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LONG-TERM CARE CREDIBILITY MONOGRAPH

American Academy of Actuaries
Long-Term Care Credibility Monograph Work Group
of the Health Practice Council

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Long-Term Care Credibility Monograph Work Group

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The American Academy of Actuaries is an 18,500+ member professional association whose mission is to serve the public and the U.S. actuarial profession. For more than 50 years, the Academy has assisted public policymakers on all levels by providing leadership, objective expertise, and actuarial advice on risk and financial security issues. The Academy also sets qualification, practice, and professionalism standards for actuaries in the United States.

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Executive Summary

When compared to other lines of insurance business, long-term care insurance (LTCI) is a relatively young and emerging product line. While the earliest policies were issued over 40 years ago, few insurers were offering products at that time. The products have changed dramatically over the decades from nursing home-only policies to comprehensive LTCI policies to combination life/annuity-LTCI policies—and, more recently, to a greater emergence of accelerated benefit riders that address LTCI expenses. Administrative, claims, and underwriting practices have also changed significantly over that time period. Different approaches have been taken in group and individual products and markets, and insurers have taken significantly different approaches to selling policies as well.

Indeed, the market has matured within the past decade to offer a variety of options to meet various consumer needs. However, with the recent low interest rate environment and the resulting pressures on insurers, many insurers are left with small blocks of policies with too little experience data to reliably explain emerging experience or predict future experience.

Pricing and repricing assumptions for LTCI products generally are developed using the past experience of the insurer and/or from industry studies. These assumptions include lapse, mortality, claim incidence, claim continuance, claim utilization (i.e., salvage), and investment returns. In developing assumptions, actuaries might want to consider the volume, accuracy, and relevance of any data utilized.

The application of credibility procedures can assist actuaries in determining whether emerging experience associated with a given assumption could be due to volatility and/or the misestimation of the underlying assumption. In addition, credibility techniques can be used to help inform the level of conservatism an actuary might want to use in setting a given assumption.

The purpose of this monograph is as follows:

- To increase the awareness of the applicability of credibility procedures to LTCI-related work and the importance of applying them to that work;
- To provide information on current practices, relevant publications, and underlying theory that an actuary could reference to inform the application of credibility procedures to LTCI-related work;

- To outline considerations for deciding on and applying credibility procedures to LTCI actuarial work, as well as presenting results; and
- To suggest next steps for advancing actuarial practice in this regard.

The various topics presented in this monograph are:

Section I provides background on the issue of credibility in LTCI, includes a list of applicable actuarial standards of practice (ASOPs), and highlights the various stakeholders that would be affected by the application of credibility procedures to LTCI as well as how they might be affected.

Section II discusses misestimation and volatility risks. Understanding whether actual experience diverging from a given assumption is a temporary random fluctuation or a permanent misestimation is an important part of assessing the financial performance of, and determining how to manage, a block of business.

Section III summarizes the history of credibility theory, including the "greatest accuracy" and "limited fluctuation" approaches. The concepts and formulas discussed in this section could be used to inform the development of credibility procedures for LTCI-related actuarial work.

Section IV outlines key considerations that an actuary might want to focus on when selecting credibility procedures for LTCI-related work.

Section V explores the potential impact(s) of using credibility procedures and the resulting attributed credibility on the presentation of results. One impact of applying credibility procedures to LTCI-related work is that the actuary gains a sense of the magnitude of the uncertainty associated with a given assumption and/or result. It is important to present results in such a manner that they communicate the level of uncertainty associated with those results.

Section VI proposes next steps with respect to this subject matter from an actuarial perspective, including potential sample research topics and suggested areas for development of more substantive professional guidance.

The **Appendix** highlights existing information related to actuarial practice and guidance related to LTCI credibility.

SECTION I
Background

Actuarial work on long-term care insurance (LTCI) depends on multiple assumptions. Some of the key assumptions underlying LTCI are morbidity, mortality, persistency (i.e., voluntary lapse), investment returns, and expenses. Estimating the credibility attributable to any experience underlying a given assumption would be helpful in both determining the reasonableness of the assumption and informing the corresponding sensitivity testing. In general, the less credible the data underlying a given assumption, the more sensitivity testing an actuary might do to frame and communicate results.

Assumptions are often based on experience, which could be credible. The basis for judging credibility should be mathematically defensible. Statistical methods have been developed and presented and certain regulatory methods have been adopted for judging credibility of LTCI data, but neither has been consistently utilized.

Some current regulations relating to credibility set a fixed minimum amount of experience for non-zero credibility. Likewise, some set a maximum volume of data beyond which credibility is assumed to be 100 percent, with the credibility of data volumes between 0 percent and 100 percent set by linear interpolaton between the two endpoints. In this situation, neither the endpoints nor the linear interpolation is consistent with statistical bases for credibility.

The use of more appropriate credibility procedures in estimating credibility generally could lead to better results for consumers and regulators as well as insurers.

Relevant Actuarial Standards of Practice (ASOPs) for LTCI Credibility

The following are ASOPs that could be considered relevant to LTCI-related actuarial work that reference credibililty or related concepts. This list is not exhaustive, but rather identifies those ASOPs that indicate the importance of considering credibility. More information on specific language in these relevant ASOPs can be found in the Appendix.

ASOP No. 3: *Continuing Care Retirement Communities*

ASOP No. 5: *Incurred Health and Disability Claims*

ASOP No. 7: *Analysis of Life, Health, or Property/Casualty Insurer Cash Flows*

ASOP No. 8: *Regulatory Filings for Health Benefits, Accident and Health Insurance, and Entities Providing Health Benefits*

ASOP No. 10: *Methods and Assumptions for Use in Life Insurance Company Financial Statements Prepared in Accordance with U.S. GAAP*

ASOP No. 12: *Risk Classification (for All Practice Areas)*

ASOP No. 15: *Dividends for Individual Participating Life Insurance, Annuities, and Disability Insurance*

ASOP No. 17: *Expert Testimony by Actuaries*

ASOP No. 18: *Long-Term Care Insurance*

ASOP No. 19: *Appraisals of Casualty, Health, and Life Insurance Businesses*

ASOP No. 25: *Credibility Procedures*

Relevant Stakeholder Perspectives

The following subsections highlight the various stakeholders that would be affected by the application of credibility procedures to LTCI as well as how they might be affected.

Regulators—Federal, State

While LTCI is subject to certain federal laws, it is generally regulated by the individual states in which the policies are issued. Policy forms, premium rates, and the business of LTCI are subject to requirements that differ among these states. When an insurer gains state approval of a new product, for example, the insurer will issue policies that start adding experience to the state-level block of policies. Actuaries monitor both state-level experience and the aggregated experience of policies issued in all states combined.

Reviewing experience at the federal and state levels may be difficult. Monitoring aggregated experience may be difficult because of different state-level requirements and because the most accurate assumptions may differ by geographic region. Monitoring state-level experience requires accumulating experience for a significant number of policies over a significant length of time (i.e., policy duration) under state-specific conditions.

Identifying and considering credible data will tend to lead to more accurate results, both in the short term as well as the long term. Therefore, credibility-adjusted data should be used wherever possible.

If an actuary cannot demonstrate the credibility of data within a particular state, it could be difficult to justify the use of data from outside the state. The credibility of outside data (e.g., regional or national data) combined with demonstrations that the outside data correlates at some confidence level with the data from within the state could help justify the use of the assumptions based on that outside data.

Company Management

Having a credible basis for rates or reserves not only leads to the development of more appropriate rates or reserves, but it can present a powerful argument for using those rates or reserves instead of revising them due to competition or marketing preferences.

Rating Agencies

When LTCI-related actuarial work is based on credible data, rating agencies can be more confident that the work is sound, which could result in a more favorable rating. A more favorable rating could improve access to capital, consumer confidence, better persistency, and increased sales activity.

Auditors

External auditors, insurer internal auditors, and state market conduct examiners would benefit from the application of credibility standards. It could increase the probability an insurer would implement sound actions and adjustments that could affect audit results, reports, and recommendations.

