	5,638	6.5%	11,689	3.9%
2-5	4,211	27.8%	3,842	9.9%	6,824	14.3%
6-10	1,095	35.8%	1,046	37.8%	1,009	44.9%
11-20	640	39.0%	707	35.3%	525	71.0%
21-30	256	59.2%	322	53.9%	193	80.7%
31-40	136	70.4%	197	49.2%	113	74.5%
41-50	86	58.6%	120	61.7%	66	86.0%
51-75	83	78.7%	139	48.0%	106	88.2%
76-100	40	54.1%	79	46.9%	48	77.8%
101-150	47	73.7%	69	49.8%	52	72.5%
151-200	18	79.7%	39	77.6%	36	89.7%
201-300	14	59.4%	33	82.8%	15	78.5%
301-500	8	50.7%	7	96.0%	13	93.5%
501+	2	100.0%	13	61.4%	11	95.0%



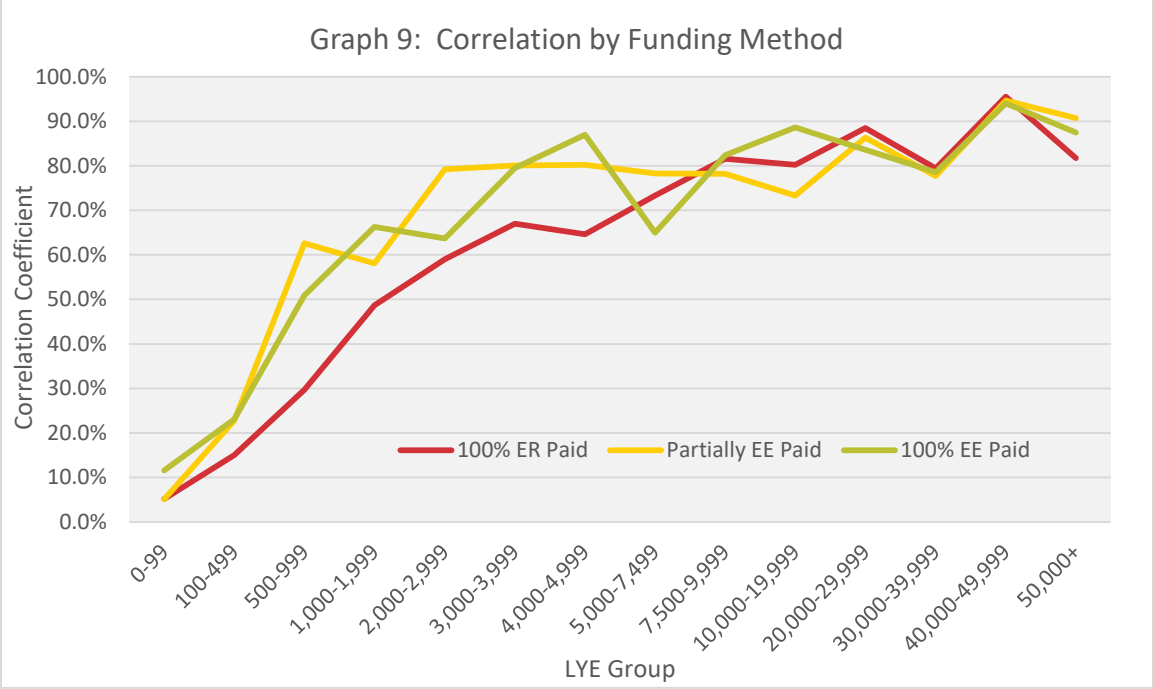
Measuring the correlation coefficients using claim count rather than LYE decreases the extent of the differences by claim incidence rate. This suggests that measuring credibility using an alternative to LYE such as actual or expected claims may provide a more consistent credibility basis. Alternative credibility methods will be discussed in more detail in Stage 2 of this study.

Test 9

In Test 9, the correlation coefficients were segmented by funding method (i.e. 100% employer-paid, 100% employee-paid and partially employee paid). Rolling 5-year experience periods were used to compute the coefficients, using a 3-year lookback period and 2-year subsequent period with no gap between the two. The results are shown below.

