Throughout the book somewhat inconsistent demands are placed on the reader, who, for example, is expected to know something of differential calculus, yet not necessarily about how to calculate exponents. One wonders how many readers will be able to proceed from learning about what an arithmetic mean is to understanding the Black-Scholes formula. In some ways there is a lack of integration across the various chapters. For example, the concept of arbitrage is used sporadically, appearing in the chapters dealing with foreign currency investments and forwards and futures, yet not in Chapter 17, which discusses the identification of mis-priced bonds. The natural question which comes to mind for prospective readers is whether they would be better served by reading this book or some combination of others (for instance a basic book on statistics and an investments text). My own view is that this book is sufficient for the background material on the mathematics of discounting and statistics, but is somewhat lacking with regard to investments. As noted above, some topics such as options and stochastic interest rate models are not covered well. Furthermore, many important areas are not treated at all, including for example the concept of market efficiency, the Arbitrage Pricing Theory, interest rate derivative securities such as swaps, corporate bonds, convertible securities, and the pricing of American-style options. In short, readers seeking a comprehensive understanding of modern financial investment theory are apt to find this book inadequate.

K. R. VETZAL

Life Insurance Mathematics (Second Edition). By H. U. GERBER (Springer, Berlin, 1995) £34

This book is an expanded version of the first edition, which was published in 1990. The significant change since the first edition is the inclusion of nearly two hundred exercises, almost fifty of which are spreadsheet based, together with either numerical answers or, more usually, an outline of the solution. These exercises and solutions have been compiled by Professor Sam Cox.

This book covers a great deal of material in very few pages; the main text is just 118 pages. The emphasis in the main text is very much on mathematical development rather than numerical calculation, and there are only a few worked examples. However, the inclusion of the exercises and solutions (76 pages in total) makes this edition far more suitable for the reader who is preparing for the Subject A2 and/or D1 examinations.

The chapter headings are:

Chapter 1, The Mathematics of Compound Interest;
Chapter 2, The Future Lifetime of a Life aged x;
Chapter 3, Life Insurance;
Chapter 4, Life Annuities;
Chapter 5, Net Premiums;
Chapter 6, Net Premium Reserves;
Chapter 7, Multiple Decrements;
Chapter 8, Multiple Life Insurance;
Chapter 9, The Total Claim Amount in a Portfolio;
Chapter 10, Expense Loadings; and
Chapter 11, Estimating Probabilities of Death.

The first edition was an English translation of the German version of the book, originally published in 1986. This was the year in which the Society of Actuaries book, *Actuarial Mathematics,* was published. As Gerber was one of the five authors of *Actuarial Mathematics,* and as both books cover similar material, it is not surprising that there are many features common to both. They both take an uncompromisingly probabilistic approach to life insurance mathematics, i.e. they treat an individual's remaining future lifetime as a random variable. Gerber is scathing in his comments on the deterministic approach to life insurance mathematics ("somewhat embarrassing") and commutation functions ("It may...be taken that...(their) days of glory...now belong to the past"). Nevertheless,

Gerber does include an Appendix on commutation functions and includes them in an illustrative life table. He asks the reader to regard this as "a sign of the conciliatory nature of the author"!

The book contains much interesting material which may be unfamiliar to some United Kingdom readers. For example, Hattendorff's Theorem, which shows that losses in successive years on a life policy are uncorrelated even though they are not independent, is in Chapter 6 and Panjer's celebrated recursion formula is derived and used in Chapter 9.

In Chapter 7, Gerber uses a competing risks model for multiple decrements, as is the case in the corresponding chapter in *Actuarial Mathematics*. It is unfortunate that he did not opt for the far more flexible and actuarially useful Markov chain (multiple state) model. The major problem with the competing risks approach is that it cannot deal with, for example, an illness-death model where transitions between states can take place in either direction, i.e. Healthy to Sick and Sick to Healthy.

Another unfortunate feature, again in common with *Actuarial Mathematics,* is that interest is treated deterministically throughout. Gerber excuses himself by saying that "no commonly accepted stochastic model (for interest rates) exists". However, it would not have been difficult to have shown the fundamental difference for a portfolio of life policies if we model interest rates as random variables. This could be achieved in a single example by assuming a simple model, for example independent and identically distributed annual interest rates, and then showing that the relative investment risk per policy cannot be reduced to an arbitrarily small level by insuring a sufficiently large number of lives, as can the mortality risk.

A final grumble concerns the references. There are 15 references listed at the end of the book, together with a brief commentary on them. These references are not referred to in the text. Gerber's material and style make life insurance mathematics a more exciting discipline than is sometimes apparent from other texts on this topic, but the poor referencing makes it more difficult for the reader to delve further into the subject.

These are minor grumbles. This is a generally excellent book which should be of interest to readers who thought they knew all there was to be known about life insurance mathematics and, with the inclusion of the exercises and solutions, to those preparing for the relevant professional examinations.

H. R. WATERS