The Roles of the Actuary in the Selection & Application of Actuarial Models

DECEMBER 2022

PROFESSIONALISM DISCUSSION PAPER

CONCEPTS ON PROFESSIONALISM

Prepared by
Committee on Professional Responsibility
Professionalism Series

Updated 2022 (originally published 2006)

American Academy of Actuaries
ACTUARY.ORG

Table of Contents

Preface 1

Background 2

The Nature of Actuarial Models 4

The Roles of the Actuary 9

Relationships With Other Professionals and Management 12

The American Academy of Actuaries is a 19,500-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.

AMERICAN ACADEMY OF ACTUARIES
1850 M STREET NW, SUITE 300, WASHINGTON, D.C. 20036
202-223-8196 | WWW.ACTUARY.ORG

Preface

This discussion paper was developed by the Committee on Professional Responsibility of the American Academy of Actuaries for discretionary use by actuaries. Its purpose is to assist actuaries in considering their various roles in the selection and application of actuarial models. This paper was not promulgated by the Actuarial Standards Board and is not binding upon any actuary. No affirmative obligations are intended to be imposed on any actuary by this paper, nor should such an obligation be inferred from any of the ideas expressed or suggestions made herein. This discussion paper is intended to stand on its own and be freely interpreted.

In fulfilling their various roles in the selection and application of actuarial models, actuaries should be guided by the Code of Professional Conduct (Code). To the extent any conflict exists or could be implied between this paper and the Code, the Code prevails. Members, reflecting upon the Code and other professional standards that apply to them, are free to accept or reject any part or the whole of this discussion paper as they choose.

Members are encouraged to share their comments on this paper with the Committee on Professional Responsibility to facilitate improvements in any future releases on this topic. Comments can be submitted to professionalism@actuary.org.

The Committee on Professional Responsibility presents these ideas with the expectation that they will be both useful and thought-provoking and will enhance the actuarial profession's consideration of its various roles in the selection and application of actuarial models. Ultimately, it is the Code that governs the responsibilities of actuaries in this area. However, the ideas and suggestions offered in this paper are intended to assist actuaries in applying the Code to their individual situations. The committee believes that expanded discussion of the concepts and suggestions offered in this paper will benefit the profession.

Background

At the end of the 20th century, the financial services industry underwent a transformation as the statutory barriers between insurance companies and banking and investment firms were eliminated and the entire industry grew increasingly global. Actuarial practice also evolved, with actuaries moving from traditional reserving activities in insurance and employee benefits practice to asset management, product and plan design, enterprise risk management, and other emerging practices. Actuaries' specialized knowledge of risk identification, quantification, and management has served them well as they move into these new areas.

Actuaries' clients and employers, as well as other interested persons, may not always understand the nature of actuarial models or the role the actuary plays in their selection and application. Non-actuaries do not always appreciate the inherent uncertainties in actuarial projections nor the extent to which actuarial models rest upon assumptions concerning the future. They may wrongly presume that an actuarial finding or estimate is an express or implied guarantee of a particular outcome. Non-actuaries may also mistakenly believe that an actuarial analysis will always yield a single "right" answer and may not appreciate that two actuaries following generally accepted practice and using appropriate methods and assumptions can, and normally will, reach two different outcomes.

It is usually prudent for actuaries to explain the contingent nature of projections and the inherent uncertainty underlying an analysis of projections made in models they use. Such an explanation is frequently made with the understanding that both actuaries and non-actuaries may use or rely on the results of such a model to make financial decisions. Further, as the profession moves into new types and areas of practice, the roles that actuaries play in selecting and applying actuarial models will necessarily evolve. Actuaries, therefore, may benefit from periodic consideration of the nature of actuarial models and the roles that the actuary plays in selecting and applying them.

