

PREFACE to the Fourth Edition

In the twenty years since the third edition was published, significant changes have occurred in actuarial education to reflect the day-to-day work that actuaries are required to do. Many of these changes have their origin in the introduction of more complex products, especially those with embedded financial derivatives, the financial crises of 2007-2008, and the resulting regulatory responses. Today, actuaries regularly use more sophisticated software to model losses, perform simulations, and make economic projections. These changes have resulted in an increased reliance on technology and techniques that incorporate stochastic analysis, including simulation. These developments motivate some of the changes and additions made in the fourth edition. A discussion of the major modifications to the text follow.

One thing that has changed significantly in the last twenty years is that interest rates in all areas of financial life are much lower than they were before. As a consequence, most of the interest rates in the first few chapters of the text have been adjusted to better reflect current values. Except for these interest rate adjustments, and the addition of a number of new examples and exercises, Chapters 1 through 5 remain essentially unchanged.

In Chapter 6, a discussion of probability distributions has been added to the introduction to probability. Though the discussion is mostly in the context summarizing discrete distributions as tables, it lays the ground work for using random variables throughout the remainder of the text. In Section 6.4, the analysis in the determination of interest rates on loans has been expanded to include the language and understanding conveyed in the most recent SOA study note on the topic, *Determinates of Interest Rates*¹. A discussion has been added to provide insight on how the interest rates used to discount the benefits in life insurances can be understood in relation to the insurance company's investments.

¹Michael A. Bean (2017). *Determinates of Interest Rates*. Society of Actuaries.

Chapter 7 preserves the material from the third edition, but provides an introduction to the future lifetime random variable, Section 7.5, and the curtate future lifetime random variable, Section 7.7. In the third edition this material first appeared in Chapter 10. This earlier introduction of random variables is not intended to make the text more theoretical, but rather to allow the reader to make the connection between the concepts and the underlying variables as the concepts are introduced in Chapters 8 and 9. The chapter has also been broken up into more sections to allow for easier access to specific topics. In particular, the expectation of life, Section 7.8, has been fully revised.

The major change in Chapters 8 and 9 deals with computations. Previously, commutation functions were emphasized as the primary computation technique for calculating the values of net single premiums represented by the life annuity and life insurance symbols. In this edition, we preserve the commutation function method by moving it to the Appendix for those still using it and as a reference for the reader who may encounter it in the actuarial literature. However, in its place we provide an introduction to building actuarial tables using recursion formulas in a specified life table and using these tables to calculate values needed for solving specific problems. Most of the examples and exercises from the third edition are preserved and updated to use this technique. This calculation method is consistent with what many life and annuity actuaries use in practice when calculating values for net single premiums. Finally, a change in terminology from net single premium to expected present value is made to be consistent with the early introduction of random variables and the terminology as seen in actuarial texts covering more advanced material.

Chapter 10 includes much of the material from the third edition, but has been expanded to include sampling from the future lifetime distribution and simulation. Simulation is increasingly used by actuaries as they are called upon to perform principles-based calculations. In Chapter 11, a new section has been added, Section 11.4 Computational and Random Variable Considerations. This section extends the new material on calculation techniques to multi-life functions, as well as introduces the reader to the underlying future lifetime random variables. Chapter 12 on pension applications is largely unchanged.

A new chapter on general insurance has been added. Chapter 13 introduces the reader to basic loss models and premium and reserve determination in general insurance. Deductibles and policy limits are introduced as is their effect on the expected loss. The chapter includes sections on the positive payment model, Section 13.3, claim frequency models, Section 13.4, aggregate claims, Section 13.5, and gross premiums and reserves, Section 13.6. More than thirty exercises have been added to accompany this new material.

Most of the chapters include Extended Spreadsheet Exercises. These exercises provide the reader with a more in-depth experience solving problems in a spreadsheet environment. Microsoft EXCEL is used. They allow the reader to see how examples and problems from the text can be extended to a more realistic setting. These problems include constructing actuarial tables to a given life table, simulating life insurance benefits using the Gompertz model, extending examples beyond their pencil-and-paper analysis, and building a retirements analysis income worksheet.

Finally, I would like to thank Michael Parmenter who has included me as a co-author in this project and all the people at ACTEX who helped prepare this revision, especially Kim Neuffer who coordinated the project and Yijia Liu for his work in preparing and typesetting the document for publication. I would like to thank the reviewers and proofreaders, Michael Bean, Daniel Geiger, John Dinius and Michael Reilly. Without them there would be no fourth edition of what we hope is a reasonably comprehensive yet friendly and readable textbook for actuarial students.

Kevin L. Shirley