Table 9 Correlation Coefficients by Funding Method and Life Years of Exposure

LYE	Funding Method		
	100% ER Paid	Partially EE Paid	100% EE Paid
0-99	5.2%	5.1%	11.6%
100-499	15.0%	22.8%	23.1%
500-999	29.7%	62.6%	50.9%
1,000-1,999	48.7%	58.1%	66.3%
2,000-2,999	59.0%	79.2%	63.7%
3,000-3,999	67.0%	80.1%	79.5%
4,000-4,999	64.6%	80.2%	87.0%
5,000-7,499	73.3%	78.3%	65.0%
7,500-9,999	81.6%	78.2%	82.4%
10,000-19,999	80.2%	73.3%	88.6%
20,000-29,999	88.5%	86.3%	83.6%
30,000-39,999	79.4%	77.7%	78.6%
40,000-49,999	95.5%	94.7%	94.0%
50,000+	81.7%	90.7%	87.5%



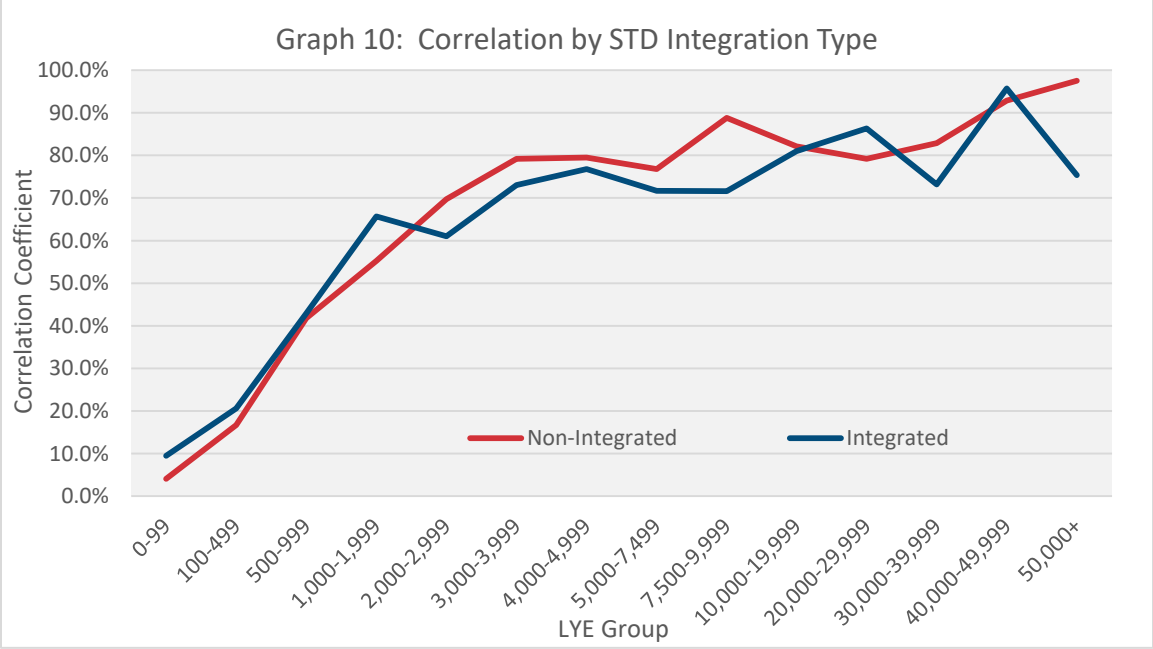
The coefficients tend to be higher for GLTD experience corresponding to coverage that is either partially or 100% employee-paid. This dynamic could be due, in part, to higher claim incidence rates often observed on contributory policies.

Test 10

Test 10 compares correlation coefficients between LTD policies integrated with STD coverage from the same carrier and non-integrated policies. Rolling 5-year experience periods were used to compute the coefficients, using a 3-year lookback period and 2-year subsequent period with no gap between the two. The results are shown below.

Table 10 Correlation Coefficients by Integration Type and Life Years of Exposure

LYE	Integration Type	
	Non-Integrated	Integrated
0-99	4.1%	9.5%
100-499	16.7%	20.6%
500-999	41.8%	42.9%
1,000-1,999	55.2%	65.7%
2,000-2,999	69.7%	61.0%
3,000-3,999	79.2%	73.0%
4,000-4,999	79.5%	76.8%
5,000-7,499	76.8%	71.7%
7,500-9,999	88.8%	71.6%
10,000-19,999	82.1%	81.0%
20,000-29,999	79.2%	86.3%
30,000-39,999	82.9%	73.2%
40,000-49,999	92.9%	95.7%
50,000+	97.5%	75.4%



The coefficients are relatively close for both segments.

