B.A.J. **11**, III, 573-590 (2005)

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Australian Actuarial Journal

Volume **10** (2), 2004

Carrett, P. *Modelling credit risk for Australian fixed interest investments.* 259-342. Over the last decade, credit risk has increasingly been shifted from banks to institutional investors. The risk premium attaching to credit has undergone large swings, with a number of commentators suggesting that current levels are low relative to the risks involved. Is taking on credit risk in the Australian market still a worthwhile proposition? What do the average portfolio returns, volatilities and probability distributions of excess returns for credit risk look like under current market conditions? This paper presents a stochastic model of the Australian fixed interest market for the purposes of investigating these questions, and outlines the challenges involved with building models in the local context.

Institute of Actuaries of Australia, Public Policy Council Committee. *Submission on the Australian Prudential Regulation Authority (APRA) consultation paper on 'Fit and Proper' Standards.* 405-410. This submission was made to the Australian Prudential Regulation Authority (APRA) in May 2004 in response to a consultation paper on 'Fit and Proper' Standards and draft Prudential Standards for people working at a senior management level and above in the regulated financial sector.

Institute of Actuaries of Australia, Superannuation and Employee Benefits Practice Committee. *Submission on complying market linked income streams.* 389-405. This submission was made in April 2004 in response to the Federal Treasurer's announcement of 25 February 2004 regarding a new complying market linked life expectancy pension. The submission presents ideas on suitable designs for complying pensions, including market linked pension products.

Institute of Actuaries of Australia, Superannuation and Employee Benefits Practice Committee. *Submission on the draft Superannuation Splitting Regulations.* 431-439. This submission was made in June 2004 in response to an invitation from the Department of the Treasury to comment on the revised regulations relating to the Government's proposed legislative framework to allow the splitting of superannuation contributions.

Institute of Actuaries of Australia, Superannuation and Employee Benefits Practice Committee. *Submission on the Superannuation Industry (Supervision) Amendment Regulations 2004 (No 2), CGT rollover relief for superannuation funds.* 411-430. This submission was made in June 2004 to Senator the Hon Helen Coonan, Minister for Revenue and Assistant Treasurer, to comment on issues arising from aspects of the amending regulations, as gazetted on 12 May 2004.

Leung, E. *Projecting the needs and costs of long term care in Australia.* 343-385. Considerable attention has been given in the recent past to the likely economic and social impact of Australia's ageing population. One particular aspect that continues to be the subject of increased commentary and conjecture is the need and subsequent costs for long term care. In this paper, a multiple state projection model based on a framework by Rickayzen and Walsh

https://doi.org/10.1017/S1357321700003275 Published online by Cambridge University Press

(2002) is constructed in order to project the number of people in Australia who are likely to require long term care.

Australian Actuarial Journal

Volume **10** (3), 2004

Fitzherbert, R. M. *Price conversion factors for historians.* 617-622. This note sets out factors for converting prices from any year back to 1860 into 2004 equivalents. These factors are only approximate. They are intended for use by historians and are only relevant in Australia.

Institute of Actuaries of Australia, International Accounting Standards Committee. *Submission on Exposure Draft 132. Request for comment on IASB ED Proposed amendments to IAS 39 — The fair value option.* 531-551. In June 2004, the Institute of Actuaries of Australia made a submission to the Australian Accounting Standards Board (AASB) commenting that support could not be given for changes to IAS 39 in the form proposed, and endorsing the AASB's initial assessment as outlined in the preface to ED 132.

Institute of Actuaries of Australia, International Accounting Standards Committee. *Submission on Exposure Draft (ED 131). Request for comment on IASB ED Proposed amendments to IAS 19 Employee benefits: Actuarial gains and losses, group plans and disclosures.* 521-530. In June 2004, the Institute of Actuaries of Australia made a submission to the Australian Accounting Standards Board (AASB) covering questions specifically raised by the AASB, as well as responses to the questions raised by the International Accounting Standards Board.

Institute of Actuaries of Australia, Superannuation and Employee Benefits Practice Committee. *Submission on the review of the provision of pensions in small superannuation funds.* 553-590. In October 2004, the Institute of Actuaries of Australia made a submission to the Treasury on the Review by the Treasury of the Provision of Pensions in Small Superannuation Funds.

Johnston, M. *Insurance pricing and capitalisation given market incompleteness and frictional costs.* 441-483. Starting from the observable fact that individuals hold concentrations of wealth in particular assets and engage in activities that produce concentrations of liability, we seek to understand what economic valuation models imply about the prices of insurance policies designed to mitigate the associated risks. Our primary conclusion is that for typical insured risks, there will be a range of feasible insurance premiums (defined as value-creating for both policyholders and shareholders). Where in the feasible range premiums will be set will be determined by the level of competition and regulation in the market for insurance policies. The feasible range exists because the market value of an insurance policy is less than the value placed upon it by the consumer. This relies on two assumptions — firstly, that the risks being insured cannot be offset by securities traded on capital markets; secondly, that consumers are averse to these risks. We investigate the corporate form of the insurance enterprise, showing how to determine the feasible combinations of shareholders' funds and premium, in the presence of taxes, expenses, and limited liability. We show that expenses and taxes, which can be viewed as 'frictional costs' of this form of risk financing, induce upper and lower bounds on the feasible levels of capitalisation for an insurance company. Our approach shows that a regulator must consider more than just the market values of the insurer's balance sheet components in determining 'fair' premiums. We finish with an illustration of how pricing information might be inferred from the consumer insurance market. This paper was developed with application to pricing of general insurance in mind, but the methods and results may be applicable to life insurance also, and may be relevant to the current debate about the notion of fair value of insurance liabilities in international accounting standards.

https://doi.org/10.1017/S1357321700003275 Published online by Cambridge University Press

NEUHAUS, W. *On the estimation of outstanding claims.* 485-518. This paper presents a discrete time model for the estimation of outstanding claims that comprises delay in two dimensions: reporting delay and valuation delay. This model allows a strict distinction between the cost of reported claims and the cost of unreported claims.

