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Australian Actuarial Journal

Volume **7** (1) 2001

Coleman, A. M. *Beyond uncertainty — turning risk into value: Presidential Address*, 9-171. The motto of the Institute of Actuaries '*Certum ex Incertis*' ('Certainty out of Uncertainty') encapsulates the *raison d'être* of the actuarial profession and its means of 'adding value'. As we enter the 21st century this seems particularly relevant. Our lives and our society generally are increasingly marked by uncertainty generated by continual change driven by globalisation, technological innovation and a transformation and/or breakdown of traditional business, economic and social structures.

Both the public and private sectors need to respond to the challenges wrought by these changes and actuaries are increasingly called upon to contribute to the development of policy, business and strategic plans created in this environment of rapid and increasing change and uncertainty. In addition, virtually every political or government decision and the operation of all business enterprises involves those concerned in taking what are commonly referred to as 'calculated risks'.

Calculating risks is at the core of what actuaries do. The origins of the actuarial profession involved creating solutions for such problems to create viable insurance mechanisms to manage risks and improve community welfare. Today, developments in fields as diverse as telecommunications, genetics, the natural environment and finance provide challenges and opportunities for actuaries to take a more pro-active role in shaping improved risk analysis and decision making processes. Accepting this challenge will take the profession 'beyond uncertainty' to achieve better 'value added' future outcomes for both decision makers and the communities and stakeholders they serve. But failing to adapt could result in stagnation and an eventual marginalisation of the profession from emerging issues in business and society generally.

In the balance of this presidential address, I intend to explore the current forces driving change and risk, consider the implications for the profession and review a number of developments of current professional interest to Australian actuaries where the Institute of Actuaries of Australia (IAAust) has been active.

Dickson, D. C. M. *Modern landmarks in actuarial science*, 217-245. For this lecture, the author has chosen to explore a part of the profession's recent past. Actuarial science has changed greatly since he first set out on the path to becoming an actuary almost twenty-five years ago. One of the drivers of change is, of course, research. Research is fundamental to the long term security and survival of a profession. In this lecture, the author discusses actuarial research that he believes has made a real difference to the profession — to the way we practise, to the conduct of research and to the material we teach. He cuts across the practice areas, so there is something of interest for all.

Farmer, J. A. *Increasing and decreasing annuities certain and time reversal*, 247-250. Standard formulae for decreasing annuities certain are derived from those for increasing annuities by reversing the direction of the time axis.

Institute of Actuaries of Australia. *Educating financial services consumers: ASIC Discussion Paper*, 185-191. In October 2000 the Institute of Actuaries of Australia prepared a

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submission to ASIC in response to its Discussion Paper entitled 'Education Financial Services Consumers'. The Institute of Actuaries of Australia generally supported ASIC's education initiative.

INSTITUTE OF ACTUARIES OF AUSTRALIA. *Family Law Legislation Amendment (Superannuation) Bill 2000*, 193-206. At the end of October 2000, the Institute of Actuaries of Australia prepared a submission to the Senate Select Committee on Superannuation and Financial Services providing comments on the draft Family Law Amendment Regulations and the draft Superannuation Industry (Supervision) regulations which were consequential upon the Family Law Legislation Amendment (Superannuation) Bill 2000. Institute of Actuaries of Australia then outlined its position in relation to: the consultation process; defined benefit interests; partially vested accumulation interests; the meaning of accumulation phase and payment phase; trustees responsibilities; order of deduction from members' benefit components; superannuation surcharge; adjustment to the base amount; splitting benefits; application of vested benefit minimum; benefits payable as pensions; and reversionary interests.

INSTITUTE OF ACTUARIES OF AUSTRALIA. *Family Law legislation Amendment (Superannuation) Bill 2000*, 207-213. On 13 November 2000 Helen Martin and Jenifer Walton gave evidence at the public hearing of the Senate Select Committee on Superannuation and Financial Services in Canberra in relation to the above mentioned Bill. Following that appearance, they wrote to the Committee providing additional comments regarding some of the issues raised at the hearing.

