The South African Actuarial Journal has been in the pipeline since 5 February 1999, when a research working group decided to recommend to the Council of the Actuarial Society of South Africa that a journal be launched. At its following meeting, Council not only agreed to the launch of a journal, but also decided to establish a permanent Research Committee. Besides being responsible to Council for the management of the Journal, the Research Committee promotes actuarial research in South Africa. It decides on, or recommends to Council, the award of prizes for research, it awards research grants from a newly established Research Fund and it maintains a “research watch” document detailing research projects proposed or in process.

Details of the Journal’s editorial policy are set out inside the back cover. As explained there, rigorous standards are being established. Of the twelve papers submitted for this issue, only five were accepted. It would be good to increase the proportion of papers accepted, provided that is not done at the expense of the standards applied. Steps are being taken to encourage the development of research skills at universities and to make the South African actuarial community aware of the difference between the Programme Committee’s requirements for discussion papers and the Journal’s requirements for publishable papers.

The membership of the Editorial Advisory Panel, which is set out inside the front cover, includes researchers of international standing in actuarial and related fields, as well as local actuaries who have experience in research. Membership of the Panel is, however, not a sinecure. For the first issue, the members of the Panel have not only been called upon to advise on referees—and in some cases to act as referees themselves—but also to advise on editorial policy.

The first issue includes papers on healthcare, retirement funds, investments and survival models. While all but one of the papers relate to the South African context (one relates to Uganda), they may well be of interest to actuaries elsewhere. One of the papers (on healthcare) has sparked some controversy, and ASSA’s Healthcare Committee was invited to respond. That committee mandated Shaun Matisonn and Dani Katz to respond on their behalf, and their letter appears in this issue. The authors of the original paper were invited to reply to that letter, but declined.

Besides refereed articles and formal responses to them, the Journal includes abstracts of actuarial articles in other journals and of actuarial dissertations and theses at South African universities, as well as book reviews. It is hoped that the Journal will itself promote further actuarial research in South Africa. A profession that does not expand and renew its knowledge base is doomed to be swamped by the currents of history.
LETTER TO THE EDITOR

We refer to the paper “The use and abuse of reinsurance in medical schemes” by HD McLeod, PG Slattery and AM van den Heever, which appears in this issue.

1. WHY REINSURE LARGE OPEN MEDICAL SCHEMES?

1.1 RISKS FACED BY OPEN SCHEMES

1.1.1 One of the major questions raised by the paper is why a large, open scheme would require reinsurance while a smaller, restricted-membership scheme would not. It appears the authors do not fully understand the nature of the risks faced by open schemes. In particular, the largest single risk of any scheme is that the increase in annual claims exceeds the increase in annual premiums. Although this seems obvious, in an open medical scheme, claims costs are a function of a number of factors, each of which has significant random variance, e.g.

- changes in the demographic profile of the membership,
- medical inflation,
- technological advances,
- benefit changes,
- HIV/AIDS,
- other epidemics, and
- seasonality of claims.

1.1.2 The variability in each of these factors needs to be projected three months before the end of the year, and the resulting uncertainty needs to be protected against.

1.2 DEMOGRAPHIC CHANGES

1.2.1 A restricted-membership scheme faces fewer demographic risks, as adverse selection is minimised by the restricted nature of its membership. The demographic changes experienced by open schemes can be unpredictable and sudden.

1.2.2 The largest risk faced by an open scheme is the loss of its younger members, who provide the subsidy for older members in the current environment. Even a large scheme can lose its reserves within a short period if its short-term pricing does not allow for the loss of the cross-subsidy provided by younger members. Reinsurance provides protection for these schemes.

1.3 MEDICAL INFLATION

In addition to changes in utilisation, the medical inflation factor adds to the uncertainty in the pricing exercise. There are two main driving forces behind medical inflation increases, viz. increases in the tariffs of the Board of Healthcare Funders (BHF) and drug inflation.
1.3.1 BHF Increases
The actual impact of BHF prescribed increases is often different from that anticipated and, in addition, is a function of a number of economic factors. BHF increases have a weighting of up to 70% in the inflationary increases.

1.3.2 Drug Inflation
The expected dollar exchange rate needs to be estimated by the scheme at least six months in advance, along with the expected US drug consumer price index, in order to determine the increase in prescribed medication charged to the scheme. Medication can comprise 30% to 40% of the overall expenditure. Reinsurance provides some protection to schemes against adverse currency movements.