In 2006, a revision to Actuarial Standard of Practice (ASOP) No. 38, *Using Models Outside the Actuary's Area of Expertise (Property and Casualty)*, was exposed by the Actuarial Standards Board. This exposure draft was intended to be applicable to all practice areas, with specific guidance on the selection and use of both actuarial and non-actuarial models outside the individual actuary's area of expertise. (After further discussion over several years, this work was used to develop a new ASOP No. 56, *Modeling*, applicable to all practice areas. A revised ASOP No. 38, *Catastrophe Modeling (for All Practice Areas)*, took effect in 2021.)

At the time of the initial exposure draft of the ASOP No. 38 revisions in 2006, the leadership of the actuarial profession determined that it would also be helpful to develop a discussion paper offering nonbinding guidance on the nature of actuarial models and the various roles actuaries play in selecting and applying them. The American Academy of Actuaries' Council on Professionalism asked the Committee on Professional Responsibility to prepare a discussion paper for broad dissemination. The purpose of the paper is not to impose mandatory requirements on actuaries, but to identify issues, enhance sensitivities, and assist actuaries and others toward a clearer understanding of the topics addressed in this discussion paper.

This paper, therefore, is intended to be broadly shared among the membership of the Academy and other actuarial organizations. In preparing this discussion paper, the committee recognized that there is likely a wide range of experience and opinion within the profession concerning the nature of actuarial models and the various roles actuaries play in selecting and applying them. However, the committee believes that actuaries working in all types and areas of professional practice can benefit from reading and considering the concepts and suggestions contained in this paper. The committee is not advocating any mandatory practices beyond those required by the Code, the ASOPs, and the *Qualification Standards for Actuaries Issuing Statements of Actuarial Opinion in the United States* (U.S. Qualification Standards or USQS). By sharing the thoughts of several experienced actuaries, the committee encourages each actuary to give appropriate consideration to the concepts and suggestions contained in this paper. Ultimately, however, each actuary must decide how to fulfill their professional responsibilities in this area.

The Nature of Actuarial Models

In the paper "The Methodology of Actuarial Science" presented to the U.K. Institute of Actuaries in 1998, J.M. Pemberton asserted, "[a]ctuarial science is concerned with the development of models which approximate the behaviour of reality and have a degree of predictive power, not the truth." Pemberton further observed that "simple laws do not adequately describe complex realities," and therefore "actuarial science deals directly with low-level generalizations, recognizing the limited nature of available regularities." Thus, as Pemberton recognized, actuarial models are simulations. He stated that models, by their very nature, are simplified representations of reality. Actuarial models, in particular, rely on estimated measures of the probability of future contingent events. Even the best model cannot predict a future contingent event will occur with 100% certainty or guarantee a specific outcome.

The paper "Principles Underlying Actuarial Science" defines various types of models as follows:

> A scientific model is an abstract and simplified representation of a given phenomenon. A mathematical model is a scientific model in which the representation is expressed in mathematical terms. A stochastic model is a mathematical model in which the representation is expressed in terms of probabilities. A dynamic stochastic model is a stochastic model that incorporates a systematic process for revising the model in response to observed results. A deterministic model of a phenomenon is a stochastic model in which a given event is assumed to occur with certainty.[1]

The models that actuaries typically use in their work are classified as either deterministic or stochastic. They are simplified representations of possible outcomes relative to future contingent events. A "contingent event" is an event whose occurrence, timing, or severity is uncertain. Actuaries recognize that even though a deterministic model produces an outcome that appears to be predicted with certainty, this "certainty" is based upon assumptions that are themselves uncertain. Therefore, deterministic models have an "if-then" characteristic. That is, if the assumptions made in the deterministic model are realized in the real world and if the real world behaves exactly as predicted by the model, then the outcome of a deterministic model will occur. Clearly, these are big "ifs" and even deterministic models are hypothetical and, at their best, can only be expected to produce outcomes reasonably within a range of possible future outcomes.