INSTITUTE OF ACTUARIES OF AUSTRALIA. *Proposed Amendment to the Superannuation Industry (Supervision) Regulations — Self-Insurance*, 175-183. In October 2000 the Institute of Actuaries of Australia wrote to the Department of Treasury and commented on the draft amendments to the SIS Regulations. The Institute of Actuaries of Australia queried whether Treasury's assumed objective of securing members' entitlements was being achieved effectively in the draft amendments and suggested an alternative approach.

AUSTRALIAN ACTUARIAL JOURNAL

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CARRETT, P. & STITT A. H. *The valuation of retail funds management companies*, 251-377. Company valuation is an especially topical issue for the retail funds management industry. Recent merger and acquisition activity has focused attention on what constitutes an appropriate value for these companies, as well as on the task of extracting value on a scale comparable to the prices paid. in addition, we are increasingly seeing valuation of funds managers being contemplated in circumstances other than mergers and acquisitions. This paper seeks to promote discussion within the actuarial profession and the broader financial services industry on the valuation of retail fund management companies by: Outlining the key elements of economic value measurement; Discussing how company valuations can be applied in practice to the management of retail fund management companies; Comparing the various fund valuation methodologies, and consequently recommending the discounted cash flow (DSF) technique as the most broadly appropriate of these methods; and Showing how DCF techniques can be applied to the specific case of retail funds management companies.

INSTITUTE OF ACTUARIES OF AUSTRALIA. *Family Law Legislation Amendment (Superannuation) Bill 2000*, 381-388. On 12 February the Institute of Actuaries of Australia sent a submission to the Senate Select Committee on Superannuation and Financial Services concerning the Family Law Legislation Amendment (Superannuation) Bill 2000. In this submission, the

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Institute of Actuaries of Australia commented on the document that had been prepared by the Attorney-General's Department in response to the submissions and testimony that had previously been given to the Senate Select Committee by interested third parties.

INSTITUTE OF ACTUARIES OF AUSTRALIA. *Review of Superannuation Industry (Supervision) Act 1993 and Certain Other Superannuation Legislation*, 389-407. On 9 May 2001 the Institute of Actuaries of Australia made a submission to the Productivity Commission's Inquiry into the Review of Superannuation Industry (Supervision) Act 1993 and Certain Other Superannuation Legislation.

THORNLEY, D. *Pricing for profit shares in group life risk business*, 411-421. This paper sets out a method for calculating a profit share formula in group life insurance which reflects the risk profile of the group. It elaborates the 1992 paper by Bozenna Hinton by allowing for a 'custom built' profit share, rather than relying on common broad rules of thumb such as number of lives. Stochastic projections examine the underwriting profit/loss to the insurer. Keywords: Profit share, life insurance, claim simulations, group life.

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INSURANCE: MATHEMATICS & ECONOMICS

Volume **29** (1) 2001

DENUIT, M. *Laplace transform ordering of actuarial quantities*, 83-102. This paper aims to study both univariate and multivariate versions of the Laplace transform order. The importance of this stochastic order relation in actuarial sciences is enhanced by outlining several possible applications.

FROSTIG, E. *A comparison between homogeneous and heterogeneous portfolios*, 59-71. We compare two portfolios: in the heterogeneous portfolio the individual risks are independent but not identically distributed. In the homogeneous portfolio the risks are independent and identically distributed. We compare the heterogeneous portfolio with two types of homogeneous portfolios. First, we assume that the distribution of each risk in the homogeneous portfolio is a mixture with equal weights of the risks in the heterogeneous portfolio, and get an upper bound for the heterogeneous portfolio. To get a lower bound we assume that the risks in the homogeneous portfolio are the average of the individual risks in the heterogeneous portfolio.