Sales/Marketing

Captive agents, independent agents, and brokers can have goals that differ from those of insurers and consumers. The use of credible data can be a powerful, persuasive foundation for actuarial reports and recommendations that realign sales professionals with these other stakeholders.

Consumers and Consumer Groups

Consumers and consumer groups want “reliable” rates and reserves, and the use of credible data to develop them would facilitate that. This means that actuaries would perform services with the objective of providing some assurance that premium rates charged and reserves calculated and held are sufficient both now and into the future. If the actuary has based assumptions and corresponding results on credible experience, consumers and consumer groups could be more likely to support any rate changes that might be necessary.

SECTION II

Understanding LTCI Insurance Misestimation and Volatility Risks

Deviations of actual experience from expected experience for a given assumption may be due to volatility inherent in that assumption or to the misestimation of that assumption. Volatility and misestimation risks within the LTCI framework, as well as how they impact functions that depend upon LTCI projections, are discussed below.

Description

Volatility recognizes that a particular variable has a specific mean and a variance. While the entire population over time is expected to be at the mean, a subset of the entire population, or the entire population for a shorter period of time, may be subject to random fluctuations. The random fluctuations represent the volatility risk. The volatility risk is measured by the variance.

Credibility procedures relate to the measurement and management of volatility risk.

In contrast, misestimation recognizes that the true mean is not represented correctly by the estimate. The estimate itself could have been derived from a subset of the total population, or perhaps the mean of the population is subject to change.[1]

Identifying whether a divergence from a particular mean is the result of expected volatility or misestimation is a critical task, because the reason for the divergence may affect management action. Although the task is critical, the identification of the reason may be challenging until the experience associated with the block of business is credible.

[1] For example, a binomial distribution will have a mean of "p" and a variance of p(1-p). The "p" value could have been assumed based on the maximum likelihood estimate of actual historic experience. The actual historic data may be limited or represent a sample that is not representative of the population to which it is being applied. The population parameter may also be subject to change over time. Therefore, the "p" value may be misestimated, and consequently the estimated value of the volatility risk as well as the average future outcomes may be wrong.

Projection assumptions for LTCI are complex. Morbidity is normally distinguished by marital status, age, gender, underwriting risk assessment, policy duration, and other demographics. It consists of three distinct components: incidence of claim, continuance on claim, and utilization while on claim. These components could be segmented further, breaking them out distinctly for nursing home, assisted living facility, and home health care, and/or for ranges of lifetime maximum benefits (e.g., unlimited or limited).

Similarly, mortality needs to be addressed separately for healthy (active) lives and disabled lives. In addition, the actuary considers such policyholder characteristics as gender, marital status, underwriting risk class, and issue age. Some will segment the disabled lives mortality further into nursing home, assisted living facility, and home health care. And some will segment it further into ranges of benefit options.

Lapses may even be addressed differently by segmenting the populations for policies with and without automatic benefit increases, and certainly with and without limited payment options.

Investment yields may appear straightforward to consider, but the anticipated and implemented investment strategies render them very complex. Furthermore, the LTC inflation explicitly or implicitly assumed in the utilization component of morbidity is likely correlated with investment yields.

The notion of correlation is not isolated to investment yields and inflation rates. If lapses are high, morbidity rates may be higher than expected because of adverse selection. And, if morbidity is higher than expected, mortality may be as well.

Each of these assumptions is an integral part of (a) pricing a policy; (b) assessing the value of an in-force policy, whether for reserving, cash flow testing, or valuing a block of business; and (c) determining whether a rate increase for a block of policies is warranted and, if so, the amount of the increase. Furthermore, the potential for volatility and misestimation associated with each of the assumptions requires additional capital to support any deviations that actually occur.

Discussion of Application and Impacts

Determination of Original Pricing

Assumptions generally are set using past experience and an actuary's assessment about whether historical factors may change in the future. Using historical data for the pricing of new policies will require a review of differences in policy features and triggers, underwriting, and potentially target customer or sales approaches.

Assuming that a mean is accurately estimated, volatility around the mean (as defined above) generally should not have an effect on the ultimate pricing of a block of business. For example, some years may have worse experience than the mean and some have better experience than the mean, but mean experience should be expected over time.

Misestimation is a bigger issue for pricing a block of business. If the morbidity rates are underestimated (by whichever dimension(s) of the morbidity factors listed above), the block is likely underpriced, which may result in a rate increase being needed for the block. If, on the other hand, mortality or lapse rates are underestimated, this will result in fewer individuals persisting and potentially fewer claims on a block of business than expected, assuming that (1) improved mortality is not accompanied by fully offsetting improved morbidity, and (2) lapses are not antiselective to the degree that they fully offset gains anticipated due to lapse.

Depending on how assumptions are set, there may be offsetting results. If an actuary underestimates morbidity incidence but overestimates morbidity continuance and salvage, the actuary may determine that the block is priced sufficiently even though the individual parameters may not be accurate. While this may not result in corrective action being needed for an existing block, a company may consider updating its pricing on new blocks assuming it expects this relationship to persist into the future. There are other combinations of misestimations of liability assumptions that may result in the business as a whole being priced in a reasonably accurate manner in the aggregate.

Investment yield overestimation may result in the reduced financial performance of a block of business. If the inflation of LTC services is highly correlated to general inflation and the policy benefits are based on actual incurred LTC expenses, the reduced investment income may be offset by smaller benefit dollars being paid. However, even if inflation is highly correlated to investment yields, the investment strategy may not address the correlation adequately and a mismatch of investment yields and inflation may mean reduced financial performance. Also, if the applicable accounting requires that the reserve basis remains static over time, reserves that assume a higher-than-actual investment yield will require an infusion of assets that were not earned by the actual investment income.

Determination of Rate Increases

Maintaining an accurate and comprehensive record of assumptions, expectations, and projections will help management understand how to react to actual experience throughout the life of the policy.

Pursuing rate increases is a potential management response to the recognition of an actual misestimation. Future assumptions may be reset because revised future experience is expected to be materially adverse relative to original expectations. The future assumptions may be revised because historic deviations are determined to be due to misestimation of assumptions rather than volatility—for example, lower-than-expected mortality and/or voluntary lapse rates that are reasonably expected to continue into the future (though the adverse effect of a smaller lapse rate may be tempered by a corresponding influence of lower lapses on adverse selection assumptions in morbidity). Future assumptions also may be revised if new information suggests a modification is necessary. For example, if a shortage of nursing students lasts for a prolonged period of time, it may be appropriate to assume that the cost of nursing care in the future will increase more quickly than previously recognized.

Valuation Projections

Best estimate assumptions are necessary for projecting the future experience of existing LTCI business for asset adequacy testing and for deferred acquisition costs recoverability testing. These projections rely on the same types of assumption analyses as used for pricing, but valuation projections also recognize that different and additional information may be available. Proactive management may be able to assess whether any deviations from expected should be attributed to volatility or misestimation. If they are attributed to misestimation, the deviations will warrant a change in the best estimate assumptions used in the projections.

Appraisal of a Business

Similar to pricing and valuing LTCI business, the assumptions applied in appraising a business are critical to assessing the value of the business. Given that a business that undergoes an appraisal generally will have been in force for some period of time, the original expectations for each assumption may be compared to new sources of information, for example:

- Any actual emerging experience from the block being appraised and/or from similar blocks of business (with due consideration to differences in underwriting methodology, distribution approach, claims adjudication practices, and history of rate increases on either block); and
- Revised expected trends for the business in the future (with due consideration to correlation of each set of assumptions).

An accurate assessment of whether volatility or misestimation is driving deviations in the historical experience will be integral in appraising the business.

Surplus Capital

Insurers may use assumption distributions to identify capital requirements. For example, if the insurer wants to be confident that in the next 12 months it can withstand adverse events with a probability of 99.5 percent, it can stochastically or statistically identify the capital required to withstand both adverse volatility and adverse misestimation risks.

Sometimes the underlying distributions are not known. In such cases, an insurance company can use statistical methods that work with unknown distributions to arrive at a reasonable capital requirement.

