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Book Review

Risk Modelling in General Insurance, Roger J. Gray and Susan M. Pitts, Cambridge University Press, 2012, 393 pp. (hardback). ISBN: 9780521863940

This is a textbook aimed at final year undergraduate students. It is also very suitable for persons taking the professional exam CT6, but it does not cover every topic in the CT6 syllabus. It covers classic topics in risk theory including loss distributions, risk models, premium principles, credibility theory, reinsurance, and an introduction to ruin theory.

The book starts with a short chapter setting out notation and prerequisite knowledge, which is at the level of a book such as Grimmett and Welsh (1986). The first substantial chapter deals with distributions commonly used to model claim numbers and claim amounts. The authors mostly describe properties of different distributions, then illustrate these distributions by simulating from them and plotting histograms. It is not entirely clear what the advantage of this is over plotting a probability function or density function, although it does illustrate for fat-tailed distributions that large claim amounts can occur. However, plots of density functions are given for some distributions, illustrating the role of different parameters. Mixture distributions are then introduced and illustrated, followed by a lengthy section on fitting models. Overall, this is a good chapter with care taken to guide the reader through the material.

Chapter 3 is concerned with short term risk models, with most of the chapter being devoted to the collective risk model. The chapter opens with general discussions on the tools required to study aggregate claims distributions, namely mean and variance of a compound distribution, the distribution of a compound sum, and convolutions, before deriving the distribution function and first two moments of aggregate claims. A discussion of finite mixture distributions is provided, leading to a study of properties of compound Poisson random variables. Numerical techniques are then considered. Panjer's recursion formula is proved, although not described accurately in the discussion. The fast Fourier transform approach is also described. This is unusual for a book written at this level, and I doubt that student readers will be able to apply it based on the short description provided. There is then a brief discussion of approximations and asymptotics, followed by a section on statistics for compound distributions. This is the first of a few places where the level changes completely and the reader has to rely on other sources to fill in details. The chapter concludes with a short discussion of the individual risk model, including compound Poisson approximation. Rather surprisingly, exact results for this model are referenced rather than presented.

Chapter 4 is about premiums, and essentially falls into three sections – premium principles, application of utility theory, and credibility theory.

Some standard premium calculation principles are listed and their properties described. Utility theory is used to explain policyholder (insurer) behaviour in deciding on what to pay (accept) as a premium. For readers unfamiliar with utility theory, a twelve page appendix provides the relevant information. The remainder of this chapter provides excellent reading for CT6 students on the subjects of Bayesian estimation and empirical Bayes credibility theory (EBCT). The authors work

through three different Bayesian estimation problems to set the scene for EBCT. The description of the Bühlmann and Bühlmann-Straub models is both thorough and clear; numerical illustrations are provided and are fully discussed.

Chapter 5 is about reinsurance. It starts with a discussion of excess of loss reinsurance, as applied to individual claims, before consideration is given to its effect on aggregate claims (but only in the compound Poisson model). A similar treatment is then given to proportional reinsurance, followed by a discussion of policy excesses. The remainder of the chapter is devoted to approaches to reinsurance that have appeared elsewhere, including choosing retention levels to maximise expected utility, using variance as a measure of risk, and setting relative retention levels. One aspect that I disliked here was the very informal style of referencing. We are told that results on relative retention levels are due to de Finetti, but no mention is made of his paper nor of Bühlmann's (1970) book which was responsible for translating de Finetti's work into English. Whilst it is probably of less importance to student readers, I did think that the bibliography could have been expanded.

Chapter 6 provides an introduction to ruin theory. It starts with the adjustment coefficient and Lundberg's inequality, then covers equations satisfied by the ultimate ruin (and non-ruin) probability, and then gives the compound geometric representation of the non-ruin probability. Cramér's asymptotic formula for $\psi(u)$ is presented, and the same numerical approaches that are discussed in Chapter 3 are applied to calculate ruin probabilities. I did not think that this chapter had been written with the same amount of enthusiasm for the material that is clearly evident earlier in the book, particularly in Chapters 2 and 3.

The final chapter contains three (theoretical) case studies. The first of these compares the different premium calculation methods described in Chapter 4, and looks at how they perform under different assumptions for individual claim amounts. The second considers the sharing of losses by applying both a policy excess and excess of loss reinsurance, and looks at expected payments for the three parties involved under different individual claim amount assumptions. The third case study looks at the effect of reinsurance on the ruin probability, first by considering its effect on the adjustment coefficient, then by looking at the explicit solution for the ultimate ruin probability in the case of exponential claims.

The book has a number of positive features for students. First, for the most part, the exposition is extremely clear. Second, there are numerous illustrations of ideas and results, supported by informative plots and tables. Third, each chapter contains a large number of exercises, with numerical solutions provided. A further feature is that the authors have used the free software package R to perform many of the calculations, and have included R code as part of the text. This approach should allow readers to easily verify numerical results given in the book and to apply the techniques to other data.

I am sad that this book is appearing after Roger's untimely death. My association with him goes back to my undergraduate days in the 1970s when he taught me a number of courses. He was a great lecturer and his passion for teaching shines through in this book.

David C.M. Dickson

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