VALDEZ, E. A. & CHERNIH, A. *Stochastically determined retirement income replacement ratios.* 593-615. Individuals all over the world are finding it more important to plan for retirement because of increased longevity and higher cost of living. The retirement income replacement ratio can be an effective tool for analyzing retirement adequacy. It is defined as the amount of retirement income expressed as a percentage of the final salary just prior to retirement. This paper develops formulas for replacement ratios showing how they can be affected by factors such as wage increases, returns on investments, pre-retirement and post-retirement mortality, and inflation and allowing for these components to be modelled stochastically. To numerically illustrate the concepts presented in the paper, we fit time series models to Australian data published by the Australian Bureau of Statistics in order to obtain estimates and a distribution of the replacement ratio. The results offer insight into future financial planning for retirement and the adequacy of retirement preparation as a whole.

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GENEVA RISK AND INSURANCE REVIEW

Volume **30** (1), 2005

ARCAND, J.-L. & GRAZIOSI, G. R. *Tax compliance and rank dependent expected utility.* 57-69. Formulating the classic Allingham and Sandmo [1972] tax compliance problem under Rank Dependent Expected Utility (RDEU) provides a simple explanation for the 'excess' level of full compliance observed in empirical studies, which standard Expected Utility (EU) theory is unable to explain. RDEU provides a compelling answer to this puzzle, without the need for the moral sentiments or stigma arguments that have recently been advanced in the literature. Formally, we show that the threshold audit probability or penalty rate at which full compliance become optimal for the decision maker are significantly lower under RDEU axiomatics than in the EU case, and that the optimal level of underreporting is lower under RDEU. Numerical simulations using various parameterizations of the probability weighting function illustrate the large quantitative differences between the two models, while a simulation of underreporting rates in the US over the past 50 years shows how RDEU can go some way towards explaining the tax-compliance puzzle.

BREYER, F. & FELDER, S. *Mortality risk and the value of a statistical life: the dead-anyway effect revis(it)ed.* 41-55. In the expected-utility theory of the monetary value of a statistical life, a well-known result found by Pratt and Zeckhauser [1996] asserts that an individual's willingness to pay (WTP) for a marginal reduction in mortality risk increases with the initial level of risk. Their reasoning is based on the so-called 'dead-anyway effect' which states that marginal utility of a dollar in the state of death is smaller than in the state of survival. However, this explanation is based on the absence of markets for contingent claims, i.e. annuities and life insurance. This paper reexamines the relationship between WTP and the level of risk under more general circumstances and establishes two main results: first, when insurance markets are perfect, for a risk-averse individual without a bequest motive, marginal WTP for survival does increase with the level of risk but this occurs for a different reason, namely an income effect. Secondly, when the individual has a bequest motive and is endowed with a sufficient amount of wealth from human capital, the effect of initial risk on WTP for

https://doi.org/10.1017/S1357321700003275 Published online by Cambridge University Press

survival is reversed: the higher initial risk the lower the value of a statistical life. In the imperfect-markets case we interpret this result as a 'constrained-bequest effect'.

BUZZACCHI, L. & VALLETTI, T. M. *Strategic price discrimination in compulsory insurance markets.* 71-97. This paper considers price discrimination when competing firms do not observe a customer's type but only some other variable correlated to it. This is a typical situation in many insurance markets — such as motor insurance — where it is also often the case that insurance is compulsory. We characterise the equilibria and their welfare properties under various price regimes. We show that discrimination based on immutable characteristics such as gender is a dominant strategy, either when firms offer policies at a fixed price or when they charge according to some consumption variable that is correlated to costs. In the latter case, gender discrimination can be an outcome of strategic interaction alone in situations where it would not be adopted by a monopolist. Strategic price discrimination may also increase cross subsidies between types, contrary to expectations.

CHIU, W. H. *A note on partial insurance and the Arrow-Pratt measure of risk aversion.* 35-40. Pratt [1964] establishes that a more risk-averse individual in the Arrow-Pratt sense has a higher compensating risk premium for full insurance, but no comparable result has been established for partial insurance. Ross [1981] shows that a more risk-averse individual in the Arrow-Pratt sense may not be willing to pay more for a reduction in risk in the sense of mean-preserving contraction. We show that a more risk-averse individual in the Arrow-Pratt sense has a higher compensating risk premium for all empirically relevant forms of partial insurance because they induce a reduction in risk in the stronger sense of Bickel and Lemann [1979].

IBARRA-SALAZAR, J. *The newsboy model: changes in risk and price.* 99-109. In this paper I extend the literature related with the newsboy model by analysing the effect on orders of changes in risk and price. I show that risk aversion is necessary and sufficient condition for the newsboy to decrease orders when the demand suffers an FSD deterioration in risk, and analyse changes in price including an effect, which has been ignored in the literature.