Summary

There are many impacts of assumptions in the LTCI business. Any of these assumptions separately or in combination may experience volatility or may be misestimated. Understanding whether the assumption divergence is a temporary random fluctuation or a permanent misestimation will be an important part of assessing the financial performance of a block of business and determining the approach to the management of a block of business. Credibility procedures relate to the measurement and management of volatility risk.

SECTION III

Credibility Theory

The focus of this section is on rate-setting given the research summarized; however, the concepts apply to all key LTCI-related assumptions and associated actuarial work.

A Summary of the History of Credibility Theory

Credibility theory was developed initially by property and casualty actuaries in the context of experience rating. The issue was the proper weight, if any, that should be given to a risk's prior loss experience. For risks large enough, with a wealth of prior experience data, it would make sense to base rates on that risk's experience. On the other hand, for small risks, prior experience may be a poor predictor of future losses, and hence may not be a suitable basis for setting rates.

Two questions arise—the first of which is: What amount of prior experience is sufficient to determine the individual risk's rate? In other words, what amount of data is sufficient to make dependable estimates and predictions? Such data is termed to be "fully credible." The word "dependable" is imprecise and is meant to indicate that this concept relies on individual circumstances and the actuary's judgment.

An early treatment of that question appeared in a 1914 paper by Mowbray.[2] Mowbray used the normal approximation to the binomial distribution to provide an estimate of the number of exposures (or equivalent number of claims) needed to reliably predict accidental deaths with a desired accuracy. (He was interested in industrial accidents in the context of workers' compensation insurance.)

While Mowbray's paper provided a way to calculate a number of claims needed for full credibility, it did not address the case of data that falls short of that number. That created a dilemma—if no credibility were to be given to the risk whose experience is just shy of the selected full credibility threshold, two similar risks may end up paying very different premiums.

[2] Mowbray, A.H. "How Extensive a Payroll Exposure is Necessary to Give a Dependable Pure Premium?" *Proceedings of the Casualty Actuarial Society 1* (1914): 24-30

This led to the second question: What to do if experience falls short of being fully credible? The answer to this question is a subject of "partial credibility."

In 1918, Whitney[3] proposed a solution to the partial credibility problem. He sought a compromise estimate between the portfolio experience and the individual risk's experience. Interestingly, his solution did not employ the concept of full credibility at all. Rather he arrived at a linear combination of the form $C = ZS + (1\text{-}Z)M$, where S was the loss frequency determined based on the risk's own experience, M was overall portfolio loss frequency, and Z was a credibility factor of the form $n/(n+K)$, where n was number of prior claims for the rated risk and K was a constant.

Whitney used confusing notation, and his paper is difficult to read. Remarkably, though, he made some observations relevant to "greatest accuracy" credibility theory that will be discussed later. For one, a credibility factor of Z can never be 1. That is, no amount of data is deemed fully credible. Second, he noted that experience rating (and the concept of partial credibility) requires heterogeneity in the portfolio.

The concept of the credibility-weighted premium being a linear function $C = ZS + (1\text{-}Z)M$ with some weight Z (referred to as credibility factor) was widely adopted by the actuarial community, but there was no universally accepted formula for Z.

Perryman[4] provided some heuristic argument for the credibility factor $Z = \sqrt{n/n_F}$, where n is the number of prior claims for the rated risk and n_F is the number of claims deemed fully credible. Longley-Cook[5] gave some rationale for using $Z = 3n/(2n + n_F)$; others suggested $Z = (n/n_F)^{2/3}$.

There is little or no theoretical support for most of these credibility factors. In fact, in order to provide theoretical support, one needs some measure of "goodness." That is, given two choices for credibility factors, one needs a metric to decide which one is better. In statistics, it is common to seek an estimator that is "best" in a particular class. The early development of a credibility factor did not provide a framework for comparing different approaches.

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[3] Whitney, A.W. "The Theory of Experience Rating." *Proceedings of the Casualty Actuarial Society 4* (1918): 274-292
[4] Perryman, F.S. "Some Notes on Credibility." *Proceedings of the Casualty Actuarial Society 19* (1931): 65-84
[5] Longley-Cook, L.H. "An Introduction to Credibility Theory." *Proceedings of the Casualty Actuarial Society 49* (1962): 194-221

Bailey[6] generally is credited with proposing a Bayesian approach to the credibility theory. He showed that for several classes of loss distributions (or, more exactly, combinations of a loss distribution and the distributions of its parameters), the Bayesian estimator that minimizes the mean square error is a linear function $C = ZS + (1\text{-}Z)M$, where Z is of the form $n/(n+K)$.

Bailey's approach—seeking a credibility premium that minimizes the mean square error—is a foundation of the "greatest accuracy" credibility. Buhlmann[7] considered the case in which subsequent observations from a risk to be rated are conditionally independent and identically distributed. He showed that in this case the best linear approximation to the Bayesian estimator is of the form $C = ZS + (1\text{-}Z)M$ with $Z = n/(n+K)$, where K reflects the measure of heterogeneity of the pool from which the risk is selected.

Subsequently, Buhlmann-Straub[8] generalized Buhlmann's approach to the case in which subsequent observations are not identically distributed but have equal means and have variances inversely proportional to exposures. (If you think of observations being claim ratios, the second assumption reflects the fact that variance of a ratio is inversely proportional to the exposure.)

Although the application of Bayesian techniques generally requires some knowledge of the prior distribution, the parameters of the prior distribution can be estimated from the data.

There have been additional developments of the credibility theory (in the Bayesian setting), but they are beyond the scope of this monograph.

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[6] Bailey, A.L. "Credibility Procedures, Laplace's Generalization of Bayes' Rule and the Combination of Collateral Knowledge with Observed Data." *Proceedings of the Casualty Actuarial Society 37* (1950): 7-23

[7] Bühlman, H. "Experience Rating and Credibility." *ASTIN Bulletin 4* (1967): 199-207

[8] Bühlman, H., and Straub, E. "Glaubwürdigkeit für Schadensätze." *Mitteilungen der Vereinigung Schweizer Versicherungsmathematiker 70* (1970): 111-133. Reprinted as "Credibility for Loss Ratios" (Brooks, C.E., trans.), Actuarial Research Clearing House (1972.2)

Credibility Methods—Limited Fluctuation, Greatest Accuracy, and Nonlinear

Full Credibility

The amount of data deemed sufficient for reliable estimates is termed “fully credible.” The concept of full credibility is closely related to the well-established statistical concepts of confidence intervals and hypothesis testing. Judgment is required in the choice of the desired accuracy (i.e., the departure of the estimate from the true value of the underlying parameter) and confidence level (i.e., likelihood of the estimate being within the selected accuracy of the true parameter value). Once these two are selected, standard statistical theory can be applied to determine the amount of data needed for full credibility.

Many actuaries practicing in the United States will be familiar with some “rules of thumb” like 1,082 claims being fully credible. These “rules of thumb” were developed under special assumptions regarding distribution of claims and may not be applicable in all circumstances. For example, the number of claims needed for full credibility will vary depending on the distribution of the sizes of claims.

Let S be a random variable representing the total claim amount for a particular risk. $S = X_1 + \cdots + X_N$ where N is a random variable representing the number of claims in an observation period and X_i represents an individual claim. Individual claim amounts X_i are assumed to be independent and identically distributed with some (possibly unknown) mean μ and standard deviation σ.

We want to find an expected number of claims, n_F that would guarantee that S is within ε percent of its true mean with the probability of 1-α, that is

$$P((1-\varepsilon)ES < S < (1+\varepsilon)ES) \geq 1-\alpha$$

Assuming that EN is large enough, S is approximately normally distributed, and therefore

$$\frac{ES}{\sqrt{Var(S)}} = \frac{z_{\alpha/2}}{\varepsilon}$$

where $z_{\alpha/2}$ denotes a quantile of the standard normal distribution.