1.4 ADVANCES IN MEDICAL TECHNOLOGY
Advances in medical technology normally result in an increase in the cost of treatment, at least in the short term, as the research and development costs are recouped. The prediction of the impact of changes in technology depends on factors such as:
- the differential in cost between existing and new technology,
- the expected utilisation change to the newer technology, and
- the impact on related treatment, e.g. hospitalisation and side-effects of treatment.
It is difficult to predict the impact.

1.5 BENEFIT CHANGES
Most schemes change benefits offered annually. These changes can be minor, such as inflationary increases on limits, or major, such as the changes in products experienced as a result of the new Medical Schemes Act at the start of 2000. The modelling of benefit changes requires a number of assumptions with no past experience on which to base these assumptions. Schemes making these changes need certainty and security for their members.

1.6 HIV/AIDS
The impact of the HIV epidemic has been well documented, and the expected impact on future claims is expected to be considerable. It is difficult to determine the impact on schemes because of the scarcity of data regarding medical scheme prevalence rates.

1.7 RECENT EXPERIENCE
1.7.1 An analysis of past claims experience for all medical schemes indicates that significant claims fluctuations have been experienced for the last ten years. This is stated in the 1998 Report of the Registrar of Medical Schemes: “The chart below shows how the operating results, as a percentage of contributions, have fluctuated over the past 10 years.” The chart depicts operating losses for schemes in five of the ten years from 1989 to 1998. (See Figure 1.)

1.7.2 The experience represents seven million lives, i.e. based on the authors’ findings in 3.3.4, the experience should have been smooth and predictable for these lives.
1.7.3 In addition, the claims experience from one of the larger open schemes, adjusted for inflation, is shown below. During the period January 1998 to December 1999, this scheme had an average of 376,000 lives exposed. However, the graph below shows that the size of the scheme did not prevent fluctuations of over 110% of the average during the period, even adjusting for inflation.
2. WHAT ABOUT THE MEMBERS?

2.1 Members have two requirements of their scheme:
– Their claims will be paid.
– Their premiums will be affordable.

2.2 However, the solvency and security members seek is difficult to attain in the medical scheme environment due to restrictions on capital raising. Reinsurance gives these members access to the balance sheet they would otherwise need to create via their own increased contributions.

2.3 It can be shown that it would be cheaper for members in terms of contributions to reinsure and pay for the use of the reinsurer’s capital than to create scheme solvency via increased member contributions.

2.4 During the period under review, reinsurance provided a significant and real increase in solvency to the schemes using it, both in terms of statutory solvency requirements and in terms of increased capital for the combined entities.

2.5 In addition, the creation of solvency within the scheme via short-term contribution increases raises the problem of equity between generations of members. Existing scheme members are creating the surplus via their increased contributions, creating a potential benefit for future scheme members who have not contributed to the surplus.

2.6 The solvency a scheme builds needs to be protected, in light of the new medical scheme regulations, and the best form of protection is to reinsure the uncertainties in the environment, and gradually build solvency reserves over time. The new legislative environment, which encourages anti-selective member movements, has made this type of protection increasingly important.

2.7 Paragraph 7.4.1 mentions the problem of double-reserving as a result of the removal of the offset for reinsurance premiums in the calculation of solvency. Surely the regulators, who have the members’ interest at heart, have the ability to avoid this cost being incurred by these members by changing these regulations? It would provide members with much cheaper access to capital, and reduce premiums dramatically. It would also ensure that equity is maintained between generations of policyholders.

3. ARE NON-SPECIALIST MEDICAL SCHEME REINSURERS “EXTRACTING PROFIT”?

3.1 SPECIALIST VS NON-SPECIALIST REINSURERS

3.1.1 An interesting point to note from the paper is the difference in cost between reinsuring with specialist reinsurers and reinsuring with organisations having a corporate
relationship with the scheme. The loss ratio quoted for specialist reinsurers in paragraph 5.3.1 is 88% of premiums. The loss ratio derived from paragraph 5.3.2 for organisations with a corporate relationship with the scheme is:

\[
\frac{3200000000 - 165000000}{3200000000} = 95%,
\]

i.e. specialist reinsurers charge approximately 7% of risk premium more than non-specialist reinsurers.

