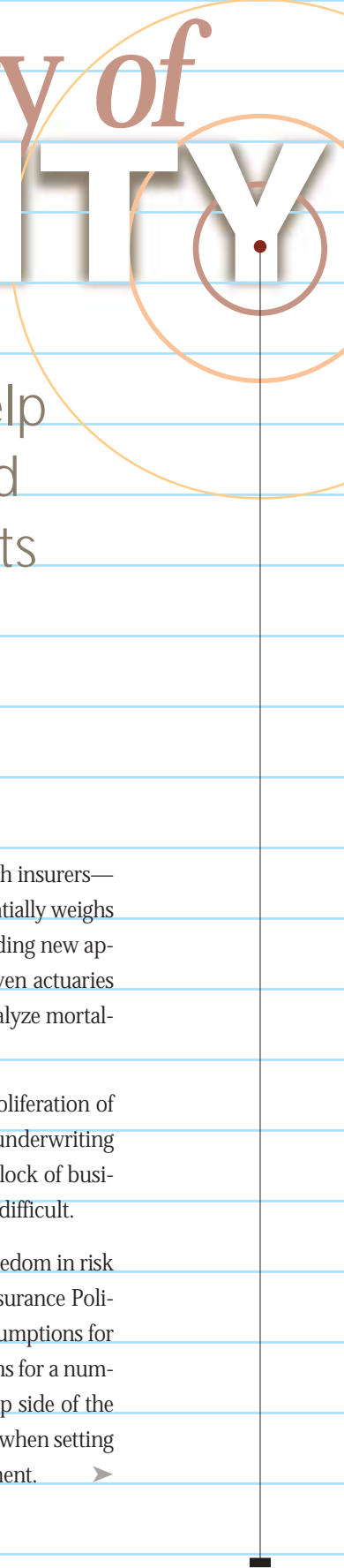


# A Credible Theory of CREDIBILITY



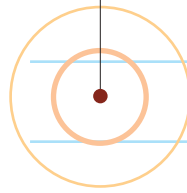
Credibility theory offers great help for life insurers who understand how to use the tool and know its potential and limitations.

By Drew Tindall and Jess Mast

**CREDIBILITY THEORY**—an old friend to many property/casualty and accident and health insurers—has been making fast friends with many individual life insurers lately. The theory, which essentially weighs past experience with current expectations to obtain an updated mortality assumption, is finding new applications in the individual life industry because of recent freedoms and responsibilities given actuaries in risk management. Changes in the marketplace also necessitate using such methods to analyze mortality experience and chart a path for the future.

Over the past decade alone, the individual life insurance marketplace has witnessed the proliferation of preferred classes, increased competitive pressures, and significant changes in medical and underwriting practices. With so many changes, credible mortality experience based on a homogeneous block of business is hard to come by, making setting accurate mortality assumptions for future business difficult.

Coinciding with the changing marketplace has been the movement to give actuaries more freedom in risk management. A prime example is Regulation XXX in the United States (Valuation of Life Insurance Policies Model Regulation), which allows actuaries to tailor more realistic valuation mortality assumptions for deficiency reserves. In Canada, actuaries have been charged with setting mortality assumptions for a number of years, where mortality assumptions are based largely on historical experience. The flip side of the new freedom means actuaries must ensure they are correctly evaluating mortality experience when setting future assumptions by using both meaningful objective measures and sound actuarial judgment. ➤



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## What Is Credibility Theory?

Credibility theory assesses how past experience can be combined with current mortality expectations to obtain an updated mortality assumption. The formula for this approach shows how new mortality expectations are estimated using a weighted average of past experience and current expectations. (See Stuart A. Klugman, Harry H. Panjer, and Gordon E. Willmot, *Loss Models From Data to Decisions*, John Wiley & Sons, Inc., New York, 1998.)

*Updated mortality assumptions = credibility factor × past experience + (1 - credibility factor) × current mortality expectations*

In practice, past experience and current mortality expectations will be given. The problem lies in finding the credibility factor. If the experience is fully credible, this factor will be one. If the experience is not credible at all, the factor will be zero. In most cases, the factor lies somewhere in between. To determine the appropriate factor, actuaries are turning to credibility theory.

There are three basic approaches to credibility theory: classical credibility (also known as limited fluctuation credibility), Buhlmann credibility (also known as greatest accuracy credibility), and Bayesian credibility.

Bayesian credibility is the most accurate way to determine a credibility-weighted mortality assumption. But it's impractical to apply in practice because the distribution assumptions needed aren't straightforward and require a lot of judgment. It also can create occasional biases because subjectivity is required in the assumptions.