Section 5: Relative Error Analysis

5.1 Analytical Methods

Credibility is used in the LTD case underwriting process to determine how much weight should be assigned to prior experience versus a carrier's overall block experience or manual rate when estimating future claims experience. When we use prior experience to predict future experience, how much error is inherent in our prediction? In LTD, one variable that is believed to reduce the error in our prediction is life years of exposure (LYE). The relative error approach measures this error directly to determine how increasing LYE affects the error in our prediction. For this purpose, we assume that our predicted claim cost is exactly equal to our historical claim cost. In other words, we assume a credibility factor of 100%. The error is then the difference between historical claim costs (CC1) and subsequent claim costs (CC2). We calculated claim costs using the same method as described in Section 3, using gross benefit and expected terminations based on the 2012 GLTD Basic Table. Relative error is calculated as the absolute value difference between CC1 and CC2, all divided by CC1. (Dividing by CC1 makes our error measure unitless). For example, if we have CC1 = 0.50% and CC2 = 0.55%, then our relative error is |0.55-0.50|/0.50 = 10%. The actual CC2 of 0.55% was 10% higher than our estimate of CC2, so our relative error is 10%. Next we grouped the data by LYE group to observe how the average relative error changes as LYE increases.

A limitation of the method described above is that CC1 must be nonzero. For a significant number of policies, especially in the lower LYE groups, there are no claims in the lookback period so CC1 is often zero. Excluding these records leads to significant data loss, and may bias the results from this method. For larger LYE groups however, there are very few, if any, policies with zero claims in the lookback period.

We also applied an alternative method in which we replaced CC1 with an expected claim cost measure. This eliminates the need to exclude records since expected claim costs will never be zero when exposure is nonzero, and also gets us closer to how credibility is used in practice with a manual rate. We tested two alternative expected claim cost measures. First, we calculated the overall expected claim costs based on the average claim costs for the entire data set. Specifically, E(CC1) is equal to the total present value of future benefits for all policy records included in the study, divided by the total covered payroll for all policy records included in the study. We excluded records with unknown elimination periods or industry data, since these fields are used in a later step.

In order to refine the expected claim cost measure to more closely resemble a "manual" rate, we calculated alternative expected claim costs which vary by case size, elimination period, industry group, definition of disability, and employer-paid vs. voluntary. This refined expected claim cost measure does not take into account many important rating variables such as age and gender mix, which was not available in the study data. A true manual rate would likely produce different results than what is reflected in this study.

To summarize, we ran the following tests related to relative error analysis:

- Test 11 - Calculate average relative error at the policy level, where relative error = |CC1-CC2|/CC1. Policies for which CC1 = 0 are excluded from the study.

- Test 12 – Calculate average relative error using a single expected claim cost measure, where relative error = |(E(CC1)-CC2)|/E(CC1).

- Test 13 – Similar to Test 12, but using a more refined expected claim cost which varies by several key variables.

The results of these tests are discussed in Section 5.2.

5.2 Test Results

Test 11

Table 11 below summarizes the results of the initial relative error test (Test 11). This test was conducted at the policy level, and relative error was calculated as the absolute difference between CC1 and CC2, divided by CC1. Policy records with no claims in the lookback period (CC1=0) have been excluded from Test 11.