JAMETTI, M. & VON UNGERN-STERNBERG, T. *Assessing the efficiency of an insurance provider — a measurement error approach.* 15-34. The purpose of this paper is to compare the cost efficiency of private and public property insurance providers in Switzerland. The most commonly used measure for this kind of exercise is the claims-premium ratio. We argue that this measure may give strongly biased results. We develop a simple model to test whether the elasticity of premiums with respect to claims is less than unity. We address the fact that premium income is relatively stable across time, while claims are not, using estimation techniques that correct for measurement error. We develop tools to cope with heteroskedasticity in such measurement errors and apply the model to a data set on 19 firms in housing insurance markets in Switzerland. We show that the public insurance providers are about 20% more cost efficient than their private counterparts.

SPREEUW, J. *The probationary period as a screening device: the monopolistic insurer.* 5-14. Stiglitz [1977], considering asymmetry of information in a monopolistic insurance market and the monetary deductible as a screening device, shows that an equilibrium is always of a separating type. High risks buy complete insurance whilst low risks buy partial insurance. In this paper, we show that a pooling equilibrium may exist if a probationary period, rather than the partial coverage in monetary terms, is used as a screening device.

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https://doi.org/10.1017/S1357321700003275 Published online by Cambridge University Press

INSURANCE: MATHEMATICS & ECONOMICS

Volume **36** (3), 2005

BALTRUNAS, A. *Second order behaviour of ruin probabilities in the case of large claims.* 485-498. In this paper, we consider the classical risk model. Assuming that the claim-size is heavy-tailed, say, subexponential, under simple conditions the second order asymptotic behaviour of ruin probabilities is obtained.

BERNARD, C., LE COURTOIS, O. & QUITTARD-PINON, F. *Market value of life insurance contracts under stochastic interest rates and default risk.* 499-516. The purpose of this article is to value some life insurance contracts in a stochastic interest rate environment taking into account the default risk of the underlying insurance company. The participating life insurance contracts considered here can be expressed as portfolios of barrier options as shown by Grosen and Jørgensen [1997]. In order to price these options, the Longstaff and Schwartz [1995] methodology is used with the Collin-Dufresne and Goldstein [2001] correction.

CZADO, C., DELWARDE, A. & DENUIT, M. *Bayesian Poisson log-bilinear mortality projections.* 260-284. Mortality projections are major concerns for public policy, social security and private insurance. This paper implements a Bayesian log-bilinear Poisson regression model to forecast mortality. Computations are carried out using Markov Chain Monte Carlo methods in which the degree of smoothing is learnt from the data. Comparisons are made with the approach proposed by Brouhns *et al.* [IME 31; Bull. Swiss Assoc. Actuaries (2002)], as well as with the original model of Lee and Carter [J. Am. Stat. Assoc. 87 (1992)].

GAJEK, L. *Axiom of solvency and portfolio immunisation under random interest rates.* 317-328. The paper concerns the interest rate risk management of insurance companies. It is assumed that assets and liabilities are stochastic processes and that regulatory demands on solvency are satisfied under the basic TSIR. Lower bounds on change in the portfolio present value are established when the interest rates change randomly. The bounds may be used to immunize the portfolio valuation when arbitrary changes of the interest rate scenarios are considered. An application to construct an optimal funding method for defined benefit pension plans is discussed in detail. In particular, a theoretical background is provided for the following conservative long-term strategy for the interest rate risk management: (1) assume a pessimistic (i.e. relatively low) interest rate scenario to discount cash flows of both assets and liabilities; (2) under this term structure of interest rates arrange the accumulated net assets cash flow to be the smallest concave majorant of accumulated liability cash flow. It is shown that this strategy is quite likely to give a positive change in the portfolio surplus in response to changing the future interest rate scenario. What is more, it leads to the least possible decrease of the portfolio net worth in the least favorable circumstances. A further improvement of this strategy is proposed.

GRONIOWSKA, A. & NIEMIRO, W. *Controlled risk processes in discrete time: lower and upper approximations to the optimal probability.* 433-440. We consider the controlled random walk as a flexible model of risk process which takes into account the possibility of intervention of the insurer. We derive a method of approximating the optimal probability of ruin from below and from above. The approximations are based on iterations of the Bellman operator. To initialize the sequence of upper approximations we can use the Lundberg bound or another upper bound on the probability of ruin.

HASHORVA, E. *Extremes of asymptotically spherical and elliptical random vectors.* 285-302. In this paper we introduce asymptotically spherical and elliptical random vectors. Based on results of Berman [1992], we study the asymptotic behaviour of the sample extremes for both

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these new classes of random vectors. Related results for the coefficient of upper tail dependence are further derived.

JAIMUNGAL, S. & YOUNG, V. R. *Pricing equity-linked pure endowments with risky assets that follow Lévy processes.* 329-346. We investigate the pricing problem for pure endowment contracts whose life contingent payment is linked to the performance of a tradable risky asset or index. The heavy tailed nature of asset return distributions is incorporated into the problem by modeling the price process of the risky asset as a finite variation Lévy process. We price the contract through the principle of equivalent utility. Under the assumption of exponential utility, we determine the optimal investment strategy and show that the indifference price solves a non-linear partial-integro-differential equation (PIDE). We solve the PIDE in the limit of zero risk aversion, and obtain the unique risk-neutral equivalent martingale measure dictated by indifference pricing. In addition, through an explicit–implicit finite difference discretization of the PIDE we numerically explore the effects of the jump activity rate, jump sizes and jump skewness on the pricing and the hedging of these contracts.