As

$ES = EX \cdot EN = \mu EN$, and $Var(S) = (EX)^2 \cdot Var(N) + Var(X) \cdot EN = \mu^2 Var(N) + \sigma^2 ENVar(S) = (EX)^2 \cdot Var(N) + Var(X) \cdot EN = \mu^2 Var(N) + \sigma^2 EN$

we get

$$n_F = EN = \left(\frac{z_{\alpha/2}}{\varepsilon}\right)^2 \left(\frac{Var(N)}{EN} + \left(\frac{\sigma}{\mu}\right)^2\right)$$

Assuming that N has a Poisson distribution *EN = Var(N),* and

$$n_F = \left(\frac{z_{\alpha/2}}{\varepsilon}\right)^2 \left(1 + \left(\frac{\sigma}{\mu}\right)^2\right)$$

(Details of the derivation above can be found in Herzog.[9])

If claim amounts do not vary (as is the case when one estimates mortality rate by count), $\sigma = 0$, and the above formula reduces to

$$n_F = \left(\frac{z_{\alpha/2}}{\varepsilon}\right)^2$$

The table below shows the expected number of claims required for full credibility for selected levels of confidence and accuracy according to the above formula.

Probability of the estimate falling within the acceptable range

DESIRED ACCURACY	90%	95%	99%
+/- 2.5%	4,329	6,146	10,616
+/- 5.0%	1,082	1,537	2,654
+/- 7.5%	481	683	1,180
+/- 10%	271	384	663
+/- 20%	68	96	166

If claim amounts vary, the ratio σ/μ can be estimated from the prior experience and be used with the formula above to produce an expected number of claims needed for full credibility.

[9] Herzog, T.N. *Introduction to Credibility Theory*. Winsted, CT: ACTEX

We have assumed above that the number of claims has Poisson distribution. Mowbray assumed binomial distribution of the number of claims, in which case it is fairly easy to see that the formula changes slightly to

$$n_F = \left(\frac{z_{\alpha/2}}{\varepsilon}\right)^2 \left(1 - q + \left(\frac{\sigma}{\mu}\right)^2\right)$$

where q represents the probability of a claim in a binomial trial. As long as q is small, there's little difference between the resulting full credibility thresholds.

The two major shortcomings of this "full credibility" are that it is based on an arbitrary choice of desired accuracy and confidence and it offers no guidance if the data are not fully credible. It may be worth noting that when data are not deemed fully credible, a confidence interval for the parameter in question can still be constructed based on the desired level of confidence (although, as the amount of data decreases, it may not be appropriate to assume that the estimate is approximately normally distributed). If this interval is too wide, point estimate from the range may need to be selected.

Finally, we should note that no amount of data is absolutely fully credible—it is always possible to set accuracy and confidence so high that the data will fall short of being fully credible; however, this is purely theoretical. In practice, it would be unreasonable to demand an accuracy of being within 0.01 percent of true value with probability of 99.99 percent.

Partial Credibility

Imagine a large insurance portfolio comprised of many individual risks. Assume that the risks, while independent, are not homogenous. For an individual risk, there are two natural choices for estimates of future claims—an estimate based solely on the past observed experience of the risk and an estimate based solely on the past observed experience of the entire portfolio. When the risk's experience is fully credible, an actuary may wish to use the estimate based on that risk's experience. If the risk has no prior experience or if that experience is deemed not credible at all, the actuary may want to assume that the risk is "average" and use the portfolio's experience. What if the risk's experience is substantial but short of being deemed fully credible?

Partial credibility attempts to answer this question by using a linear combination of the two estimates. The method assigns a weighting (called credibility factor and usually denoted by Z) to the risk's own experience and gives the complement of this weight to the portfolio's overall experience. It is important to note that regardless of the method used to calculate the credibility factor, the resulting weighted estimate is biased unless the risk happens to be truly "average."

There are two widely accepted methods used to determine the appropriate credibility factor: limited fluctuation credibility and greatest accuracy credibility.

The **limited fluctuation approach** does not have as robust a theoretical backing as the greatest accuracy approach; however, it is often used by U.S. actuaries because of its simplicity and practicality. It produces fairly stable estimates from one experience period to the next, an important consideration when credibility is employed to determine an individual risk's premiums.

Using the same notation as above, if the credibility-weighted estimate is to be $C = ZS + (1\text{-}Z)M$, where Z is the credibility factor, S is the estimate based on risk's own experience and M is the estimate based on the overall portfolio experience, the limited fluctuation approach attempts to set Z so that the part of the estimate based on the risk's own experience, namely $Z\,S$, is within εES of its true mean ZES with high probability. Symbolically, we require that

$$P(-\varepsilon ES < Z(S - ES) < \varepsilon ES) \geq 1 - \alpha$$

Similarly as before, assuming that S is approximately normal and N has Poisson distribution leads to

$$n = EN = Z^2 \left(\frac{z_{\alpha/2}}{\varepsilon}\right)^2 \left(1 + \left(\frac{\sigma}{\mu}\right)^2\right) = Z^2 n_F$$

Solving for Z leads to a familiar square root formula, $Z = \sqrt{n/n_F}$.

By design, one would not expect the ZS component to change much from one rating period to the next. Hence, the entire credibility-weighted estimate C will tend to be very stable.

Note that the limited fluctuation theory heavily relies on judgment in selecting the parameters. Also, the credibility factor is developed with a goal of placing as much weight on the risk's own experience as possible while assuring stability of the resulting credibility premium. The credibility premium is not meant to be optimal or a best estimate of the risk's true premium.

Greatest accuracy credibility is essentially a Bayesian technique. Assume that $X_1, \dots, X_n$ represent claim amounts experienced by the risk being rated in prior n periods. Assume further that all X_i's have the same (possibly unknown) distribution that depends on a parameter θ. Finally assume that given θ, X_i's are independent.

One can think of θ as defining the risk profile of the individual whose claims are being observed. It is assumed that this profile remains the same from one observation period to the next, and that each period's observation is independent of other periods' observations. Different risks within the portfolio have different risk profiles.

For each risk in the portfolio, let $\mu(\theta) = E(X|\theta)$, and $\sigma^2(\theta) = Var(X|\theta)\sigma^2$. (Random variable X represents one period claim amounts for this risk.) $\mu(\theta)$ represents the risk's average claim amount which is assumed to stay the same from one observation period to the next. $\sigma^2(\theta)$ represents variance of claims amount for the risk from one period to the next.

Assuming we know the distribution of the parameter θ for the entire portfolio of risks, we can use Bayesian analysis to calculate posterior distribution of θ given observed claims $X_1, \dots, X_n$. Similarly, we can calculate expected value of X_{n+1} given $X_1, \dots, X_n$. Generally, expected value of X_{n+1} is not going to be a linear function of prior observations $X_1, \dots, X_n$; however, we can look for the best linear approximation to the Bayesian predictive mean. It turns out that it has the form postulated by Whitney

$$C = Z \cdot \bar{X} + (1 - Z)M$$

where $\bar{X} = (X_1 + \cdots + X_n)/n$ is the mean of prior observations, $M = E[\mu(\theta)]$ is the expected claim across all risk profiles (unconditional mean), and $Z = n/(n+K)$ with the constant K given by

$$K = \frac{E[\sigma^2(\theta)]}{Var[\mu(\theta)]}$$

The numerator in the expression for K is typically referred to as the expected value of the process variance (EPV). For each risk in the portfolio, claim volatility across time may be different. EPV represents the mean of these volatilities. A small value of EPV means that for most risks, claim amounts do not vary much from one period to the next. Subsequently, few observations should be sufficient to get a confident estimate of the average claim. And indeed, small values of K correspond to a high credibility factor.

The denominator in the expression for K is typically referred to as the variance of hypothetical means (VHM). It is a measure of heterogeneity of the portfolio. If all risks have similar expected claims, prior experience gives us little information. And indeed, large values of K correspond to low credibility. Note that if all risks in the portfolio have identical expected claims (same expected mean $\mu(\theta)$), the denominator in the expression for K becomes 0 and K itself becomes infinity. That is, no matter what the size of the prior experience, it has zero credibility. This is because, if all risks have the same expected claims, individual risk's experience does not contribute any information as to its expected mean (beyond what is known for the entire portfolio).

Application to LTCI

The limited fluctuation approach usually can be carried out. It requires a full credibility threshold and a complement of credibility. The first usually can be determined based on the selected parameters of accuracy and certainty and the coefficient of variation of the underlying distribution. Industry studies, consultant data, or original pricing assumptions can serve as a source of information for a selection of the complement of the credibility.