Actuaries are called upon to identify, understand, quantify, and manage a wide range of business risks in the financial services industries. The information typically used by actuaries

1 "Principles Underlying Actuarial Science," published in the July 2008 issue of the *Actuarial Practice Forum* of the Society of Actuaries.

to fulfill these responsibilities includes a vast body of recorded observations on many kinds of risks, as well as the theoretical and practical understanding of how such risks operate. Observations of actual experience usually constitute the actuary's primary facts, which the actuary then processes through a series of hypotheses and assumptions that, taken together, form an actuarial model. Actuarial research can provide a means to test the validity and appropriateness of the hypotheses and assumptions underlying a particular model.

Much of actuarial practice is devoted to the measurement and management of actuarial risks, i.e., risks that are inherently contingent in nature and usually have financial implications. Actuarial models provide frameworks for analysis, allowing the actuary to project probable outcomes based on past experience adjusted for known material changes in circumstances. They are usually expressed in mathematical terms and typically are designed to be consistent with fundamental principles of actuarial science. They are the embodiment of hypotheses and assumptions that, in the actuary's professional judgment, reasonably represent the likely course of future events, adjusted as appropriate to recognize the inherent uncertainty in any projection of the future. An actuarial model, therefore, can be understood to be a mathematical representation of the financial effects of contingent future events, based on, but not limited to:

- Assumptions concerning the frequency, timing, and severity of the events;
- Assumptions concerning the time value of money; and
- Current available data concerning the risk(s) being modeled.

Actuarial models may contain many elements and are usually based upon multiple interrelated assumptions about various aspects of risks associated with an entity's business. Thus, for example, an actuarial model could be simple enough to analyze the effect of a single interest rate projection on the accumulation of monetary value or complex enough to analyze all material aspects of the business operations of an insurance company in order to estimate the company's likely future financial viability. More complex models typically have the utility of permitting longer-range projections of a variety of developments. Models normally are adjusted periodically. Actuaries tend to refine their models over time by comparing model results to actual results and making changes in the assumptions used or the simulation techniques applied within the model. These changes will tend to improve the model's output in terms of the model's ability to accurately represent the real world. These refinements are made as application of the model by the actuary and comparison of its results to actual experience provide a better understanding of how the model can be improved as a predictor of future outcomes.

Frequently, actuaries use models to chart the plausible futures within a given framework, based on actuarial principles, past history, and known circumstances that, in the actuary's

professional judgment, are likely to have a material impact on the actuary's analysis. This modeling approach often involves a stochastic process in which anticipated, equally likely assumption sets are input to produce a range of equally likely outcomes. It is clear that such a modeling approach does not predict any specific future outcome but provides a range of possible future outcomes that, in their totality, may imply something about the reasonable range in which a future actual result can be expected to lie. It is in the nature of this modeling approach that there is always a probability associated with the likelihood that reality will fall within the predicted range. The probability is less than 1 and only approaches 1, or certainty, as the range of reasonable possible outcomes expands to include every possible result. Expecting certainty from an actuarial model effectively makes the model useless since it provides no additional information about an anticipated event. Therefore, actuarial models do not and cannot predict the future with certainty.

Many different actuarial models may be constructed to simulate the same or similar future events. Some actuarial models may be more sophisticated, i.e., may contain more assumption variables or more detailed calculations than others. However, regardless of their level of sophistication, all models are simulations of the future. It is highly likely that different models applied with the same input assumptions will produce outcomes that differ. Such different results can only be interpreted in relation to the specific model that produced them, taking into consideration the probability associated with the model result implied by the model. None of these results can be reliably considered a prediction of an outcome that can be expected with certainty. While some model results may turn out in hindsight to have been closer to the actual real outcome, no inference should be drawn that one model was incorrect and another more "accurate" just because of this effect.