KAAS, R. & TANG, Q. *A large deviation result for aggregate claims with dependent claim occurrences.* 251-259. In this paper we study precise large deviations of a compound sum of claims, in which the claims arrive in groups and the claim numbers in the groups may follow a certain negative dependence structure. We try to build a platform both for the classical large deviation theory and for the modern stochastic ordering theory.

KALUSZKA, M. *Optimal reinsurance under convex principles of premium calculation.* 375-398. Suppose an insurer wants to have a reinsurance contract minimizing a convex measure of his retained risk or maximizing a utility function. Suppose the reinsurer's premium is fixed. The premium calculation principle of the reinsurer is a convex functional of his cover. Explicit forms of optimal reinsurance contracts are derived for some classes of convex principles including, among others, the exponential, p-mean value, semi-deviation, semi-variance, Dutch and Wang's principles. The paper is a continuation of the work of Kaluszka [IME 35] which deals with mean-variance premium calculation principles.

LIU, G. W. & YING, Z. B. *Ruin probability in the continuous-time compound binomial model.* 303-316. The continuous-time compound binomial model, introduced in this paper, is a continuous-time version of the compound binomial model in discrete time. Its skeleton chain is coincided with the compound binomial model and its limiting case is the compound Poisson model. We set the risk model in the framework of PDMP and get a exponential martingale by virtue of the extended generator (coupled with a discrete part) of the PDMP. The theory of change of measures is developed for this model. Some results are derived for the ruin probabilities, such as the general expressions for ruin probabilities, Lundberg bounds and Cramér–Lundberg approximations and etc. All the results are parallel to the corresponding ones in the compound Poisson risk model. And a closed-form expression for the ruin probability is obtained under some special cases.

MENONCIN, F. *Cyclical risk exposure of pension funds: a theoretical framework.* 469-484. We study the asset allocation problem for a pension fund, which operates in a PAYG system and periodically revises its investment strategies. If the optimal amount of wealth invested in risky assets is always positive, then during the management period the optimal portfolio is constantly riskier (less risky) than Merton's portfolio when the growth rate of workers is higher (lower) than the growth rate of pensioners. In particular, there exists a time when the risk exposure is a maximum (minimum).

PAULSEN, J., KASOZI, J. & STEIGEN, A. *A numerical method to find the probability of ultimate*

https://doi.org/10.1017/S1357321700003275 Published online by Cambridge University Press

ruin in the classical risk model with stochastic return on investments. 399-420. Let $\psi(y)$ be the probability of ultimate ruin in the classical risk process compounded by a linear Brownian motion. Here y is the initial capital. We give sufficient conditions for the survival probability function $\phi = 1 - \psi$ to be four times continuously differentiable, which in particular implies that ϕ is the solution of a second order integro-differential equation. Transforming this equation into an ordinary Volterra integral equation of the second kind, we analyze properties of its numerical solution when basically the block-by-block method in conjunction with Simpsons rule is used. Finally, several numerical examples show that the method works very well.

PROMISLOW, S. D. & YOUNG, V. R. *Unifying framework for optimal insurance.* 347-364. For a given loss X, suppose that one can purchase partial insurance $I(X)$ where $0 \leq I(x) \leq x$ for all x, subject to a premium principle $H(I)$. The object is to choose I to optimize some quantity $G(I, H(I))$. A classical problem of this type is a theorem of Arrow that seeks to maximize the expected utility of resulting wealth, when $H(I)$ is some nondecreasing function of $E(I)$. In this paper, we present a unifying framework for determining optimal insurance for general G and H. To perform the required analysis, we consider the notion of the derivative of a functional. This allows us to include previous results within our framework, including Arrow's Theorem, Young's work on Wang's premium principle, and the work of Gajek and Zagrodny on minimizing the variance of retained claims subject to a standard deviation premium principle.

REIJNEN, R., ALBERS, W. & KALLENBERG, W. C. M. *Approximations for stop-loss reinsurance premiums.* 237-250. Various approximations of stop-loss reinsurance premiums are described in literature. For a wide variety of claim size distributions and retention levels, such approximations are compared in this paper to each other, as well as to a quantitative criterion. For the aggregate claims two models are used, both involving various model parameters. In the first model the claims are simply independent, while a certain dependence structure is assumed in the second model. A relatively simple rule of thumb is formulated for choosing the best approximation for either model. This approximation satisfies the aforementioned criterion. Finally, by comparing the two models, it is demonstrated that a small degree of dependence between the claims already has a substantial effect on the stop-loss premiums. The difference can run up to a factor 500.

SARKAR, J. & SEN, A. *Weak convergence approach to compound Poisson risk processes perturbed by diffusion.* 421-432. We obtain the ruin probability and expected discounted penalty function for a diffusion-perturbed classical risk model, by taking limits in a sequence of compound Poisson processes that converge weakly to the former. This allows us to improve upon a result of Tsai and Willmot [IME 30].

THOMSON, R. J. *The pricing of liabilities in an incomplete market using dynamic mean–variance hedging.* 441-455. In this article the method of pricing the liabilities of a financial institution by means of dynamic mean–variance hedging is applied to the situation of an incomplete market that is nevertheless in equilibrium with homogeneous expectations. For a given stochastic asset–liability model that is consistent with the market, the article shows how to determine the price at which, subject to specified provisos, a prospective transferor or transferee would be indifferent to the transfer of the liabilities.