3.1.2 The point about investment income in paragraph 5.3.2 is misleading and is not based on fact:
- Most schemes bill in arrear, and would then pay their reinsurance premiums in arrear. Allowing for receipt of reinsurance premiums in arrear, the delay in claims payments and interest rates on cash, the interest earned on these contracts would only be 0.5% of the risk premium.
- Both specialist and non-specialist reinsurers would earn the 0.5% interest, i.e. it is not additional profit earned by non-specialist reinsurers.

3.2 COST OF CAPITAL

3.2.1 The authors have not allowed for the cost of holding capital for both specialist and non-specialist reinsurers. The minimum capital requirement during the period was 30% of reinsurance premium for quota-share contracts and up to 100% for stop-loss contracts in terms of guidelines issued by the Financial Services Board (FSB). Assuming a cost of capital of 25% a year, the cost of capital for a quota-share scheme is approximately 7.5% of the risk premium and for stop-loss cover it can be up to 25% of the risk premium.

3.2.2 Based on the cost of capital it appears that many of the non-specialist reinsurers are offering reinsurance at rates below their cost of capital, i.e. the schemes that reinsure with these organisations get reinsurance at below market-related rates. This is possible because many of these reinsurers have a better understanding of the risk posed by the scheme, and are willing to risk their balance sheets at a lower cost as their businesses depend on the support they provide to the scheme.

4. ALIGNING THE INCENTIVES OF SCHEME, ADMINISTRATOR AND MEMBER

In addition, the reinsurance ensures that the incentives of the scheme and administrator are aligned, as both share in the losses caused by rising or unmanaged claims costs. The reinsurer is also motivated to focus on managed-care initiatives, thus ensuring lower future contribution increases and enhancing value for members.

5. OTHER

5.1 On the topic of risk spreading, the authors comment in paragraph 2.8 that they are not analysing any of the “subsequent retrocessions (which may have involved a specialist
reinsurer). It is difficult to say there is no risk spreading if subsequent retrocessions are not analysed as well. In addition, risk spreading from medical scheme to external reinsurer will still result in a reduced risk of insolvency as both scheme and reinsurer have their own capital base.

5.2 The authors should try to standardise the analysis on reinsurance premiums by rand amount instead of by number of insurance contracts (see paragraph 7.5.1). For example, one of the large reinsurers whose reinsurance premiums would have comprised up to 50% of the total premium for 1999, made a loss on the reinsurance contract in 1999 according to its scheme accounts. The difference between the losses on 5% of contracts as shown by the authors and losses on 50% of premiums would require a different conclusion from that reached by the authors.

5.3 Paragraph 5.3.2 mentions investment income that “could have been of the order of a further R150m”. These figures are baseless, and the method of reaching this conclusion should be clarified.

5.4 In paragraph 7.3.6 the authors say that in the majority of cases no sound actuarial basis could be found for the reinsurance offered. The authors should define the basis used in the paper in order to better ascertain the reasonability of their comments. As mentioned above, the schemes reinsuring with non-specialist reinsurers appear to have received value on the basis of:
– cost compared to specialist reinsurers and the cost of capital,
– increased certainty for the scheme as to claims cost, and
– enhanced solvency for the scheme.

5.5 Paragraph 7.3.7 mentions that reinsurance harms solvency. But the solvency of reinsurers is almost always considerably higher than that of the medical scheme being reinsured, and reinsurers have greater access to capital than the schemes they reinsure. As a result, reinsurance in fact enhances the solvency of the scheme it reinsures.

6. CONCLUSION

6.1 This paper provides a good source of statistics on the use of reinsurance in medical schemes, a practice that has been expanding in the uncertain healthcare environment.

6.2 In our view this paper provides a subjective analysis of reinsurance contracts, and we encourage the authors to follow up with a more objective investigation following clearly defined actuarial guidelines.

6.3 The conclusions drawn from the paper are in many cases unsubstantiated; for example there is no clear calculation shown for interest income earned, and the basis for these comments should be expanded upon.
6.4 The case that large schemes do not need to reinsure, that members suffer as a result of reinsurance arrangements and that non-specialist reinsurers are profiteering is not clear from this paper. In particular:
- There are very strong actuarial reasons to reinsure large schemes due to the uncertain environment in which they operate. Risks such as changes in demographic profiles, medical inflation, increasing costs as a result of technological improvements, benefit changes, HIV/AIDS, other epidemics and the seasonality of claims require understanding and the use of appropriate risk management techniques such as reinsurance.
- Members gain from reinsurance as a result of lower premiums due to a longer term to build scheme surplus.
- Non-specialist reinsurers in many cases are charging schemes reinsurance rates below their cost of capital.