Suppose that an actuary calculates the claim ratio (the ratio of actual claims to expected claims) for a block of LTCI policies. A ratio in excess of 1 may be a result of statistical variation, incorrect pricing assumptions, or both.

An Academy report[10] suggests that the following approach may be reasonable for determining a credibility-weighted estimate for the claim ratio for a block of LTCI policies.

Assuming that claim incidence has a Poisson distribution, the expected number of claims required for full credibility is

$$n_F = \left(\frac{z_{\alpha/2}}{\varepsilon}\right)^2 \left(1 + \left(\frac{\sigma}{\mu}\right)^2\right)$$

Accuracy and confidence levels of 5 percent and 90 percent, respectively, result in the first factor in the formula above being 1,082. The second factor could be estimated from the data or based on professional judgment. If the second factor equals 3, then that will yield a full credibility standard of 3,246.

Now, the credibility-weighted estimate of the actual claim cost becomes $C = ZA + (1\text{-}Z)E$, where A equals the actual observed claim cost, E is the expected claims cost and $Z = \sqrt{n/3{,}246}$ is the credibility factor (n is the number of actual claims in the data).

[10] Long-Term Care Reserving Work Group—Credibility Subgroup, *Progress Report*, American Academy of Actuaries, 2003

Finally, the credibility-weighted estimate of the claim ratio becomes $R = Z(A/E) + (1\text{-}Z)$.

The choice of the complement of credibility E plays an important role here. Limited fluctuation credibility provides some heuristic explanation for the credibility factor, but gives no guidance on the choice of the complement. Depending on the circumstances, in the example above, it may be appropriate to use the claim cost expected in pricing, one based on the overall experience of the company (across many blocks of LTCI business), or one based on external inputs (e.g., industry studies or consultant data).

The greatest accuracy approach presents more challenges. There will often not be sufficient information to fully execute the approach. One of the approaches proposed in Hardy and Panjer[11] is to calculate annual actual-to-expected ratios for which the expected is some standard basis. This may work well for mortality in cases in which there is generally a standard reference table. It also may work reasonably well for lapses and incidence rates. The goal would be to calculate a credibility estimate of the ratio of company experience to the standard table.

Typically, an insurer will be able to observe the volatility of this ratio from one year to the next, but it may lack the data to know the variability among companies. To calculate the credibility factor, one would need the industry mean actual-to-expected ratio (that would also serve as a complement of credibility), the variance of ratios among companies (or block of business), and mean annual volatility of the ratio.

As noted above, many challenges disappear when credibility is applied to make adjustments to the segments of the portfolio. In that case, the actuary will have available information on the volatility of annual loss ratios for the segments, variance of ratios between the segments, and overall ratio for the portfolio.

Here is an example of the application of the Buhlmann-Straub model to the mortality data (from Hardy and Panjer).

An intercompany mortality study collects mortality data from a number of insurance companies. Let S_{ij} represent number of deaths for company i in year j, $i = 1, \dots, n; j = 1, \dots, k$. (The study encompasses k years of experience from n companies.)

Let P_{ij} denote the expected number of deaths based on the $i^{\underline{th}}$ company exposure in year j and a standard mortality table. Finally, let $X_{ij} = S_{ij}/P_{ij}$ denote actual-to-expected ratio of actual deaths to tabular deaths.

[11] Hardy, M.R., and Panjer, H.H. "A Credibility Approach to Mortality Risk." *ASTIN Bulletin* 28(2): 269-283

Our goal is to find the credibility estimate of expected value of $X_{i\,k+1}$ given the observed values $X_{i1}, \dots, X_{ik}$. That is, we want to predict the level of $i^{\underline{th}}$ company mortality (as a multiple of the standard table) for the next year.

Consistent with Buhlmann-Straub model it is assumed that

$$E\left[X_{ij}\middle|\theta_i\right] = \mu(\theta_i) \qquad and \qquad Var[X_{ij}|\theta_i] = \frac{\sigma^2(\theta_i)}{P_{ij}}$$

Recall that the first of these two conditions means that the expected value of the mortality ratio X_{ij} for a given company i does not change from one year to the next. The second condition states that the variance of the ratio changes only due to differences in exposures.

(Hardy and Panjer make an additional assumption about the fourth central moment that we will omit, as it does not appear in the credibility formula.)

Let $P_i = \sum_{j=1}^{k} P_{ij}$ denote the total expected (tabular) claims for the company i. If we were to predict $X_{i\,k+1}$ solely on the basis of the past observed experience of the $i^{\underline{th}}$ company, we would calculate overall experience ratio

$$\bar{X}_i = \frac{1}{P_i}\sum_{j=1}^{k} P_{ij}X_{ij}$$

It turns out that the credibility estimate (the best linear approximation to the Bayesian estimator) is

$$\tilde{\mu}_i = Z_i\bar{X}_i + (1 - Z_i)E[\mu(\theta_i)]$$

where

$$Z_i = \frac{P_i}{P_i + \varphi} \qquad \text{and} \qquad \varphi = \frac{E[\sigma^2(\theta_i)]}{Var[\mu(\theta_i)]}$$

Even though in practice, exact distributions of $\mu(\theta_i)$ and $\sigma(\theta_i)$ are unlikely to be known, they can be estimated from the data (see Hardy and Panjer [11] for details).

Other examples of application of the credibility theory to the estimation of the mortality and lapse rates can be found in *Credibility Theory Practices.*[12]

[12] Klugman, S., Rhodes, T., Purushotham, M., and Gill, S. *Credibility Theory Practices*. Society of Actuaries/MIB Solutions

Challenges & Limitations

It should be noted that, under both approaches (i.e., limited fluctuation and greatest accuracy), there is a concern about whether past experience is a good predictor of the future.

Unlike the property and casualty practice area in which credibility theory had its beginnings, LTCI typically requires a long time to develop meaningful experience. Therefore, in many cases, estimates derived from one group of policyholders may need to be applied to predict experiences of another group of policyholders. Due to changes in benefit designs, care delivery systems, historical pricing, and other factors, the experience of individuals that bought the policies in the 1990s may be significantly different from the experience of those who are buying it today.

Similarly, many assumptions vary not only by issue age, but by policy duration, benefit design, and potentially other factors. What is deemed to be a fully credible experience may cover only some durations or attained ages. It is unclear whether credibility theory can be used to formulate accurate predictions about future experience that involves later durations and higher attained ages.

In the case of the limited fluctuation approach, assumptions may need to be made regarding the complement of credible experience (i.e., the subject experience). It is possible for a block of business to be sufficiently different from the industry average that a credibility-weighted estimate is implausible. That is, standard hypothesis testing would return a very small p-value. Even if that is not the case, there may be several competing complements of credibility, and it may not be clear which of them is most suitable.

Note that this problem does not exist in the situation in which credibility theory is used to adjust rates between segments of the portfolio. In that case, the overall portfolio provides a natural source for the complement of credibility. An example of that could be a situation in which an actuary decides to use credibility theory to adjust rates by state.

Why Credibility Procedures Are Useful

While the two most common credibility approaches have been outlined above, we have only touched on the reasons why credibility procedures are useful tools for an actuary. That said, a number of reasons have been outlined in other sections of this monograph.

Whitney's [2] early work on credibility cited "the necessity, from the standpoint of equity to the individual risk, of striking a balance between class-experience on the one hand and risk-experience on the other." Is this "equity" issue relevant in the context of LTCI?

In his overview of the credibility theory, Goulet[13] gives the following guidance regarding the choice between the two methods:

- "The goal of partial limited fluctuation credibility … is to incorporate into the premium as much individual experience as possible while still keeping the premium sufficiently stable."
- The goal of the greatest accuracy approach "is to find the best premium to charge an insured, where the best is in the sense the premium estimator is the closest estimator to the true premium."

Goulet goes on to state, with respect to the greatest accuracy approach, that the credibility factor, "will henceforth mostly reflect the degree of heterogeneity of the portfolio, rather than the degree of stability of an individual risk's experience." This is a crucial point. For a homogenous portfolio, credibility has little to offer. All risks are similar, so the overall portfolio experience can be used to determine premiums that are commensurate with risk, and individual risk experience adds no information. For a portfolio composed of large but identical risks, limited fluctuation theory may assign full credibility to each risk's experience, but greatest accuracy credibility may assign them no credibility at all.