WANG, G. & YUEN, K. C. *On a correlated aggregate claims model with thinning-dependence structure.* 456-468. In this paper, we consider a risk model with n ($n \geq 2$) dependent classes of insurance business. Stochastic sources related to claim occurrences of the n classes are classified into m groups. It is assumed that each event in the kth ($k = 1, 2, \ldots m$) group may cause a claim in the jth class ($j = 1, 2, \ldots n$) with a certain probability. Within this framework,

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there exists certain correlation between the n claim-number processes due to the so-called thinning-dependence structure. We examine basic properties of the proposed risk process and study upper bounds for the ruin probability under certain assumptions. We also investigate the impact of the thinning-dependence structure as well as that of the classification of the stochastic sources on the ruin probability.

WU, R., WANG, G. & ZHANG, C. *On a joint distribution for the risk process with constant interest force.* 365-374. We consider the classical risk process with constant interest force. We derive the explicit expression for the joint distribution of three actuarial diagnostics: the time of ruin, the surplus immediately before ruin and the deficit at ruin.

INSURANCE: MATHEMATICS & ECONOMICS

Volume **37** (1), 2005

BASSAN, B. & SPIZZICHINO, F. *Bivariate survival models with Clayton aging functions.* 6-12. In some recent papers, the authors considered a function B that describes the level curves of an exchangeable bivariate survival function $\bar{F}$. The function B permits the analysis of several "multivariate aging properties" of $\bar{F}$. In this paper, the authors consider survival models characterized by the condition that B is a Clayton copula and analyze a related invariance property. This property concerns the family of level curves of the joint survival function of residual lifetimes, when "ages" are increasing.

COLANGELO, A., SCARSINI, M. & SHAKED, M. *Some notions of multivariate positive dependence.* 13-26. The authors study new notions of positive dependence that are associated to multivariate stochastic orders of positive dependence introduced recently by Colangelo *et al.* [J. Multivar. Anal., to appear]. In particular, they discuss the relationship of these new notions to other existing concepts of positive dependence.

EMBRECHTS, P., HÖING, A. & PUCCETTI, G. *Worst VaR scenarios.* 115-134. The worst possible Value-at-Risk for a non-decreasing function ψ of n dependent risks is known when $n = 2$ or the copula of the portfolio is bounded from below. In this paper we analyze the properties of the dependence structures leading to this solution, in particular their form and the implied functional dependence between the marginals. Furthermore, we criticise the assumption of the worst possible scenario for VaR-based risk management and we provide an alternative approach supporting comonotonicity.

FRAHM, G., JUNKER, M. & SCHMIDT, R. *Estimating the tail-dependence coefficient: properties and pitfalls.* 80-100. The concept of tail dependence describes the amount of dependence in the lower-left-quadrant tail or upper-right-quadrant tail of a bivariate distribution. A common measure of tail dependence is given by the so-called tail-dependence coefficient. This paper surveys various estimators for the tail-dependence coefficient within a parametric, semiparametric, and nonparametric framework. Further, a detailed simulation study is provided which compares and illustrates the advantages and disadvantages of the estimators.

FREDERICKS, G. A., NELSEN, R. B. & RODRÍGUEZ-LALLENA, J. A. *Copulas with fractal supports.* 42-48. Using an iterated function system, the authors construct families of copulas whose supports are fractals. In particular, they show that the members of one family have supports with arbitrary Hausdorff dimensions in the interval (1,2). They also employ those copulas to construct more general bivariate distribution functions with fractal supports.

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LEWANDOWSKI, D. *Generalised diagonal band copulas.* 49-67. This paper investigates the class of generalized diagonal band (GDB) copulas, which form an extension of diagonal band (DB) copulas originally introduced by Cooke and Waij [1986] for application in simulating high-dimensional distributions for dependent random variables. Ferguson [1995] provided a method for constructing copulas which include the convex closure of DB copulas. Bojarski [2001] provided a different extension of the original DB construction and obtained (independently) the same class as Ferguson, which we now call the GDB. Our interest in GDB copulas results from their possible application in the vinecopula method for simulating high-dimensional dependent vectors; see Cooke [1997], Bedford and Cooke [2001], and Kurowicka and Cooke [2003]. This method requires using copulas with certain properties which GDB copulas often possess. We list these requirements and construct distributions that meet them using the class of GDB copulas.

MESFIOUI, M. & QUESSY, J.-F. *Bounds on the value-at-risk for the sum of possibly dependent risks.* 135-151. In this paper, explicit lower and upper bounds on the value-at-risk (VaR) for the sum of possibly dependent risks are derived when only partial information is available about the dependence structure and the individual behaviors. When the marginal distributions are known, a reformulation of a result of Embrechts *et al.* [2003] makes it possible, under some regularity conditions, to compute explicit bounds for the VaR under various dependence scenarios. In the case where only the means and the variances of the risks are available, explicit bounds are obtained from an optimisation over all possible values of the correlation matrix associated with the vector of risks. Analytical and numerical investigations are presented in order to investigate the quality of these bounds.

MOLINA, J. J. Q. & SEMPI, C. *Discrete quasi-copulas.* 27-41. We introduce the concept of discrete quasi-copula, investigate its properties, and use it in order to develop a general method for constructing quasi-copulas.