JOSA-FOMBELLIDA, R. & RINCÓN-ZAPATERO, J. P. *Minimization of risks in pension funding by means of contributions and portfolio selection*, 35-45. We consider a dynamic model of pension funding in a defined benefit plan of an employment system. The prior objective of the sponsor of the pension plan is the determination of the contribution rate amortizing the unfunded actuarial liability, in order to minimize the contribution rate risk and the solvency risk. To this end, the promoter invests in a portfolio with n risky assets and a risk-free security. The aim of this paper is to determine the optimal funding behavior in this dynamic, stochastic framework.

LANDSMAN, Z. M. & SHERRIS, M. *Risk measures and insurance premium principles*, 103-115. Risk measures based on distorted probabilities have been recently developed in actuarial science and applied to insurance rate making. We propose a risk measure that has the

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properties of risk aversion and diversification, is additive for losses and consistent in its treatment of insurance and investment risks. We show that the risk measure based on distorted probabilities is not consistent in its ordering of insurance and investment risks.

PERRY, D. & STADJE, W. *Function space integration for annuities*, 73-82. We derive explicit formulas for the expected values of annuities with a random interest rate, modeled by a reflected Brownian motion at zero (RBM) stopped by certain Markov times. We consider times τ of the following kinds: (i) τ is constant, (ii) τ is a random and independent of the RBM X, (iii) τ is the first time X reaches a prespecified level, and (iv) minima of these stopping times. The case of Brownian motion without reflection is also briefly discussed.

PERRY, D., BERG, M. & POSNER, M. J. M. *Stochastic models for broker inventory in dealership markets with a cash management interpretation*, 23-34. We study the problem of a broker in a dealership market whose buffer content (cash flow) is governed by stochastic price-dependent demand and supply. Three model variants are considered. In the first model, buyers and sellers (borrowers and depositors) arrive independently in accordance with price-dependent compound Poisson streams. The second and the third models are two variants of diffusion approximations. For a certain natural revenue function, taking into account the trade-off between holding and shortage costs (opportunity loss and interest rates), we define relevant cost functionals that lay the groundwork for optimization purposes. The approach in analyzing and computing the cost functionals is based on the optional sampling theorem applied to a certain martingale.

WINDCLIFF, H., FORSYTH, P.A. & VETZAL, K. R. *Valuation of segregated funds: shout options with maturity extensions*, 1-21. One of the most popular investments available in the Canadian market today is a mutual fund with the added feature of a long term maturity guarantee. These types of investments are known as segregated funds. They often have very complex option features. For example, these contracts typically contain multiple embedded shout options which permit the holder to reset the guarantee level and the maturity date for which it applies many times during the life of the contract. These funds also provide mortality benefits if the investor dies prior to the maturity date. This paper explores the valuation of segregated funds using an approach based on the numerical solution of a set of linear complementarity problems. Our results indicate that the option components of some of these contracts seem to be underpriced, especially for riskier funds with relatively high volatilities. This assumes that investors exercise their options optimally. Non-optimal behaviour by investors of course reduces the values of the embedded options, and we provide some illustrative results along these lines. We also show that alternative contract specifications which generate similar present values may require substantially different proportionate fees, since the expected durations of the contracts can be quite different.

YUEN, K. C. & GUO, J. Y. *Ruin probabilities for time-correlated claims in the compound binomial model*, 47-57. In this paper we consider the ruin probability for a risk process with time-correlated claims in the compound binomial model. It is assumed that every main claim will produce a by-claim but the occurrence of the by-claim may be delayed. Recursive formulas for the finite time ruin probabilities are obtained and explicit expressions for ultimate ruin probabilities are given in two special cases.