Buhlmann credibility is more theoretically sound. But used in the traditional way, Buhlmann credibility is less practical to apply to mortality studies because mortality needs to be estimated for a given risk class, not for exposure with an unknown risk class. It's also often difficult to get enough experience for this method to be useful.

Classical credibility is much easier to use compared to the other methods because it uses a simple formula and gives reasonable results in almost all scenarios. It also handles the problem of having limited experience because it uses underlying assumptions to judge credibility and doesn't rely heavily on the experience. The only criterion that classical credibility may not satisfy is that it may not give unbiased results because some judgment is required to apply the method.

In most cases, classical credibility can be a good guide to assess the credibility of past mortality experience. In the case where a more accurate estimate of credibility may be warranted, Bayesian credibility should be applied because it's the most accurate technique. Regardless of which method is used, it should follow the four basic guidelines to be sound:

- Produce reasonable results;
- Be practical in its application;
- Provide results that are not materially biased;
- Balance the responsiveness of mortality expectation to experience while minimizing fluctuations in mortality expectations.

## Why Didn't We Use It Before?

Credibility theory has been used for years in one form or another in other areas of the industry. Areas such as property/casualty and accident/health have benefited from using credibility theory because claims occur at a relatively high rate and the pricing horizon is relatively short. This provides sufficient recent experience to use for future expectations.

Individual life insurers in the United States ignored credibility theory mainly because claims occur much less frequently in these blocks. Furthermore, recent changes in the marketplace, which increase the heterogeneity of experience, complicate the application of credibility theory.

Certainly, market changes won't disappear and claim rates will remain low compared to property/casualty and accident/health frequencies. However, credibility theory can be useful when proper considerations are given to past experience. Furthermore, regulatory guidelines and competitive pressures together demand more credible and precise mortality expectations.

Unlike their U.S. counterparts, life actuaries in Canada have been using a crude form of credibility theory for a number of years in setting their valuation assumptions. Early on, credibility levels were very prescriptive and, for no apparent reason, were different based on whether a company's experience was better or worse than similar industry experience. Recently, however, credibility theory has been used to provide a more theoretically sound basis for determining the credibility of a company's own experience.

## How Do We Use It Now?

Suppose an experience study has just been completed. Results show experience is 20 percent higher than expected. Should you use the experience, current expectations, or a number somewhere in between as the basis for future mortality expectations? While actuarial judgment often determines where to set future mortality expectations, credibility theory helps to quantify its subjectivity and make a better, more informed decision.

Another situation involves an X-factor analysis where an X factor fails hypothesis testing. When is the experience credible enough to signal that the X factor needs to be changed? Likewise, when an X factor does need to be changed, what should it be changed to? Up to this point many companies haven't had to change X factors when failures occur because testing has covered limited experience. As more experience builds, credibility theory will play a bigger role in deciding when and to what level X factors should be changed.

Credibility theory may also be useful in setting reinsurance premiums for nontraditional or unusual blocks of business with little to no past experience. In the first year, reinsurers set premiums based on the best estimate of mortality. As experience begins to unfold, a credibility-weighted premium based on experience and the best estimate of mortality can be charged to the direct company. Such a process helps direct companies keep reinsurance premiums at a reasonable level while helping reinsurers to mitigate risk.

Actuarial judgment remains necessary when setting mortality assumptions. Credibility theory's role is as an objective checkpoint to ensure that unwanted biases don't come into play when setting future mortality assumptions. The theory must be applied along with a thorough understanding of the business being studied. If the underlying assumptions of the theory are breached, the results may not be meaningful.

Still, credibility theory has certain limitations.

- **Credibility of current expectations.** In some cases, current mortality expectations are assumed to be fully credible when applying credibility theory. In practice, however, this is rarely the case. Rather, the actuary determines a weighted average of past experience and current best-estimate mortality, which isn't fully credible. Even though this method isn't theoretically sound, it provides a practical and reasonable approach to determine an evidence-based best estimate of mortality.

The amount of confidence in current expectations drives the extent to which the actuary relies on credibility theory. In other words, if the "best guess" for mortality expectations has been purely a guess, then the actuary will rely more heavily on emerging experience to set a new best estimate.

- **Homogeneity of exposure.** Of all limitations, this one causes credibility theory to be used incorrectly the most. Users of credibility theory must realize that the closer the data lean toward homogeneity and comparability with current expectations, the higher the credibility is likely to be. That's because when credibility theory is supplied, it assumes that the exposure underlying past experience is consistent with the exposure underlying current mortality expectations.

Experience, however, rarely matches contemporary expectations. For example, past experience is unlikely to reflect the plethora of preferred classes that have become available in recent times. Changes to underwriting criteria, the agent workforce, medical practices, and the business environment in general cause underlying characteristics to shift continuously. While past and current

exposure characteristics will never be the same, a threshold for the amount of changes allowed needs to be maintained so that the credibility of past experience can be evaluated.