STANHOPE, S. *Case studies in multivariate-to-anything transforms for partially specified random vector generation.* 68-79. This paper considers methods for sampling from random vectors characterised by marginal distributions and a correlation matrix, rather than a full joint distribution. The paper begins by describing the normal-to-anything (NORTA) transform for sampling from such random vectors. Limitations of the NORTA transformation motivate the development of a more general framework for partially specified random vector generation, and several alternatives to NORTA are described. NORTA and its alternatives are compared to a previous methodology for generating bivariate gamma random vectors; while each method considered generates random vectors with gamma marginals and appropriate correlations, both NORTA and its alternatives are shown to offer what could be considered to be more desirable joint distributional qualities. Finally, it is demonstrated that in the context of generating multivariate gamma random vectors some of the limitations of NORTA can in fact be overcome by considering its alternatives.

VAN DEN GOORBERGH, R. W. J., GENEST, C. & WERKER, B. J. M. *Bivariate option pricing using dynamic copula models.* 101-114. This paper examines the behaviour of bivariate option prices in the presence of association between the underlying assets. Parametric families of copulas offering various alternatives to the Gaussian dependence structure are used to model this association, which is explicitly assumed to vary over time as a function of the volatilities of the assets. These dynamic copula models are applied to better-of-two-markets and worse-of-two-markets options on the Standard and Poor's 500 and Nasdaq indexes. Results show that option prices implied by dynamic copula models can differ substantially from prices implied by models that fix the dependence between the underlyings, particularly in times of high volatilities. In the study, the Gaussian copula also produced option prices that differed significantly from those induced by non-Gaussian copulas, irrespective of initial volatility

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levels. Within the class of alternatives considered, option prices were robust with respect to the choice of copula.

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JOURNAL OF RISK AND INSURANCE

Volume **72** (3), 2005

BROCKETT, P. L., COOPER, W. W., GOLDEN, L. L., ROUSSEAU, J. J. & WANG, Y. *Financial intermediary versus production approach to efficiency of marketing distribution systems and organisational structure of insurance companies.* 393-412. An examination of the efficiency of the marketing distribution channel and organisational structure for insurance companies is presented from a framework that views the insurer as a financial intermediary rather than as a "production entity" which produces "value added" through loss payments. Within this financial intermediary approach, solvency can be a primary concern for regulators of insurance companies, claims-paying ability can be a primary concern for policyholders, and return on investment can be a primary concern for investors. These three variables (solvency, financial return, and claims-paying ability) are considered as outputs of the insurance firm. The financial intermediary approach acknowledges that interests potentially conflict, and the strategic decision makers for the firm must balance one concern versus another when managing the insurance company. Accordingly, we investigate the efficiency of insurance companies using data envelopment analysis (DEA) having as insurer output an appropriately selected (for the firm under investigation) combination of solvency, claims-paying ability, and return on investment as outputs. These efficiency evaluations are further examined to study stock versus mutual form of organisational structure and agency versus direct marketing arrangements, which are examined separately and in combination. Comparisons with the "value-added" or "production" approach to insurer efficiency are presented. A new DEA approach and interpretation is also presented.

CUMMINS, J. D. & PHILLIPS, R. D. *Estimating the cost of equity capital for property-liability insurers.* 441-478. This article presents new evidence on the cost of equity capital by line of insurance for the property-liability insurance industry. To do so we obtain firm beta estimates and then use the full-information industry beta (FIB) methodology to decompose the cost of capital by line. We obtain full-information beta estimates using the standard one-factor capital asset pricing model and extend the FIB methodology to incorporate the Fama-French three-factor cost of capital model. The analysis suggests the cost of capital for insurers using the Fama-French model is significantly higher than the estimates based upon the CAPM. In addition, we find evidence of significant differences in the cost of equity capital across lines.

DOHERTY, N. A. & SMETTERS, K. *Moral hazard in reinsurance markets.* 375-391. This article attempts to identify moral hazard in the traditional reinsurance market. We build a multiperiod principal-agent model of the reinsurance transaction from which we derive predictions on premium design, monitoring, loss control, and insurer risk retention. We then use panel data on U.S. property liability reinsurance to test the model. The empirical results are consistent with the model's predictions. In particular, we find evidence for the use of loss-sensitive premiums when the insurer and reinsurer are not affiliates (i.e. not part of the same financial group), but little or no use of monitoring. In contrast, we find evidence for the extensive use of monitoring when the insurer and reinsurer are affiliates, where monitoring costs are lower.

https://doi.org/10.1017/S1357321700003275 Published online by Cambridge University Press

LEMAIRE, J. *The cost of firearm deaths in the United States: reduced life expectancies and increased insurance costs.* 359-374. The United States remains far behind most other affluent countries in terms of life expectancy. One of the possible causes of this life expectancy gap is the widespread availability of firearms and the resulting high number of U.S. firearm fatalities: 10,801 homicides in 2000. The European Union experienced 1,260 homicides, Japan only 22. Using multiple decrement techniques, I show that firearm violence shortens the life of an average American by 104 days (151 days for white males, 362 days for black males). Among all fatal injuries, only motor vehicle accidents have a stronger effect. I estimate that the elimination of all firearm deaths in the United States would increase the male life expectancy more than the total eradication of all colon and prostate cancers. My results suggest that the insurance premium increases paid by Americans as a result of firearm violence are probably of the same order of magnitude as the total medical costs due to gunshots or the increased cost of administering the criminal justice system due to gun crime.