6.5 Reinsurance is currently regulated by the FSB, which has had considerable experience with reinsurance regulation in South Africa. Since many of the arguments put forward by the authors of this paper appear to be unsubstantiated, we would recommend that the existing regulation by the FSB should continue and that it should not be transferred to the Registrar of Medical Schemes, the body represented by the authors.

Shaun Matisson and Dani Katz
Healthcare Committee, Actuarial Society of South Africa
ABSTRACTS OF RECENT THESES AND DISSERTATIONS
AT SOUTH AFRICAN UNIVERSITIES

An Investigation into the Suitability of Using Garch Processes for Pricing Options on the SAFEX All Share Index Futures Contracts by S Miller for MBusSc at the University of Cape Town

This dissertation primarily sets out to investigate the possibility of incorporating autoregressive conditional heteroskedasticity (ARCH) assumptions in an option-valuation model for the All Share Index option contracts, as an alternative to the constant-variance assumption required by the Black-Scholes option-pricing model. This involves an assessment of whether the log returns of the ALSI futures (the instruments underlying the ALSI option) follow an ARCH process. A secondary objective is to assess the potential for using an ARCH process to model the ALSI spot log returns. This could have the following uses:

– pricing over-the-counter ALSI spot options; and
– using the forecast spot return ARCH volatility as a proxy for the forecast ALSI future log return volatility if they behave similarly.

Evidence of ARCH presence is determined by examining autocorrelation in the squared error terms of the log returns. Although some statistically significant autocorrelations were found, the lags that exhibited these significant autocorrelations showed no pattern. Furthermore, lags that exhibited statistically significant autocorrelations changed over time.

Bond Indices in South Africa by Y Stander for MSc at the University of the Witwatersrand

This dissertation determines who the users of the Bond Exchange-Actuaries indices are, and how these indices are used in practice. A survey was used to establish what the market participants believed to be inadequacies in the indices as well as possible changes that should be considered. The need for change is justified and the nature of changes that should be considered is discussed.

The dissertation also addresses criticisms of the Bond Exchange-Actuaries yield curve, particularly that this curve does not always show acceptable behaviour at the short and very long maturities, and that the technique used to derive this curve is inadequate. Alternative empirical yield-curve models and equilibrium models are considered. Selected yield-curve models are fitted to South African bond data. To test whether the yield-curve functions are able to take on the different appropriate shapes as required, yield curves are fitted to data from various historical periods. Other issues that are also discussed are whether NCD (negotiable certificates of deposit) rates or JIBAR (Johannesburg Interbank Agreed Rate) curves should be used at the short end of the curve.
Property insurance covers policyholders against losses arising from a wide range of occurrences. Premiums are calculated by taking into account estimates of the frequency and severity of the losses. Estimating the frequency and severity of claims caused by natural catastrophes is difficult, due to the relatively low frequency of natural catastrophes, and the unavailability of historical catastrophe claims data. The accumulation of a large number of claims in the area affected by the catastrophe is of particular interest to insurers and reinsurers alike.

This dissertation discusses the fundamental issues underlying the modelling of insurance losses from natural catastrophes in South Africa. A suggestion is given of the key parameters that need to be taken into account, and a framework is given for models describing losses arising from floods, hail and tornadoes.
ARTICLES IN OTHER JOURNALS


Fraser E & Page M: Value and momentum strategies: evidence from the Johannesburg Stock Exchange

The purpose of this paper is twofold: to determine the independent validity of momentum and value strategies when applied to the industrial sector of the Johannesburg Stock Exchange and to determine whether the outcomes of these strategies are interrelated.


Ward M: The CAPM in an options pricing framework

This paper critically considers the definition of risk and the expectations framework of the capital asset pricing model. It considers the use of option theory in an attempt to deal with these issues. Particular reference is made to the dynamics of the Johannesburg Stock Exchange.