In general, three factors cause actual and expected mortality to be different: random fluctuations, inaccuracy in current expectations, and differences in exposure bases. When applying credibility theory, one needs to make sure that a very low percentage of the difference comes from differences in exposure.

- **Number of claims.** Credibility theory shouldn't be applied to blocks of business with little experience. Obviously, one claim should not suggest changing expectations. A good rule of thumb would be never to use credibility theory when there are fewer than 10 deaths in a given study cell.

- **Context for setting assumptions.** Even though credibility theory may give reasonable results, the context in which the expectation is being used drives how the mortality assumption is set. For example, increased competitive pricing pressure may cause premiums to be lower than credibility theory would suggest. Similarly, conservatism built into valuation mortality would imply rates that are too high. Even though credibility theory would suggest lower rates, this may not be suitable for valuation purposes.



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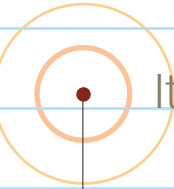
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It would not be unreasonable to see actuarial standards of practice incorporating credibility theory as a preferred approach for readjusting X-factor mortality.

- *Results: Numbers vs. amount.* When applying credibility theory, factors derived using results by number of claims may not be applicable to results by amount paid in claims. Results by amount show much more variability than those by number. Factors such as average claim amount and the standard deviation of claim amounts need to be considered to derive a credibility factor by amount.

#### A Changing Environment

Practices and plan designs continually change, and current situations will have different underlying forces than previous ones. While the past provides helpful insights into the future, it reveals little about the effects of changes. Since the general credibility theory formula weighs past experience with current expectations, how do you handle past experience that's not necessarily consistent with current and future expectations?

- Identify and weigh degrees of homogeneity and heterogeneity among the groups of data studied in order to attain the level of understanding and confidence needed for deciding how to move forward in using the data.
- Adjust past experience to reflect changes appropriately that have occurred since the average exposure period of the study. For example, if the underlying experience reflects mixes of business different from what's currently present, the experience should be normalized to better reflect current mixes and the impact of changing exposures.

Some common changes that should be reflected include the addition or deletion of preferred classes, changes to underwriting criteria, the effects of replacement activity, conversions from term to permanent plans, changes in the distribution of business, and changes in policy features that may affect mortality.

- Adjustments also should reflect changes expected to occur if current assumptions will be used on future business, such as those for secular improvements in mortality. Even if the underlying business resembles past and current experience, medical advancements that have already occurred and will continue to lower mortality may not be reflected in the experience available for study.
- Changes in target markets to include higher socioeconomic classes are apt to increase average policy sizes, which often portend further improvements in mortality. Such improvements

result from a higher standard of living and increased usage of underwriting tools, e.g., medical exams, lab tests, attending physician statements, etc. Some of these requirements also may heighten the sentinel effect of underwriting because some higher-risk applicants will choose to apply elsewhere to avoid being examined or tested.

- Heterogeneity of exposure from the inclusion of conversions often distorts mortality experience on regularly underwritten business that was originally classified as "standard." For example, conversions from term to permanent plans should be excluded from experience used to evaluate credibility of experience on regularly underwritten individual life business. Other examples of heterogeneity include policies on nonforfeiture option, policies originally issued as substandard but changed to standard, and policies originally issued on tobacco-user basis but later changed to nontobacco-user premium rates.

#### Credibility Theory and the Industry

The U.S. Actuarial Standard of Practice No. 25 (ASOP 25) addresses the use of credibility theory in the areas of accident/health, property/casualty, and group term life insurance. The Life Committee of the Actuarial Standards Board is now reviewing the applicability of ASOP 25 to the individual life area.

In Canada, the Committee on Life Insurance Financial Reporting (CLIFR) has developed a draft educational note titled "Expected Mortality: Fully Underwritten Canadian Individual Life Insurance Policies." This note is designed to assist actuaries in setting valuation mortality expectations with the use of credibility theory.

Future use of credibility theory is likely to occur in the industry. It would not be unreasonable to see actuarial standards of practice incorporating credibility theory as a preferred approach for readjusting X-factor mortality. Larry Gorski, life actuary with the Illinois Department of Insurance, has alluded to using credibility theory for resetting X-factor mortality. Certainly actuarial judgment drives conclusions; however, documentation on applying credibility theory would help to reinforce the actuary's decision.

Even without required regulations, credibility theory can play an important role in helping to judge the credibility of experience. With so many changes occurring in the marketplace, coupled with actuaries' added responsibilities, using some form of credibility theory is necessary—as is understanding its limitations. Ultimately, judgment will drive mortality assumption levels, but credibility theory gives an objective basis to make a sound judgment. ●

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