Table 11: Relative Error Analysis at Policy Level, Using Actual Experience

LYE Group	Policy Count	Included Policies (CC1>0)	LYE (Lookback)	Claims (Lookback)	Mean (CC1)	Mean (RE)	St Dev (RE)
0-99	71,372	11,362	728,089	13,748	3.75%	**143%**	581%
100-499	44,109	18,604	4,349,419	32,951	1.54%	**185%**	715%
500-999	7,239	5,782	4,088,909	19,708	0.84%	**204%**	1021%
1,000-1,999	4,393	3,990	5,602,192	24,123	0.74%	**149%**	603%
2,000-2,999	1624	1,568	3,850,741	15,411	0.70%	**128%**	1266%
3,000-3,999	908	885	3,074,457	13,130	0.75%	**88%**	596%
4,000-4,999	607	587	2,628,393	11,210	0.71%	**88%**	262%
5,000-7,499	836	817	4,931,140	20,921	0.73%	**60%**	122%
7,500-9,999	472	438	3,760,458	18,445	0.79%	**55%**	216%
10,000-19,999	615	595	8,230,575	38,437	0.81%	**49%**	192%
20,000-29,999	184	184	4,408,375	17,014	0.69%	**34%**	37%
30,000-39,999	81	81	2,752,589	11,906	0.80%	**26%**	23%
40,000-49,999	42	42	1,867,682	9,223	0.71%	**28%**	32%
50,000+	99	99	9,889,231	38,677	0.67%	**44%**	127%

We observe that the mean relative error generally decreases as LYE increases, which is consistent with the pattern seen in the correlation coefficients in Section 3 (higher correlations correspond to less error in the prediction). We also see a similar slope where the mean relative error is decreasing rapidly up to 5,000 lives. At 5,000 and higher life years, the relative error continues to decrease, though at a somewhat slower rate. There was some unexpected volatility observed in the 50,000+ LYE group, which may be driven by characteristics of the groups which are not fully captured in the study.

Table 11 also shows that the mean claim cost in the historical period (Mean(CC1)) is much higher for the lower LYE groups. This is caused by the exclusion of policies with CC1=0 which artificially inflates the average claim cost measure, especially for the lower LYE groups which have a large proportion of policies with zero claims.

If we assume that the claim costs in the lookback period are used to predict future claim costs in the subsequent period, or in other words we assume that historical experience is assigned 100% credibility, then we can use the mean relative error from Test 11 to determine the level of error inherent in our prediction. For example, for a group with 30,000 LYE, if we assign 100% credibility to prior experience then actual claim cost experience over the next two years will be 26% higher or lower, on average, than our prediction. This highlights the limitations of credibility methods,

and the volatility inherent in LTD claim data, even for the largest of groups and may reflect the impact of experience drift, or movement in the underlying "true" expected claims.

Test 12

Table 12.a contains the results from Test 12, which uses overall expected claim costs for the entire data set in place of CC1 in the relative error formula. This is conceptually representative of using a single manual rate as the claim cost predictor, with no credibility given to experience for any particular policy. Policies with missing elimination period or industry information have been excluded from Test 12 and Test 13.

Table 12.a: Relative Error Analysis Using E(CC1) as Predictor

LYE Group	Policy Count	Included Policies	LYE (Lookback)	Claims (Lookback)	Mean (CC1)	Mean (RE)	St Dev (RE)
0-99	71,372	54,566	3,153,435	10,569	0.61%	**181%**	398%
100-499	44,109	34,643	7,112,403	26,562	0.67%	**156%**	230%
500-999	7,239	5,925	4,153,882	16,316	0.70%	**107%**	125%
1,000-1,999	4,393	3,469	4,841,767	19,753	0.70%	**90%**	128%
2,000-2,999	1624	1,292	3,169,095	12,483	0.68%	**78%**	91%
3,000-3,999	908	741	2,573,966	11,162	0.76%	**76%**	84%
4,000-4,999	607	468	2,096,553	9,088	0.74%	**71%**	81%
5,000-7,499	836	685	4,131,748	17,333	0.72%	**67%**	69%
7,500-9,999	472	339	2,895,259	12,281	0.74%	**62%**	71%
10,000-19,999	615	481	6,630,299	30,701	0.79%	**63%**	77%
20,000-29,999	184	160	3,848,223	15,406	0.71%	**54%**	53%
30,000-39,999	81	67	2,274,812	9,469	0.74%	**52%**	55%
40,000-49,999	42	35	1,550,023	7,731	0.68%	**61%**	60%
50,000+	99	80	6,906,168	23,236	0.64%	**42%**	40%

Table 12.b compares the results from Test 11 and Test 12.