[13] Goulet, V. "Principles and Applications of Credibility Theory." *Journal of Actuarial Practice Vol. 6* (1998): 5-62

SECTION IV

Considerations in the Selection of Credibility Procedures for LTCI

The following is a summary of the items that might be considered when selecting credibility procedures for LTCI-related actuarial work.

Professional and Regulatory Sources

Applicable state and federal laws, regulations, and rules should be considered when selecting credibility procedures for LTCI-related actuarial work. An actuary, in particular, may consider any relevant ASOPs, other professional guidance, and other relevant resources as well. High-level summaries of this information are included in the Appendix.

Purpose and Application

Actuaries may want to consider the purpose and the application of the LTCI-related actuarial work when determining what credibility procedure(s) might be used. A number of questions could be asked in this regard: What is the context? Should the impact of the credibility procedure tend to be conservative or aggressive, and what would that mean practically? Should the procedure be more responsive to emerging experience or lead to more stable results?

Subject Experience

When reviewing subject experience for the purpose of applying credibility procedures, it would be useful to consider all underlying characteristics or variables that could lead to material differences in results, including (for example):

- Underwriting;
- Benefit qualifications/triggers;
- Administration, and especially claim adjudication;
- Distribution;
- Product features (e.g., benefit period, elimination period, expense reimbursement vs. indemnity, restoration of benefits, etc.); and
- Anything else experience indicates.

While many variables would need to be considered for nearly all blocks of business and applications, experience analyses might lead an actuary to consider other variables as well.

In situations where limited data are available for one or more variables, data across those variables potentially could be combined to improve the credibility of the subject data (i.e., when the current dataset is expected to resemble the future dataset with respect to the underlying distributions of business).

Related Experience

When considering related experience for the purpose of applying credibility procedures, the following factors might be considered regarding the potential data sources:

- Accessibility;
- Quality;
- Types and amounts of information for each covered person; and
- Experience period (i.e., relative to the target experience period).

In addition to considering the source(s) of the related experience (e.g., insured vs. population data), the homogeneity/heterogeneity of the amounts and underlying characteristics of that data compared to subject data might be considered, including:

- Underwriting;
- Benefit qualifications/triggers;
- Administration, and especially claim adjudication;
- Distribution;
- Product features (e.g., benefit period, elimination period, expense reimbursement vs. indemnity, restoration of benefits, etc.); and
- Anything else the experience indicates.

The goal would be to identify a source of related experience that is as similar to the subject experience as possible, but that includes more data (i.e., as much as possible) than the subject experience does at the applicable level(s).

Full and Partial Credibility

After applying the selected credibility procedure to the subject experience and determining the credibility attributable to that experience for a given assumption to be utilized in a given context, and then identifying a corresponding body of related experience, the following concepts could apply:

- **Full credibility**: The subject experience could be deemed fully credible and the optimal source of data for the assumption and context at hand. No related experience would be required in this scenario.
- **Partial credibility**: The subject experience could be deemed to have some level of credibility attributable to it, but not so much that it could not be informed by related experience. In this scenario, the subject experience and the related experience would be combined as referenced below.

In the latter scenario, when the subject experience is deemed to have some level of credibility attributable to it, the subject experience and the related experience could be combined in some manner in the development of a best-estimate result.

The Application of Credibility Theory to LTCI

The previous section of this monograph summarized relevant credibility theory for review and consideration when selecting credibility procedure(s) for LTCI-related applications. While the principles and formulae presented in that section may inform the selection of such procedures, it will also be helpful to discuss the practical application(s) further in this section as well.

Much of this monograph has focused on the concept of and proposed formulae that relate to limited fluctuation credibility theory and its application to developing projected claim costs. To summarize, this area of credibility theory addresses the question of whether a company has enough experience to (for example) develop projected claim costs or even a specific assumption based on its own data, or whether external (i.e., industry) data should be used to do so. When a given company's data are deemed to not be fully credible, as defined in limited fluctuation credibility theory given the parameters selected, formulae for weighting its data with industry average data are applied.

As most actuaries practicing in the area of LTCI are aware, the practical application of limited fluctuation credibility theory is challenging for this product. LTCI data is heterogeneous and continues to evolve with time, which limits the ability to develop large homogeneous datasets that can be used to represent industry averages. LTCI has been available in the market in various forms since the 1980s. Over the past 30 years, the business has evolved considerably. Benefits, coverages, underwriting, claims management practices, and care delivery have evolved over time and vary greatly from insurer to insurer. With this much historical and ongoing variation, it would be difficult to collect a sufficiently large homogeneous dataset to achieve full credibility as defined by limited fluctuation credibility theory, depending on the parameters selected.

Limited fluctuation credibility theory is also difficult to apply in the area of experience monitoring. Given the issue-age premium rating structure and steep morbidity curve that are characteristic of LTCI products, it might be impractical for an insurer to wait for fully credible experience, as defined in limited fluctuation credibility theory given the parameters selected, to emerge before reacting to observed experience deviations. Delays in reaction increase the severity of any required corrective actions, which might jeopardize the financial status of the insurer and might have adverse effects on policyholders. On the other hand, insurers should not be too quick to react to experience fluctuations that occur naturally as a result of the volatility that is inherent in a low-incidence product.

When applying credibility theory to the practice of experience monitoring, it might be important to consider going beyond determining whether or not observed experience for a given assumption is fully credible. It might also be important to ask the questions, “How credible is the observed experience?” and “Is the observed experience credible enough to demonstrate that a given assumption is incorrect?”

The first question could be answered by applying classic statistical credibility theory to the observed data. For example, if one assumes that claim incidence rates are binomial in nature (i.e., a person not already on claim either incurs a claim during an observation period or does not), then the standard deviation for an observed claim incidence rate would be

$$\frac{\sqrt{nq(1-q)}}{n}$$

where n equals exposures (e.g., life years) and q equals the observed incidence rate.

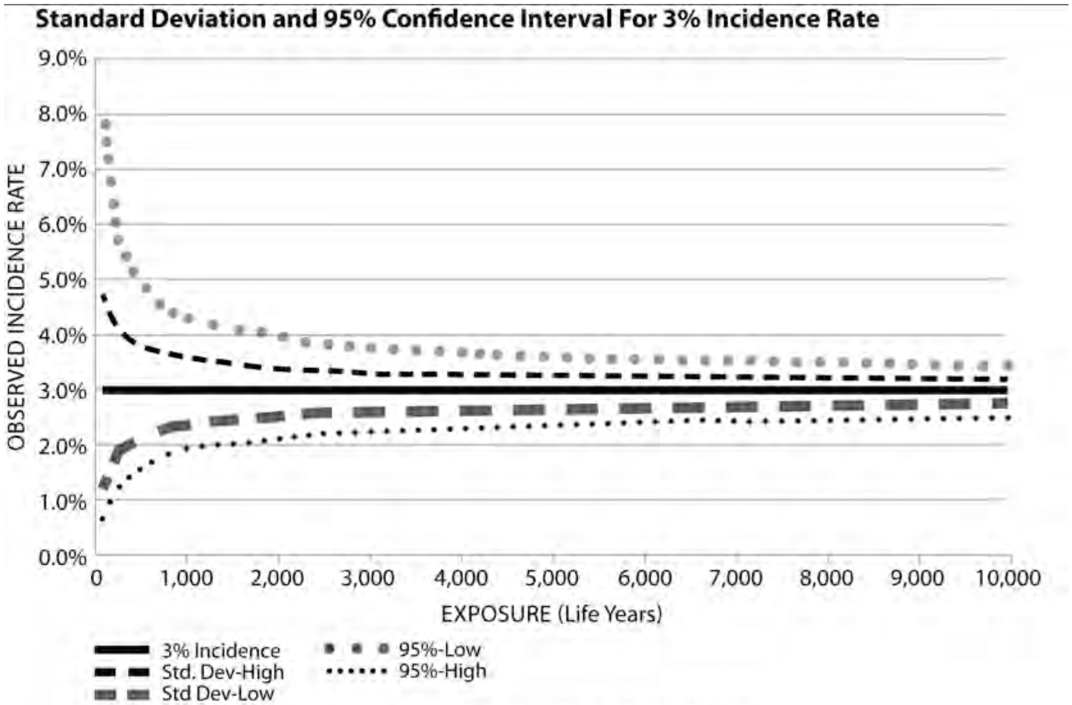
This formula allows the actuary to provide a sense of the credibility attributable to the observed data. The table below illustrates the statistical credibility of observed incidence rates for various exposures in life years:

One Standard Deviation is +/- the Following:

OBSERVED INCIDENCE	EXPOSURES (Life Years)							
RATE	100	250	500	1,000	2,500	5,000	10,000	20,000
0.5%	0.71%	0.45%	0.32%	0.22%	0.14%	0.10%	0.07%	0.05%
1.0%	0.99%	0.63%	0.44%	0.31%	0.20%	0.14%	0.10%	0.07%
3.0%	1.71%	1.08%	0.76%	0.54%	0.34%	0.24%	0.17%	0.12%
5.0%	2.18%	1.38%	0.97%	0.69%	0.44%	0.31%	0.22%	0.15%
10.0%	3.00%	1.90%	1.34%	0.95%	0.60%	0.42%	0.30%	0.21%
20.0%	4.00%	2.53%	1.79%	1.26%	0.80%	0.57%	0.40%	0.28%
30.0%	4.58%	2.90%	2.05%	1.45%	0.92%	0.65%	0.46%	0.32%

Developed by work group members based on the binomial distribution formula.

A graphical view of the convergence of the confidence interval for a 3 percent observed incidence rate is provided below. In addition to the standard deviation, the 95 percent Bayesian confidence interval is also displayed.



Developed by work group members based on the binomial distribution formula.

This sense of the credibility of observed data can be useful in making informed judgments about how to both interpret and present emerging experience results to management.

In order to answer the second question ("Is the observed experience credible enough to demonstrate that a given assumption is incorrect?"), comparing the observed experience to what was expected using the corresponding assumption, along with exposure counts, may be useful. For example, if the expected incidence rate for an observation period is 2 percent and the observed incidence rate is 3 percent, one could be 95 percent confident that the expected incidence rate is incorrect, even with as little as 1,000 life year exposures. Other examples in which the expected and observed rates are closer and exposures are greater could be reviewed and presented in the context of how likely it might be that the expected assumption would remain appropriate.

SECTION V

Impact of Credibility Procedures Used

and Resulting Attributed Credibility on the Presentation of Results

One impact of applying credibility procedures to LTCI-related work is that the actuary gains a sense of the magnitude of the lack of certainty associated with a given assumption and/or a result. Given that, it is important to present results in such a manner that they communicate the appropriate level of uncertainty.

While many actuarial projects require a single answer to a given question (e.g., a single best-estimate gross premium reserve value), presenting assumptions and/or results in continuums or ranges would provide the appropriate context for reviewing and interpreting those assumptions and/or results. For example, the answer to a question might be a single average number, but that number could be presented in the context of a range of values within which X percent of actual results would be expected to fall. This could be communicated via table, graphically, or both.

The ranges or continuums of results referenced above could be developed via the following means:

- **Sensitivity testing:** Running a small number of tests reflecting fixed deviations from starting-point assumptions either individually or in combination. The deviations would generally be determined using actuarial judgment (i.e., are not statistically based) and would be symmetrical in nature.
- **Multi-scenario deterministic testin**g: Running a much larger number of tests reflecting fixed deviations from starting-point assumptions either individually or in combination. The deviations would generally be determined using actuarial judgment (i.e., are not statistically based), but the ranges would be much larger and symmetrical in nature.

- **Stochastic testing:** Running a much larger number of tests reflecting deviations from starting-point assumptions, either individually or in combination, developed based on statistical distributions usually based on actual historical experience. The deviations would be determined using statistical distributions and simulation tactics, and the ranges would also be determined utilizing those distributions and tactics.

SECTION VI
Next Steps

The purpose of this monograph is as follows:

- To increase the awareness of the applicability of credibility procedures to LTCI-related work and the importance of applying them to that work;
- To provide information regarding the current practice, relevant publications, and underlying theory that an actuary could reference to inform the application of credibility procedures to LTCI-related work;
- To outline considerations for deciding on and applying credibility procedures to LTCI actuarial work, as well as presenting results; and
- To suggest next steps for advancing actuarial practice in this regard.

This monograph is a first step toward developing professional actuarial guidance relating to this topic. The consensus of the group is that more specific guidance would be helpful once the body of research regarding this topic is more developed and there are clear best practices regarding some LTCI-related topics.

The following are two potential research ideas:

- Developing a comprehensive summary of credibility theory with direct applicability to LTCI-related actuarial work; and
- Performing research in which differing credibility procedures, methods, and assumptions are tested on actual blocks of historical data with the goal of developing recommended approaches to applying credibility procedures to various LTCI-related work and in various contexts.

Appendix

Members of this work group have significant experience in all areas of LTCI-related actuarial practice, including product development and pricing, experience analysis, valuation and financial reporting, projections, etc., in insurance company, consulting, and regulatory contexts. Based on the experience of those on the work group and their knowledge of actuarial practice, there do not appear to be any common practice patterns relating to the application of credibility theory or procedures to LTCI-related actuarial work. In fact, our experience would indicate that there are differing approaches to applying credibility theory and/or procedures to LTCI-related work, and even understanding whether the application of credibility theory and/or procedures is required in LTCI-related work.

Relevant Documentation

In order to facilitate LTCI actuaries' review of this subject matter, we have assembled a list of potentially relevant documentation related to the application of credibility theory and/or procedures to LTCI-related actuarial work. The following list was compiled in a document titled Consolidated Notes *Pertaining to Credibility* developed by the SOA/AAA LTC Pricing Work Group - Subgroup B:

- American Academy of Actuaries' Life Valuation Subcommittee, *Credibility Practice Note*, July 2008;
- Mahler, H.C.; and Dean, C.G., *"Credibility,"* Chapter 8, 2001;
- Hassett and Januzik, *Credibility: Theory Meets Regulatory Practice*;
- Stuart Klugman, Society of Actuaries, *Session slides for "Credibility Theory," 2007 Valuation Actuary Symposium*, September 18, 2007; and
- Longley-Cook, "*Credibility and Event Counts*" Table, 1962.

The following additional documents were identified by members of the work group as worthy of consideration as well:

- Society of Actuaries Health Section, *Issues in Applying Credibility to Group Long-Term Disability Insurance*, SOA, 2013;
- Robinson, SOA Health Section news article, *"Credibility Theory for the Health Actuary: The Need for an Inter-Company Experience Study" (*Pages 6-9*)*, 2000;

- The Committee on Life Insurance Research, The Financial Reporting Section the Product Development Section of the Society of Actuaries, *Credibility Theory Practices,* SOA, 2009;
- Long-Term Care Reserving Work Group—Credibility Subgroup, *Progress Report*, American Academy of Actuaries, 2003;
- Society of Actuaries' Long-Term Care Insurance Section, *Understanding the Volatility of Experience and Pricing Assumptions in Long-Term Care Insurance*, SOA, 2014; and,
- Society of Actuaries' Long-Term Care Insurance Section, *The Volatility in Long Term Care Insurance Report*, SOA, 2014.

While the 2003 summary from Academy LTC Reserving Work Group – Credibility Subgroup is the only document we have identified for which the purpose was to develop and present an approach to applying credibility theory and procedures to LTCI-related actuarial work (and, in this case, specifically in the development of morbidity assumptions), and while it has been used in practice by some, it should not be considered a comprehensive or authoritative document on the subject.

As referenced previously, state laws and regulations sometimes prescribe credibility standards to be applied to LTCI-related actuarial work. While knowledge of and compliance with any applicable state laws and regulations are required in LTCI-related actuarial work, a specific discussion of those standards is outside the scope of this monograph. There is a brief summary of state credibility standards included in the *Consolidated Notes Pertaining to Credibility* discussed earlier in this section.

