

Preface

Actuarial profession is one of the prestigious professions around the world. An actuary has to evaluate the entire operation of the insurance business deploying a variety of tools from actuarial science, which are heavily based on the statistical techniques and principles from finance and economics. With the liberalization of the insurance industry in India, the demand for actuaries and actuarial courses is increasing. The aim of this book is to cater to the needs of students intending to pursue actuarial profession and to familiarize them with application of various statistical methods used in the insurance industry. The book elaborates on actuarial concepts and statistical techniques in multiple decrement models with their application in pension funding, and multi-state transition models with application in disability income insurance. This book is written in the same style as my book “Actuarial Statistics: An Introduction Using R” published by Universities Press, India, in 2009, which discusses statistical tools for the computations of premiums and reserves for life insurance products and annuities in single decrement models, using R software.

In some policies, benefit to a single life or a group, is subject to a type of contingency. For example, the death of an individual may be due to an accident or due to any other cause. In most of the insurance policies, the coverage is firstly given for the base cause, and then there are policy riders for additional benefits. If death is due to an accident, then the benefit structure is different; usually benefit is more than the base coverage. In such cases, the benefit structure and consequently the premium structure depend on time to death and the cause of the death. Survivorship models incorporating two random mechanisms, time to termination and various modes of termination, are known as multiple decrement models. The first chapter introduces the multiple decrement model and the construction of the multiple decrement table using the associated single decrement model and central rate bridge.

Chapter 2 discusses calculation of premiums and reserves in life insurance products when the benefit depends on the cause of decrement along with the time to decrement.

A major application of multiple decrement models is in pension plans and employee benefit plans. In these schemes, the benefit paid on termination of employment depends upon the several causes of termination. The cause of termination may

be withdrawal, disability, death, or retirement. The benefits on retirement often differ from those payable on death or disability. As a consequence, the actuarial present value of the benefits depends on the cause of death along with the future life time of an individual. To determine the rate of contribution in pension funds and to value the pension fund at specified times, it is necessary to find the actuarial present value of the benefits. Therefore, survivorship models for employee benefit systems and pension funds include random variables for both time to termination and cause of termination. Chapter 3 is devoted to the application of multiple decrement models for evaluating the cost of a given pension plan at a specific time. Once the estimate of the ultimate cost of the plan is determined, the next step is to determine the contributions required to pay for the estimated cost in an orderly manner, so that the estimated cost of the plan is spread over future years. These actuarial techniques are referred to as actuarial cost methods or actuarial funding methods. A funding method specifies the pattern, that is, the frequency, and the amount of aggregate contributions required to balance the benefit payments. Chapter 4 reviews some of these methods.

As an extension of multiple decrement models, the multi-state model of transitions is discussed in Chap. 5, when the transitions among the states are governed by Markov models. Multiple state models have proved to be appropriate models for an insurance policy in which the payment of benefits or premiums is dependent on being in a given state or moving between a given pair of states at a given time. Such a model is useful to decide premium in continuing care retirement communities model in health insurance and disability income insurance model in employee benefit schemes.

In all these chapters, it is assumed that the rate of interest in the calculations of actuarial present values is deterministic and usually constant over the period of policy. However, the assumption of deterministic interest will be rarely realized in practice, particularly for long-term policies. Chapter 6 introduces in brief stochastic models for interest rates and calculation of premiums for some products in this setup.

The highlight of the book is its usage of R software for statistical computations. R software is freely available from public domain. In all the Universities in India and abroad the use of R software is increasing tremendously. Most of the recent books incorporate R software for statistical analysis. To be consistent with the recent trend and demand, R software is used in this book to compute various monetary functions involved in insurance business. R commands are given for all the computations, and meanings of these are explained, so that a reader unfamiliar with R can also use it. All the tables inserted in the book and solutions to all illustrative examples are worked out using R. The command-driven R software brings out very clearly the successive stages in statistical computations.

The book builds on from the very basic concepts, defining and explaining the terms and to move on to their applications and actual computations with R. It is easy to follow and moves on step-by-step from basics to detailed calculations. The book contains many solved examples illustrating the theory. For better assimilation of the material, exercises are given at the end of each chapter. Statistical prerequisites to

the book are concepts and computation of premiums and reserves for some standard insurance products based on single decrement models.

I hope that this book will be instructive and will induce interest among the students about the actuarial profession. I am sure the book will be helpful for those who wish to prepare for examinations conducted by actuarial societies worldwide.

Feedback, in the form of suggestions and comments from colleagues, students, and all readers, is most welcome.

I thank all my friends, colleagues, and family members for encouragement and support received throughout this venture. I am indeed thankful to the students who opted for this course in the last couple of years. They provided me the incentive to study rigorously and to collect and set a variety of problems, all of which are helpful in writing this book.

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