Table 12.b: Comparison of Average Relative Error for Tests 11 and 12

LYE Group	Mean (RE)	
	Test 11	Test 12
0-99	143%	181%
100-499	185%	156%
500-999	204%	107%
1,000-1,999	149%	90%
2,000-2,999	128%	78%
3,000-3,999	88%	76%
4,000-4,999	88%	71%
5,000-7,499	60%	67%
7,500-9,999	55%	62%
10,000-19,999	49%	63%
20,000-29,999	34%	54%
30,000-39,999	26%	52%
40,000-49,999	28%	61%
50,000+	44%	42%

When we compare the results of Test 12 with those from Test 11 we see that for groups with fewer than 5,000 LYE, Test 12 generally produced lower relative error. For these lower LYE groups, then, the overall average (expected) claim cost was a better predictor of future experience than the group's own experience. At and above 5,000 LYE, however, relative error is lower for Test 11, meaning that for these groups their own claim experience is a more accurate predictor, on average, than overall expected claim costs. Again, results for the largest LYE group (50,000+ lives) are anomalous.

Test 13

Test 13 uses a more refined expected claim cost assumption that is still calculated based on average experience for the entire block but varies by several key variables which seemed to drive claim cost differences, including case size, elimination period, industry, definition of disability, and funding method (employer-paid versus employee-paid). Results under Test 13 are shown below.

Table 13.a: Relative Error Analysis Using Refined E(CC1) as Predictor

LYE Group	Policy Count	Included Policies	LYE (Lookback)	Claims (Lookback)	Mean (CC1)	Mean (RE)	St Dev (RE)
0-99	71,372	54,533	3,153,435	10,569	0.61%	**191%**	461%
100-499	44,109	34,616	7,112,403	26,562	0.67%	**157%**	237%
500-999	7,239	5,924	4,153,882	16,316	0.70%	**101%**	112%
1,000-1,999	4,393	3,469	4,841,767	19,753	0.70%	**81%**	93%
2,000-2,999	1624	1,292	3,169,095	12,483	0.68%	**69%**	80%
3,000-3,999	908	741	2,573,966	11,162	0.76%	**65%**	67%
4,000-4,999	607	468	2,096,553	9,088	0.74%	**58%**	53%
5,000-7,499	836	684	4,131,748	17,333	0.72%	**56%**	59%
7,500-9,999	472	339	2,895,259	12,281	0.74%	**51%**	59%
10,000-19,999	615	481	6,630,299	30,701	0.79%	**52%**	73%
20,000-29,999	184	160	3,848,223	15,406	0.71%	**48%**	68%
30,000-39,999	81	67	2,274,812	9,469	0.74%	**60%**	74%
40,000-49,999	42	35	1,550,023	7,731	0.68%	**35%**	27%
50,000+	99	80	6,906,168	23,236	0.64%	**40%**	32%

Table 13.b compares the results from Tests 11, 12 and 13.

Table 13.b: Comparison of Average Relative Error for Tests 11, 12 and 13

LYE Group	Mean (RE)		
	Test 11	Test 12	Test 13
0-99	143%	181%	191%
100-499	185%	156%	157%
500-999	204%	107%	101%
1,000-1,999	149%	90%	81%
2,000-2,999	128%	78%	69%
3,000-3,999	88%	76%	65%
4,000-4,999	88%	71%	58%
5,000-7,499	60%	67%	56%
7,500-9,999	55%	62%	51%
10,000-19,999	49%	63%	52%
20,000-29,999	34%	54%	48%
30,000-39,999	26%	52%	60%
40,000-49,999	28%	61%	35%
50,000+	44%	42%	40%

Using the new, refined expected claim cost as our predictor in Test 13 has improved results, relative to Test 12 (i.e., average relative error is lower for most LYE segments), suggesting that improving the refinement of manual rates leads to a better ability to predict claim costs. There is some

volatility, such as for LYE group 30,000-39,999. Average experience is clearly a better predictor for groups with less than 5,000 LYE, the two become relatively evenly-matched for groups between 5,000 and 19,999 LYE, and for groups with 20,000 or more LYE the group's own experience becomes the better predictor.

Additional Test – Test 14

Test 11 uses actual historical claim cost experience to predict subsequent experience, which essentially assigns prior experience 100% credibility. Test 13, on the other hand, uses average claim cost experience for the dataset as a whole, which can be loosely defined as a proxy for a manual rate (albeit with some key rating variables ignored). Test 13 can therefore be interpreted as assigning a credibility factor of 0. We can then use these two relative error approaches to explore optimal credibility weighting factors which would minimize the relative error of our predictions for each LYE group. Table 14 shows the relative error for each LYE group, with different credibility factors assigned to the historical experience. In this table, "experience rate" refers to the historical claim costs for each policy, CC1, and "manual rate" refers to the refined expected claim costs calculated using average experience from the entire data set (Test 13 approach).