Actuarial models are sensitive to the assumptions used. Typically, actuarial models rely on historical experience as a source for model assumptions. However, no two time periods are ever truly identical, which makes experience derived from past history less than predictive of future potential events. Reasons for this are such things as changes in the legal, social, and economic environment that occur from time to time, making historical experience a potentially poor basis for projections of the future. For example, courts continuously interpret insurance contract and employee benefit plan terms, thereby expanding or restricting the obligations created by those terms. Claimants' attitudes toward filing insurance claims change; plan participants become more or less likely to choose early retirement; and the economic environment changes, making the incidence of claims more or less likely and their severity more or less costly than in the past. Even if an actuary modifies the past-observed experience data to account for such changes, these modifications can only subjectively approximate the future effect on the experience data. This ever-changing environment contributes to making projecting future events a highly uncertain exercise.

Further, most actuarial models take into account factors and influences in the business environment that cannot be readily quantified. Many situations involve value judgments and counter forces such as competitive strategies in risk management, product design, and marketing. Actuarial models are designed to take into account events that are more likely to occur *on average* and, therefore, do not necessarily model very infrequent catastrophic events for which historical experience has little or no predictive value, for example, meteorite impacts or the occurrence of some unknown, highly contagious plague. Even more common events such as floods, fires, and hurricanes that strike with extraordinary force may be difficult to incorporate into an actuarial model without distorting results for most of its uses. However, actuaries may be asked to model such extraordinary or very infrequent catastrophic events to establish an extreme range against which model results of more commonplace risks may be measured.

Actuarial models are invaluable tools for managing or evaluating the financial consequences of risk over time. However, models at their best are hypothetical in the sense that the modeled results are highly dependent on the assumptions used. The choice of assumption or the availability of valid data upon which to base model assumptions is a critical element in the modeling process. It is possible that comprehensive and accurate data is not available to the actuary or that the actuary has been requested to use a specific predefined set of assumptions in the modeling process. Any user of model results is usually wise to take into account the assumptions used and the original purpose of the model, and evaluate the model outcomes in that light. An analysis of model results based on flawed data may be more likely to produce inappropriate actions. It must be remembered, however, that even the best actuarial models—thoughtfully applied using accurate and comprehensive historic data—can yield results that differ significantly from emerging experience. The magnitude of the event or thing being modeled can impact the range of possible outcomes or the likelihood that a particular outcome may be outside the modeled range. Actuaries who use models in their work understand the probabilistic nature of modeling and routinely take this effect into account when making decisions influenced by model results. Users of actuarial work products are normally prudent to keep in mind the probabilistic nature of modeling and may find it prudent to obtain a second actuarial opinion from time to time or under appropriate circumstances.

Some of the models actuaries use include but are not limited to the following:

- Financial simulations based upon capital management strategy or asset/liability analysis;
- Neural network-based artificial intelligence systems for use in credit analysis;
- Monte Carlo models and regime-switching models for interest rate scenario generation for financial reporting or the strategic development of investment options;
- Risk quantification and prediction models;
- Credit risk modeling and management, both to measure solvency and to price financial products;
- Hedging and other risk management quantification techniques;
- Product pricing;
- Valuation of risk;
- Risk adjustment models; and
- Pension valuations.

The Roles of the Actuary

The actuarial profession has long been at the forefront in identifying, assessing, measuring, managing, and mitigating risks. To fulfill these responsibilities, actuaries make use of actuarial models. Actuaries play a variety of roles with respect to actuarial models and may use actuarial models differently depending on the circumstances. Arguably, almost every task an actuary performs can be considered to involve use of a "model," insofar as the work actuaries do usually involves anticipating, measuring, and providing information necessary for managing risk. Models, which attempt to show plausible future financial outcomes associated with contingent events, are a useful tool in this endeavor. It should be recognized that, typically, the actuary's work product is aimed at managing or mitigating risk, not eliminating it. This is because the financial cost associated with the elimination of all of the possible risks a business enterprise or other entity may face is usually prohibitive.