MA, Y.-L. & BROWNE, M. J. *Subsidization and choice in the group health insurance market.* 413-439. This study investigates the effect of group health insurance plan choice on insurance unit price. The empirical findings suggest that the unit price of insurance, as measured by the ratio of the premium to expected indemnity benefits, is lower in group plans that offer employees a choice of different insurance options and require a premium contribution than it is in plans lacking at least one of these two features. The analyses suggest that lower unit prices are related to an increase in indemnity benefits and that the reduction in the unit price is greater for lower risks. The findings indicate that although subsidisation of high risks by low risks occurs with group health insurance, the degree of subsidisation is less when employees are offered a choice of health insurance plans.

PIGGOTT, J., VALDEZ, E. A. & DETZEL, B. *The simple analytics of a pooled annuity fund.* 497. This article provides a formal analysis of payout adjustments from a longevity risk-pooling fund, an arrangement we refer to as group self-annuitisation (GSA). The distinguishing risk diffusion characteristic of GSAs in the family of longevity insurance instruments is that the annuitants bear their systematic risk, but the pool shares idiosyncratic risk. This obviates the need for an insurance company, although such instruments could be sold through a corporate insurer. We begin by deriving the payout adjustment for a single entry group with a single annuity factor and constant expectations. We then show that under weak requirements a unique solution to payout paths exists when multiple cohorts combine into a single pool. This relies on the harmonic mean of the ratio of realised to expected survivorship rates across cohorts. The case of evolving expectations is also analyzed. In all cases, we demonstrate that the periodic-benefit payment in a pooled annuity fund is determined based on the previous payment adjusted for any deviations in mortality and interest from expectations. GSA may have considerable appeal in countries which have adopted national defined contribution schemes and/or in which the life insurance industry is noncompetitive or poorly developed.

SARABIA, J. M., CASTILLO, E., GÓMEZ-DÉNIZ, E. & VÁZQUEZ-POLO, F. J. *A class of conjugate priors for log-normal claims based on conditional specification.* 479-495. In this article, a new methodology for obtaining a premium based on a broad class of conjugate prior distributions, assuming lognormal claims, is presented. The new class of prior distributions arise in a natural way, using the conditional specification technique introduced by Arnold, Castillo, and Sarabia (1998, 1999). The new family of prior distributions is very flexible and contains, as particular cases, many other distributions proposed in the literature. Together with its flexibility, the main advantage of this distribution is that, due to its dependence on a large number of hyperparameters, it allows incorporating a wide amount of prior information.

https://doi.org/10.1017/S1357321700003275 Published online by Cambridge University Press

Several methods for hyperparameter elicitation are proposed. Finally, some examples with real and simulated data are given.

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NORTH AMERICAN ACTUARIAL JOURNAL

Volume **9** (2), 2005

DREKIC, S. & WILLMOT, G. E. *On the moments of the time of ruin with applications to phase-type claims.* 17-30. We describe an approach to the evaluation of the moments of the time of ruin in the classical Poisson risk model. The methodology employed involves the expression of these moments in terms of linear combinations of convolutions involving compound negative binomial distributions. We then adapt the results for use in the practically important case involving phase-type claim size distributions. We present numerical examples to illuminate the influence of claim size variability on the moments of the time of ruin.

FREES, E. W. & WANG, P. *Credibiltiy using copulas.* 31-48. Credibility is a form of insurance pricing that is widely used, particularly in North America. The theory of credibility has been called a 'cornerstone' in the field of actuarial science. Students of the North American actuarial bodies also study loss distributions, the process of statistical inference of relating a set of data to a theoretical (loss) distribution. In this work, we develop a direct link between credibility and loss distributions through the notion of a copula, a tool for understanding relationships among multivariate outcomes. This paper develops credibility using a longitudinal data framework. In a longitudinal data framework, one might encounter data from a cross section of risk classes (towns) with a history of insurance claims available for each risk class. For the marginal claims distributions, we use generalised linear models, an extension of linear regression that also encompasses Weibull and Gamma regressions. Copulas are used to model the dependencies over time; specifically, this paper is the first to propose using a t-copula in the context of generalised linear models. The t-copula is the copula associated with the multivariate t-distribution; like the univariate t-distributions, it seems especially suitable for empirical work. Moreover, we show that the t-copula gives rise to easily computable predictive distributions that we use to generate credibility predictors. Like Bayesian methods, our copula credibility prediction methods allow us to provide an entire distribution of predicted claims, not just a point prediction. We present an illustrative example of Massachusetts automobile claims, and compare our new credibility estimates with those currently existing in the literature.

GERBER, H. U. & SHIU, E. S. W. *The time value of ruin in a Sparre Andersen model.* 49-84. This paper considers a Sparre Andersen collective risk model in which the distribution of the interclaim time is that of a sum of n independent exponential random variables; thus, the Erlang(n) model is a special case. The analysis is focused on the function $\phi(u)$, the expected discounted penalty at ruin, with u being the initial surplus. The penalty may depend on the deficit at ruin and possibly also on the surplus immediately before ruin. It is shown that the function $\phi(u)$ satisfies a certain integro-differential equation and that this equation can be solved in terms of Laplace transforms, extending a result found in Lin (2003). As a consequence, a closed-form expression is obtained for the discounted joint probability density of the deficit at ruin and the surplus just before ruin, if the initial surplus is zero. For this formula and other results, the roots of Lundberg's fundamental equation in the right half of the complex plane play a central role. Also, it is shown that $\phi(u)$ satisfies Li's (2003) *renewal equation*. Under the assumption that the penalty depends only on the deficit at ruin and that

https://doi.org/10.1017/S1357321700003275 Published online by Cambridge University Press

the individual claim amount density is a combination of exponential densities, a closed-form expression for $\phi(u)$ is derived. In this context, known results of the Cauchy matrix are useful. Surprisingly, certain results are best expressed in terms of divided differences, a topic deleted from the actuarial examinations at the end of the last century.