Table 14: Relative Error Analysis Using Case Rate as Predictor
Case Rate = (1 – Z) x Manual Rate + Z x Experience Rate

LYE Group	Credibility Factor Z Assigned to the Experience										
	0%	*10%*	*20%*	*30%*	*40%*	*50%*	*60%*	*70%*	*80%*	*90%*	*100%*
0-99	**191%**	191%	199%	212%	231%	258%	300%	370%	511%	935%	N/A
100-499	157%	**153%**	156%	163%	174%	191%	217%	262%	351%	618%	N/A
500-999	101%	97%	**96%**	97%	100%	105%	114%	129%	158%	238%	N/A
1,000-1,999	81%	76%	73%	**72%**	72%	73%	77%	83%	95%	126%	142%
2,000-2,999	69%	65%	61%	60%	**59%**	59%	60%	63%	69%	82%	137%
3,000-3,999	65%	59%	55%	52%	50%	49%	**48%**	49%	51%	56%	68%
4,000-4,999	58%	53%	50%	47%	46%	**45%**	46%	48%	51%	58%	70%
5,000-7,499	56%	53%	49%	46%	44%	42%	**42%**	42%	43%	47%	56%
7,500-9,999	51%	47%	43%	41%	40%	39%	**39%**	39%	41%	45%	60%
10,000-19,999	52%	45%	40%	37%	35%	33%	32%	**32%**	33%	36%	49%
20,000-29,999	48%	41%	37%	33%	31%	29%	28%	**27%**	28%	28%	31%
30,000-39,999	60%	51%	45%	40%	35%	32%	29%	27%	25%	**24%**	25%
40,000-49,999	35%	33%	31%	29%	28%	27%	27%	**26%**	26%	27%	29%
50,000+	40%	37%	33%	31%	28%	27%	25%	24%	23%	**23%**	24%

The values in bold from the table above represent the lowest relative error for each LYE group. We can see that for lower LYE groups, a lower credibility factor is found to minimize error, and as we increase LYE, the credibility factor which minimizes the error in our predictions increases. This is consistent with our current understanding of credibility. Note that we have excluded several values from the 100% credibility column for the lowest LYE groups since the need to exclude policies with zero claims has skewed the results for these groups. Interestingly, even at the highest LYE groups the relative error produced by the 90% credibility scenario was lower than the relative error produced by assuming 100% credibility.

The results presented in this report show that there is still significant volatility in LTD claims experience even at the highest LYE groups, and consequently that our estimates of future experience using past experience are far from perfect for these largest groups. Table 14, however, reminds us that volatility and credibility are two separate concepts, and that assigning high levels of credibility to prior experience may still be optimal despite the underlying volatility of LTD claims experience.

Note that this analysis is preliminary, and that expanding this approach will be the primary focus of Stage 2 of the Credibility Study.

Section 6: Reliance and Limitations

6.1 Reliance

In conducting the analysis, researchers relied upon the database developed MIB specifically for the GLTD Credibility Experience Study. Unless otherwise described, researchers did not audit or independently verify any of the information furnished, except for a high level review of the data for reasonableness and consistency. To the extent that any of the data or other information supplied was incorrect or inaccurate, the results of this analysis could be materially affected.

6.2 Limitations on Use and Distribution of Report

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The results in this report are technical in nature and are dependent on certain assumptions and methods. No party should rely upon these results without a thorough understanding of those assumptions and methods. Such an understanding may require consultation with qualified professionals.

The underlying analysis was performed using assumptions about future LTD claim costs. Differences between claim cost projections and actual claim cost amounts depend on the extent to which future experience conforms to the assumptions made for this analysis. It is certain that actual experience will not conform exactly to the assumptions used in this analysis. Actual claim costs will differ from projected claim costs to the extent that actual experience deviates from expected experience.

We, Paul Correia and Tasha Khan, are Consulting Actuaries with Milliman and members of the American Academy of Actuaries. We meet the qualification standards of the American Academy of Actuaries for rendering the actuarial opinion contained in this report.

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