The Code defines "Actuarial Services" as "Professional services provided to a Principal by an individual acting in the capacity of an actuary. Such services include the rendering of advice, recommendations, findings, or opinions based upon actuarial considerations." The Code provides guidance to actuaries in rendering "Actuarial Services" but does not exclusively delineate the various services actuaries provide to their clients and employers. The actuary's roles in model use rest in two basic areas: selection, design, development, or modification of an appropriate model; and choice of assumptions appropriate for use in the application of the modeling process.

In some instances, an actuary may be called upon to quantify and project a financial risk of uncertain nature, size, or financial value associated with a contingent event. In such an instance, the actuary may select an actuarial model that attempts to identify the various aspects of the risk, assign a probable range of values to each of those aspects, and come to conclusions about the most probable magnitudes of the financial consequences associated with the occurrence of the contingent event. Examples of some such instances are risks associated with terrorism, weather events, mold, death, or disease.

In other instances, an actuary may be called upon to adjust or adapt a model to reflect one or more unusual aspects of a risk. In such instances, the actuary exercises professional judgment in deciding how to adapt or adjust the model, and actuaries might reasonably differ on what model to use as a starting point or how best to adjust it. Examples of some such instances are risks associated with a change in law or regulation that calls for a change in an actuarial model, using a model designed for use in the United States in a foreign country, or using a model from another discipline for actuarial purposes. (For example, using meteorological models to quantify potential hurricane damage.)

Actuarial models vary considerably, and some models may be better than others for a particular project. When deciding what model to use or what model assumptions are most appropriate, actuaries typically consider factors including but not limited to the following:

- Whether the design of the model and the assumptions used are reasonable in light of the purpose of the analysis;
- Whether the model appropriately reflects fundamental principles of actuarial science;
- Whether the model is consistent with accepted actuarial practice;
- Whether the model can be used with available data; and
- Whether the model output is consistent with the actuary's intended use of the model.

The selection of an actuarial model is a matter of professional judgment, and many actuaries have preferences concerning which models to use to accomplish particular analyses. It is not uncommon for two actuaries to select two different models to perform the same or a similar task and for both models to reflect generally accepted actuarial practice. It is quite common for many actuarial modeling approaches, different in the underlying details of their construction, to be designed to satisfy the requirements of a particular task and for each to provide results that fall within an acceptable range of plausible future financial outcomes. For example, there are many different actuarial pricing and valuation models in use.

Actuaries may be called upon to assist a principal (i.e., client or employer) to select an actuarial model for an analysis. For example, a pension plan sponsor may ask the actuary to help select assumptions for purposes of a Statement of Financial Accounting Standards (SFAS) 106 analysis. In such an instance, the actuary is called upon by precepts 1, 3, and 8 of the Code to offer the advice with integrity, skill and care; to comply with any applicable ASOPs; and to take reasonable steps to ensure that the actuary's work product (in this instance, a recommendation on what assumptions to select) is not used to mislead or to violate or evade the law. However, the actuary in that case typically is not responsible for the principal's choice of model, nor is the actuary precluded from conducting an analysis using whatever model the principal selects, so long as the actuary can do so in compliance with the Code.

Actuaries frequently use various methods to evaluate data provided to them by their principals. Confidence limit testing, the method of maximum likelihood, Bayesian estimates, and credibility theory judgments are examples of some of the methods used. Actuaries may wish to review ASOP No. 23, *Data Quality*, for additional guidance on data testing and use.

Once an actuarial model is selected, the actuary typically conducts the analysis and takes appropriate steps to validate the results. That is, the actuary determines whether the model accurately produces the results expected by its design with the given set of assumptions employed. In addition, sensitivity testing permits the actuary to evaluate the reasonable range in which the financial results of the model can be expected to fall with some degree of probability. Sensitivity testing shows to what extent financial results projected by the model will change with changes in the assumptions employed. Ultimately, comparing the model output against emerging experience over time can also help the actuary confirm or adjust the model design.