Robertson M, Firer C & Bradfield D: Identifying and correcting misclassified South African equity unit trusts using style analysis

Biekpe N & Moore MJ: Measuring volatility using bilinear GARCH models

This paper examines a scalar second-order bilinear GARCH model of the form:

\[
\sigma_t^2 = \alpha^T \sigma_{t-1}^2 + \varepsilon_t^2 + \sum_{j=1}^{q} \hat{\sigma}_j \sigma_{t-j} + \sum_{j=1}^{p} \hat{\rho}_j \varepsilon_{t-j} + \sum_{j=1}^{p} \hat{\sigma}_j \varepsilon_{t-j}
\]

where \( s_{t-1} \) and \( e_{t-1} \) are respectively the lag values of the standard deviation and residuals of the FTSE 100 index. The primary aim is to present the BGARCH model as another useful tool for modelling volatility.


Aitken IM: South Africa: the occupational pension scene

This paper describes current issues in occupational pension schemes in South Africa.

Asher A: Loading members with investment choice

This paper discusses why South African retirement funds might not respond to requests for member investment choice in defined contribution schemes. The author
suggests that the major question facing retirement fund investors is the continuing existence of the equity risk premium. In the light of uncertainty as to its future, it is suggested that investment choice is unlikely to be of much value to members as it overloads them with worry and expense.

*Orion 15 (1/2) (2000)*

Swart J: Optimising investment performance through international diversification

In this paper the potential benefits of international diversification for South African investors are considered. The stability over time of the correlation structure is investigated and simple *ex-ante* investment strategies are formulated and evaluated.


Van Rensburg P: Macroeconomic variables and the cross-section of Johannesburg Stock Exchange Returns


This issue of *SAJE* contains three articles on capital gains tax.

Grote M & Fletcher K: Capital gains tax in South Africa

Steenekamp TJ: Good tax practice and taxing capital gains

Black PA: Capital gains tax: critical notes


This special issue of *SAJE* contains articles on the economic effects of AIDS, as well as articles on economic aspects of intervention. They were selected from papers presented at a symposium in Durban, on the eve of the XIII International AIDS Conference in July 2000. The symposium was organised by the International AIDS Economic Network.

Bonnel R: HIV/AIDS and economic growth: a global perspective

This is written by an employee of the World Bank and reflects that institution’s policy.
Arndt C & Lewis JD: The macro implications of HIV/AIDS in South Africa: a preliminary assessment


Lundberg M, Over M & Mujinja P: Sources of financial assistance for households suffering an adult death in Kagera, Tanzania

Stillwaggon E: HIV transmission in Latin America: comparisons with Africa and policy implications

Kumaranayake L & Watts C: HIV/AIDS prevention and care interventions in sub-Saharan Africa: an econometric analysis of the costs of scaling-up
An Introduction to Actuarial Studies by ME Atkinson and DCM Dickson, Edward Elgar Publishing Limited (2000).

As the name implies, this book is intended to be an introductory text for students entering the study of actuarial science. The authors are Maggie Atkinson, a former lecturer at the University of Melbourne, and David Dickson, the Professor of Actuarial Studies at the same university. Their stated aim in writing this text is to provide a single, introductory text which gives an overview of the full range of actuarial techniques and practices. The main body of the book is divided into four significant chapters:

– the valuation of financial transactions (essentially compound interest);
– demography (which includes an introduction to survival models);
– actuarial practice (in the field of life insurance, health insurance, pensions – or “superannuation” – and general insurance); and
– the valuation of contingent payments (elementary life contingencies).

As most of the subject matter is covered in other actuarial textbooks in much more detail, this book will have little appeal or use to actuaries in practice. Therefore the review that follows evaluates the book in terms of its aim, namely being a single introductory text for actuarial students. I have taken as a benchmark the first-year actuarial science course at the University of the Witwatersrand, and assessed the book in terms of whether it would be a suitable text in terms of coverage and level of detail for that course.

The chapter on the valuation of financial transactions covers the work that is the foundation of most introductions to actuarial science. It is easy to use and introduces certain topics well, in particular the equation of value and the use of complex annuities. The concept of nominal interest rates on the other hand could have contained more explanation.

Fixed interest securities were introduced before the difference between income of a capital as opposed to an interest nature, the analysis of an annuity being one of the last sections of this chapter.

The standard actuarial tool of interpolation is covered, but with no warnings about the inaccuracies of the method or the ways to minimize such inaccuracies. The chapter makes no reference to varying annuities, nor does it deal with continuous annuities or the force of interest.