INSURANCE: MATHEMATICS & ECONOMICS

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ARMSTRONG, M. J. *The reset decision for segregated fund maturity guarantees*, 257-269. A segregated fund is a mutual fund whose value is protected by a maturity guarantee. An

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investor in such a fund may have the option of periodically resetting this guarantee to extend its life and increase the guaranteed amount. We model this guarantee reset decision using a discrete time Markov chain and analyse a decision strategy based upon a return threshold. We characterise the optimal value for this threshold and examine its properties. We show that the intuitive strategy of resetting the guarantee whenever the fund's value has increased is not optimal but seems to provide good results.

Blake, D., Cairns, A. J. G. & Dowd, K. *Pensionmetrics: stochastic pension plan design and value-at-risk during the accumulation phase*, 187-215. We estimate values-at-risk (VaR) in the accumulation phase of defined-contribution pension plans. We examine a range of asset-return models (including stationary moments, regime-switching and fundamentals models) and a range of asset-allocation strategies (both static and with simple dynamic forms, such as lifestyle, threshold and constant proportion portfolio insurance). We draw four conclusions from our investigations. First, we find that defined-contribution (DC) plans can be extremely risky relative to a defined-benefit (DB) benchmark (far more so than most pension plan professionals would be likely to admit). Second, we find that the VaR estimates are very sensitive to the choice of asset-allocation strategy. The VaR estimates are also sensitive, but to a lesser extent, to both the asset-returns model used and its parameterisation. The choice of asset-returns model is found to be the least significant of the three. Third, a static asset-allocation strategy with a high equity weighting delivers substantially better results than any of the dynamic strategies investigated over the long term (40 years) of the sample policy. This is important given that lifestyle strategies are the cornerstone of many DC plans. Fourth, conservative bond-based asset-allocation strategies require substantially higher contribution rates than more risky equity-based strategies if the same retirement pension is to be achieved.

Brekelmans, R. & De Waegenaere, A. *Approximating the finite-time ruin probability under interest force*, 217-229. We present an algorithm to determine both a lower and an upper bound for the finite-time probability of ruin for a risk process with constant interest force. We split the time horizon into smaller intervals of equal length and consider the probability of ruin in case premium income for a time interval is received at the beginning (resp. end) of that interval, which yields a lower (resp. upper) bound. For both bounds we present a renewal equation which depends on the distribution of the present value of the aggregate claim amount in a time interval. This distribution is determined through a generalization of Panjer's [*ASTIN Bull.* **12** (1981)] recursive method.

Jasiuleqicz, H. *Probability of ruin with variable premium rate in a Markovian environment*, 291-296. The probability of ruin is investigated under the influence of a premium rate which varies with the level of free reserves. In the considered risk model, the occurrence of claims is described by the Cox process.

Marceau, É. & Rioux, J. *On robustness in risk theory*, 167-185. In this paper, we consider the robustness properties of some estimators in the context of a few natural problems in risk theory. They are the calculation of excess of loss premiums, stop-loss premiums in both individual and collective risk models, and the probability of ruin. For that purpose, we introduce the influence function (and its empirical equivalent, the sensitivity function) and we apply it to the non-parametric plug-in estimators of those quantities. We find that they all have unbounded influence function. In order to obtain estimators with bounded influence function, we consider parametric estimators. We note that the shape of the influence function for any function of the parameters is fixed by the method used for estimating them. We propose the use of minimum distance methods in order to obtain robust estimators. We compare one of them, the minimum Cramér-von Mises estimator, with the maximum likelihood estimator and the non-parametric plug-in estimator with various illustrations.

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OLIVIERI, A. *Uncertainty in mortality projections: an actuarial perspective*, 231-245. The use of mortality tables that include a forecast of the future trends of mortality (the so-called 'projected tables') for life insurance valuations is analysed. In particular, annuity and term assurance portfolios are considered. The (systematic) risk inherent in the adoption of a table that might not properly represent future mortality is modelled. Some tools for facing such risk are briefly discussed.