Relevant ASOPs

The following is a list of the references to credibility in current ASOPs with annotations as necessary:.

ASOP No. 3: Continuing Care Retirement Communities
(http://www.actuarialstandardsboard.org/pdf/asops/asop003_124.pdf)

This standard includes the following language:

> "3.8.6 Reasonableness of Assumptions—The actuary should review the assumptions for reasonableness. The assumptions should be reasonable, in the actuary's professional judgment, in the aggregate and for each assumption individually, using relevant information available to the actuary.

In reviewing the assumptions for reasonableness, the actuary may consider such factors as the following:

a. the purpose of the measurement;
b. the frequency with which the projections are expected to be updated;
c. the length of the projection period;
d. the sensitivity of the projections to the effect of variations in key actuarial assumptions;
e. the potential variability of the assumption;
f. the size of the CCRC's resident population;
g. the ability to increase fees or decrease expenses in future periods;
h. the level of surplus available to provide for adverse fluctuation; and
i. any significant margins for uncertainty which have been included in the actuarial assumptions."

(Authors' comment: Most Continuing Care Retirement Communities (CCRCs) do not have very credible data due to low incidence levels. Blending the data of a partially credible CCRC with other data requires particular care in assuring adequate homogeneity. The credibility measure for both the CCRC and any source of complementary data could be critical to the appropriate valuation and rate setting for the CCRC.)

ASOP No. 5: Incurred Health and Disability Claims
(http://www.actuarialstandardsboard.org/pdf/asops/asop005_126.pdf)

This standard includes the following language:

> "3.4 Data Requirements and Assumptions— … Consistent with ASOP No. 23, *Data Quality*, the actuary should make appropriate efforts to obtain accurate data from claim processing reports, accounting systems, and other relevant internal organization sources in order to determine incurred claims. External sources may be needed to provide reasonableness checks on limited data."

ASOP No. 7: Analysis of Life, Health, or Property/Casualty Insurer Cash Flows
(http://www.actuarialstandardsboard.org/pdf/asops/asop007_128.pdf)

This standard includes the following language:

> "3.10.6 Limitations of Models, Assumptions, and Data—Cash flow estimates can vary considerably as a result of the model used, the assumptions selected, and the data. When results are highly volatile, additional analysis may be appropriate."

ASOP No. 8: Regulatory Filings for Health Benefits, Accident and Health Insurance, and Entities Providing Health Benefits
(http://www.actuarialstandardsboard.org/pdf/asops/asop008_176.pdf)

This standard includes the following language:

> "3.4.6 Health Cost Trends—The actuary should consider historical experience trendswhen estimating future trends. Projected trends may be based on insured or population data. When medical expense trends are projected, the actuary should consider detail by service category (for example, inpatient, outpatient, professional, and drug) or service setting (for example, nursing home, home care, or assisted living facility), separated by cost and utilization, if relevant, reasonably available, and credible."

> "3.7 Use of Past Experience to Project Future Results
>
> In making these determinations, the actuary should consider the applicability and credibility of the data. These considerations may differ for the total claims in a period, the claims for a particular service category, and the experience trends. To the extent that the filing actuary concludes that the experience data is not applicable or credible for a particular use, the filing actuary should identify additional sources that are appropriate (see ASOP No. 25, *Credibility Procedures*).

ASOP No. 10: Methods and Assumptions for Use in Life Insurance Company Financial Statements Prepared in Accordance with U.S. GAAP
(http://www.actuarialstandardsboard.org/pdf/asops/asop010_130.pdf)

This standard includes the following language:

> "3.3 <u>Best-Estimate Assumptions</u>—In instances where GAAP requires best-estimate assumptions, the actuary should use assumptions that reflect management's assessment of emerging experience without provisions for risk or uncertainty. …The actuary should use actuarial judgment to determine which interpretation of best-estimate is appropriate for the situation at hand with reference to the applicable authoritative GAAP guidance. …The actuary's advice should consider the company's actual recent experience data, if, in the actuary's judgment, it is relevant and credible.

The actuary should also consider relevant industry data or data from other similarly situated companies to supplement available company specific data. ASOP No. 23, *Data Quality*, gives further guidance to the actuary on issues related to the selection of data, use of imperfect data, and reliance on data supplied by others."

ASOP No. 12: Risk Classification (for All Practice Areas)
(http://www.actuarialstandardsboard.org/pdf/asops/asop012_132.pdf)

This standard includes the following language:

"2.3 Credibility—A measure of the predictive value in a given application that the actuary attaches to a particular body of data (predictive is used here in the statistical sense and not in the sense of predicting the future)."

ASOP No. 15: Dividends for Individual Participating Life Insurance, Annuities, and Disability Insurance
(http://www.actuarialstandardsboard.org/pdf/asops/asop015_134.pdf)

This standard includes the following language:

"3.3 Dividend Factors—The actuary should develop dividend factors based on an analysis of policy factors and actual experience of the participating block for which dividends are being determined. However, when actual experience is not determinable, available, or credible, the actuary should consider the experience and trends in experience of similar classes of business either from the same insurer, from industry sources, or from other non-industry sources, in that order of preference."

(Authors' comment: In developing an appropriate dividend scale, credible experience should be used to the extent available. To the extent that experience is not credible, an appropriate complementary set of data may be required. If credibility is lacking, dividend development may need to be deferred. Knowing whether the experience is sufficiently credible could be critical to creating an appropriate dividend scale.)

ASOP No. 17: Expert Testimony by Actuaries
(http://www.actuarialstandardsboard.org/pdf/asops/asop017_135.pdf)

(Authors' comment: As referenced in section 1.2 of ASOP No. 17, while this standard is intended to provide specific guidance with respect to expert testimony, reference should also be made to other actuarial standards of practice concerned with the actuarial substance of the assignment. Applicable credibility-related provisions from other relevant standards would impact work performed under this standard as well.)

ASOP No. 18: Long-Term Care Insurance
(http://www.actuarialstandardsboard.org/pdf/asops/asop018_136.pdf)

This standard includes the following language:

> "3.5 Sensitivity Testing—The actuary should perform sensitivity testing of reasonable variations in assumptions prior to finalization of assumptions. Where the data used for establishing actuarial assumptions have limited statistical credibility, the range of sensitivity testing should be expanded."

ASOP No. 19: Appraisals of Casualty, Health, and Life Insurance Businesses
(http://www.actuarialstandardsboard.org/pdf/asops/asop019_137.pdf)

This standard includes the following language:

> "3.3 Setting Assumptions—When setting assumptions for use in an appraisal, the actuary should consider the historical experience of the insurance business, adjusted to reflect known material changes in the environment and identifiable trends to the extent such information is available. When experience of the business is unavailable or insufficient to provide a credible basis on which to develop assumptions, the actuary should consider other information sources in setting assumptions."

ASOP No. 25: Credibility Procedures Applicable to Accident and Health, Group Term Life, and Property/Casualty Coverages
(http://www.actuarialstandardsboard.org/pdf/asops/asop025_174.pdf)

This standard includes the following language:

> "3.1 Purpose and Use of Credibility Procedures—Credibility procedures covered by this standard are used for two purposes: 1) to evaluate subject experience for potential use in setting assumptions without reference to other data; and 2) to improve the estimate of the parameter under study. Credibility procedures may be used for tasks such as pricing, ratemaking, prospective experience rating, and reserving.."

"3.2 Selection or Development of Credibility Procedure—The actuary should use an appropriate credibility procedure when determining if the subject experience has full credibility or when blending the subject experience with the relevant experience. The procedure selected or developed may be different for different practice areas and applications. Additional review may be necessary to satisfy applicable law. In selecting or developing a credibility procedure, the actuary should consider the following criteria:

a. whether the procedure is expected to produce reasonable results;
b. whether the procedure is appropriate for the intended use and purpose; and
c. whether the procedure is practical to implement when taking into consideration both the cost and benefit of employing a procedure.

The actuary should apply credibility procedures that appropriately consider the characteristics of both the subject experience and the relevant experience. The actuary should consider the predictive value of more recent experience as compared to experience from earlier time periods."

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