Alternatively, the actuary may apply the model to project experience for a past period of time in order to determine how closely the financial results of the model reflect reality. Depending on the circumstances, an actuary might also select or utilize a different model using the same assumptions and data and compare the outcome against the results from the first analysis.

Whenever an actuary designs, adapts, selects, or uses an actuarial model (or advises on what model a principal should select), the actuary exercises professional judgment. This exercise of professional judgment is applied with the understanding that models can be expected to provide only a reasonable result within a plausible range of possible future outcomes. No model can be expected to accurately predict which of the possible future outcomes will actually occur. Therefore, when an actuary applies reasonable assumptions in a reasonable model, the fact that actual results may be different from the results projected by the model should be expected and would not necessarily be an indicator of poor actuarial judgment.

Relationships With Other Professionals and Management

Managing risk is almost never the responsibility of a lone individual within a business enterprise. The varied nature of risk types and impacts typically demands that many people work collaboratively to identify, understand, quantify, and manage risk. Similarly, developing a framework for managing the numerous and diverse financial risks a business faces usually requires the varied perspectives of all the professionals within or consulting with the business who play a significant role in the risk management process.

Actuaries together with other professionals have significant roles in identifying, assessing, measuring, managing, and mitigating financial risks of the companies they work for. However, the ultimate responsibility for a company's ongoing financial solvency typically rests not with the professionals who advise the company, but with management.

Although individual actuaries may take on broad management responsibilities in a particular financial services enterprise, more often actuaries serve as advisors to their principals, applying actuarial models to analyze contingent events and their associated risks, as well as providing actuarial services so that their principals can, among other priorities:

- Make informed business decisions to achieve their objectives;
- Comply with accounting standards; and
- Comply with legal and regulatory requirements.

Typically, the actuary is responsible for the appropriateness of the actuarial model used in the analysis, except for any methods or assumptions prescribed by the principal, and for complying with generally accepted actuarial practice. However, the actuary does not guarantee that actual results will not deviate from the model's projections, nor does the actuary guarantee the enterprise's financial performance. The purpose of the advice the actuary and other professional advisers provide to a company's management is to minimize financial risk within the constraints set by management, not eliminate it.

Actuaries typically do not work alone to advise management concerning the risks facing an enterprise. Rather, actuaries usually work cooperatively with and rely upon the expertise and professional integrity of accountants, auditors, claims adjusters, marketers, underwriters, attorneys, data scientists, technology experts, and other professionals. These individuals have differing and complementary skills and responsibilities, and each fulfills a critical function in advising company management. Management makes final decisions in consultation with actuaries and other professionals, and may decide for business reasons to deviate from the actuary's recommendations. For example, an actuary may make a recommendation with

respect to a decision to enter a new line of business or with respect to features and benefits to be contained in the products the company already issues, but it is management, not the actuary, that makes business decisions based on the advice it receives from its professional advisers and is ultimately responsible for those decisions.

The responsibilities of consulting actuaries, in particular, are limited both by the scope of their individual assignments and by their access to information about the companies they serve. When an actuary serves as a consultant, he or she typically undertakes to perform only those assignments that are specifically requested by management, which may significantly impact the actuary's ability to manage risks that the actuary has identified and measured. Actuaries also depend on company management and the other professionals who work for the company to provide them with complete and accurate data and other information to support their professional opinions. In addition, they typically have access to only such materials (for example, policy forms, claims data, reinsurance agreements, etc.) as their principals provide to them.

While the advisory role that actuaries play is a crucial one, it is played in concert with the various responsibilities undertaken by other professional advisers and, ultimately, is interpreted by company management. Although the actuary's goal is to provide, often through the use of actuarial models, materials and outputs that will be useful to the management of a company or other entity in minimizing financial risk, company management is ultimately responsible for the outcomes that result from its decisions.

AMERICAN ACADEMY OF ACTUARIES
1850 M STREET NW, SUITE 300, WASHINGTON, D.C. 20036
202-223-8196 | **ACTUARY.ORG**