POWERS, M. R. & SHUBIK, M. *Toward a theory of reinsurance and retrocession*, 271-290. There is a natural tradeoff in insurance markets between the benefits of increasing the number of competitors, and the drawbacks of weakening the law of large numbers by diminishing the average amount of insurer reserves. In this investigation, we consider the possibility of an optimal number of reinsurance/retrocession levels — and an optimal configuration of each of these levels — in the design of the insurance industry. A general question that may be asked of all financial institutions is: what factors limit the number of 'layers of paper' to be constructed?

YANG, H. & ZHANG, L. *On the distribution of surplus immediately after ruin under interest force*, 247-255. In this paper, we consider the problem of the severity of ruin for a compound Poisson model with a constant interest rate. By using the techniques of Sundt and Teugels [IME 16 (1995)], equations satisfied by the distributions of surplus immediately after ruin have been obtained. Some special cases are also discussed.

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BEIRLANT, J. & GUILLOU, A. *Pareto index estimation under moderate right censoring*, 111-125. Real claim data sometimes are censored from above at a high value induced by the sum insured. In this note we examine the behaviour of extreme-value methods in such settings and propose an adaptation of the popular Hill (1975) estimator. It is argued that the censoring typically cannot exceed 5% for an effective use of the methods suggested.

HANNERZ, H. *Presentation and derivation of a five-parameter survival function intended to model mortality in modern female populations*, 176-187. A single analytical expression for the probability of survival from birth to age x that would hold good for all ages in the entire human life span has been sought for centuries. With an eight-parameter function, Heligman and Pollard achieved this goal, for integer values of x, in 1980. The present paper introduces a five-parameter survival function intended to model human mortality in modern female populations. The introduced function is not only defined for integers. It is defined for all ages.

LÉVEILLÉ, G. & GARRIDO, J. *Recursive moments of compound renewal sums with discounted claims*, 98-110. Under regularity conditions, Léveillé & Garrido [6] gives a derivation of the first two moments (resp. asymptotic) of a Compound Renewal Present Value Risk (CRPVR) process using renewal theory arguments. In this paper, with the same procedure and assuming that all the moments of the claim severity and the claims number process exist, we get recursive formulas for all the moments (resp. asymptotic) of the CRPVR process.

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NORBERG, R. *On bonus and bonus prognoses in life insurance*, 126-147. The surplus on a life insurance policy is defined, at any time during the term of the contract, as the difference between the second order retrospective reserve and the first order prospective reserve. General principles for redistribution of the systematic part of the surplus as bonus are formulated, and various special bonus schemes are discussed. Techniques for forecasting future bonuses are worked out in an extended model with stochastic experience basis. Numerical illustrations are provided.

PICARD, P. & LEFÈVRE, C. *On the probability of (non-) ruin in infinite time*, 148-161. In the context of the classical Poisson ruin model Gerber (1988a,b) and Shiu (1987, 1989) have obtained two formulae for the ruin and non ruin probabilities in infinite time. Here these two formulae are generalized to the case of an arbitrary premium process when all claims are integer-valued, as in Picard & Lefèvre (1997). Moreover, this generalization throws a new light on the two known formulae and it then leads very simply to a third new formula.

ROOTZÉN, H. & TAJVIDI, N. *Can losses caused by wind storms be predicted from meteorological observations?* 162-175. This paper contains a study of the extent to which aggregate losses due to severe wind storms can be explained by wind measurements. The analysis is based on 12 years of data for a region, Skåne, in southern Sweden. A previous investigation indicated that wind measurements from six recording stations in Skåne was insufficient to obtain accurate prediction. The present study instead uses geostrophic winds calculated from pressure readings, at a regular grid of size 50 kilometres over Skåne. However, also this meteorological data set is seen to be insufficient for accurate prediction of insurance risk. The results indicate that currently popular methods of evaluating wind storm risks from meteorological data should not be used uncritically by insurers or reinsurers. Nevertheless, wind data does contain some information on insurance. risks. There is a need for further research on how to use this information to improve risk assessment.

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