Demography follows, and includes population pyramids, the survival function, and the life table and stationary populations. The chapter reads easily and touches on interesting points, such as the effect of immigration on a country’s mortality profile and the difference in mortality experienced by different socio-economic groupings. A small number of exercises are given at the end of the chapter, as is the case for the financial
transactions and contingent payment chapters. Answers for all exercises are given at the back of the book, but not worked solutions.

The chapter on actuarial practice provides a good overview of the traditional areas in which actuaries have worked, without going into much detail. However, an opportunity was lost in not mentioning the broader fields in which actuaries have become involved, such as investments, merchant and retail banking, capital products and financial management. The fact that actuaries work in “other fields” is only alluded to in the opening paragraph, and a chance to show the value of the actuarial approach in other fields was lost. One small point, the authors state inaccurately that trauma assurance (dread disease) was only introduced in the last ten years, rather than a more accurate “last twenty”.

The final chapter deals with contingent payments, adopting the modern spreadsheet approach rather than the use of commutation functions. The chapter succeeds in giving an overview, though it is somewhat less successful than the other chapters in that the concepts are more complicated and the material covered and provided is the bare minimum needed to introduce the concept. As a consequence it gives a “flavour of actuarial mathematics” rather than the detail needed to utilise some of the techniques effectively (which to be fair is one of the authors’ stated intentions.)

In summary, the authors broadly succeed in showing “a slice of the actuarial landscape” through “a superficial but not trivial coverage of a broad range of topics”. The book is unlikely to find a place as an introductory textbook for those wishing to become actuaries; its value lies rather in providing a good overview of traditional actuarial thought and as such should prove useful in the teaching of actuarial studies in a broader, non-actuarial financial degree. It can also be recommended as a well written, non-technical text for those allied practitioners who are interested in finding out what actuaries do and on what the actuarial thought processes are based.

SC Jurisch


Mathematical Models of Derivatives is divided into seven chapters:

– general characteristics of financial derivative models (40 pages);
– pricing models for one-asset European options (40 pages);
– pricing models for multi-asset European options (39 pages);
– American options (44 pages);
– numerical schemes for pricing options (46 pages);
– path-dependent options (54 pages); and
– bond and interest-rate derivatives (37 pages).

There are exercises at the end of each chapter, though no solutions.

This book is intended for students studying “advance (sic) analytical and numerical
techniques to price financial derivatives and manage portfolio risk” towards undergraduate degrees in finance.

In my view, it is more suitable as a comprehensive – but dry – reference on the pricing of derivatives. Actuaries and students may find it too mathematically intensive and lacking in insight into market practice to serve as an introduction to the subject. For example, no details are provided of the actual derivative instruments available. The book focuses on options, but no options strategies are described. In this regard, one cannot resist comparison with Hull’s *Options, Futures & Other Derivatives*, the primary reading for the profession’s Certificate in Derivatives. Hull better informs an actuary who intends to use the derivatives markets.

*Mathematical Models of Derivatives* uses stochastic calculus as its single line of approach when deriving pricing formulae. This contrasts with the more intuitive approach of the other Certificate in Derivatives reading, Baxter and Rennie’s *Financial Calculus*. The arbitrage-pricing mindset essential for pricing derivatives is very different from the traditional insurance-pricing approach of assuming a probability model for the payoffs. Actuaries may prefer a book, such as Baxter and Rennie, that explains the limitations of the traditional actuarial approach to the pricing of derivatives.

The book’s emphasis is on equity options, only the last chapter addressing interest-rate derivatives. This last chapter describes all the major stochastic interest-rate models, though little detail is given of the rationale for each model.

The book’s major strength is its discussion of numerical pricing methods (binomial and finite-difference models and Monte Carlo simulation) and path-dependent options (including barriers, lookbacks and Asian options). Here the book is at its most practical. The discussion of truncation errors, convergence and numerical stability will give the practitioner a fair degree of confidence when applying these numerical methods to the pricing of path-dependent exotics.

Another useful section is the generalisation of the Black-Scholes pricing model to multiple underlying assets in Chapter 3. Foreign currency options and options on the minimum or maximum of several assets are discussed in some detail. The notation is clear and the formulae are illustrated with figures.

In conclusion, the level of the book falls between an introductory text and the many mathematically rigorous texts available. These advanced texts are often specific to either equity or interest-rate derivatives. Actuaries are likely to find the book a useful reference on the pricing of vanilla options and particularly the more exotic derivatives, but it is less suitable as an introduction to derivatives.

**MR Greenwood**