MANISTRE, B. J. & HANCOCK, G. H. *Variance of the CTE estimator.* 129-156. The Conditional Tail Expectation (CTE), also called Expected Shortfall or Tail-VaR, is a robust, convenient, practical, and coherent measure for quantifying financial risk exposure. The CTE is quickly becoming the preferred measure for statutory balance sheet valuation whenever real-world stochastic methods are used to set liability provisions. We look at some statistical properties of the methods that are commonly used to estimate the CTE and develop a simple formula for the variance of the CTE estimator that is valid in the large sample limit. We also show that the formula works well for finite sample sizes. Formula results are compared with sample values from real world Monte Carlo simulations for some common loss distributions, including equity-linked annuities with investment guarantees, whole life insurance and operational risks. We develop the CTE variance formula in the general case using a system of biased weights and explore importance sampling, a form of variance reduction, as a way to improve the quality of the estimators for a given sample size. The paper closes with a discussion of practical applications.

NG, A. C. Y. & YANG, H. *Lundberg-type bounds for the joint distribution of surplus immediately before and at ruin under the Sparre Andersen model.* 85-107. In this paper we consider the Sparre Andersen insurance risk model. Three cases are discussed: the ordinary renewal risk process, stationary renewal risk process, and s-delayed renewal risk process. In the first part of the paper we study the joint distribution of surplus immediately before and at ruin under the renewal insurance risk model. By constructing an exponential martingale, we obtain Lundberg-type upper bounds for the joint distribution. Consequently we obtain bounds for the distribution of the deficit at ruin and ruin probability. In the second part of the paper, we consider the special case of phase-type claims and rederive the closed-form expression for the distribution of the severity of ruin, obtained by Drekic *et al.* (2003, 2004). Finally, we present some numerical results to illustrate the tightness of the bounds obtained in this paper.

PINKHAM, C. A., IVANOVIC, B. & CUMMING, M. E. *2003 Swiss Re blood pressure study of insured lives.* 1-16. Blood pressure, one of the most important mortality risk factors, is a common life insurance underwriting tool for classification of preferred, standard, and substandard risks. In order to assess changes in mortality risk associated with blood pressure since the last major intercompany study, Swiss Re's Research & Development and Medical Departments conducted a longitudinal study of blood pressure readings collected at the time of policy issue. Mortality risk associated with different blood pressure levels on nearly 300,000 life insurance policies issued without any other ratable impairments was evaluated. The study cohort was formed by policies issued from 1975 through 2001, which generated over 8,600 claims within the study period. Univariate and bivariate blood pressure mortality results are shown along with results for other key covariates (sex, smoking status, issue year period, policy duration, and cardiovascular family history) for a subset of the cohort that had blood pressure readings of 120/80 mm Hg or lower.

REMPALA, G. A. & DERRIG, R. A. *Modelling hidden exposures in claim severity via the EM algorithm.* 108-128. We consider the issue of modeling the latent or hidden exposure occurring through either incomplete data or an unobserved underlying risk factor. We use the celebrated expectation maximisation (EM) algorithm as a convenient tool in detecting latent (unobserved) risks in finite mixture models of claim severity and in problems where data imputation is needed. We provide examples of applicability of the methodology based on real-

https://doi.org/10.1017/S1357321700003275 Published online by Cambridge University Press

life auto injury claim data and compare, when possible, the accuracy of our methods with that of standard techniques. Sample data and an EM algorithm program are included to allow readers to experiment with the EM methodology themselves.

NORTH AMERICAN ACTUARIAL JOURNAL

Volume **9** (3), 2005

BOYLE, P. P., LAI, Y. & TAN, K. S. *Pricing options using lattice rules.* 50-76. There are many examples of option contracts in which the payoff depends on several stochastic variables. These options often can be priced by the valuation of multidimensional integrals. Quasi–Monte Carlo methods are an effective numerical tool for this task. We show that, when the dimensions of the problem are small (say, less than 10), a special type of quasi–Monte Carlo known as the lattice rule method is very efficient. We provide an overview of lattice rules, and we show how to implement this method and demonstrate its efficiency relative to standard Monte Carlo and classical quasi–Monte Carlo. To maximise the efficiency gains, we show how to exploit the regularity of the integrand through a periodisation technique. We demonstrate the superior efficiency of the method both in the estimation of prices as well as in the estimation of partial derivatives of these prices (the so-called Greeks). In particular this approach provides good estimates of the second derivative (the gamma) of the price in contrast to traditional Monte Carlo methods, which normally yield poor estimates. Although this method is not new, it appears that the advantages of lattice rules in the context of insurance and finance applications have not been fully appreciated in the literature.

GOLD, J. *Accounting/actuarial bias enables equity investment by defined benefit pension plans.* 1-21. Although pension finance theory says most defined benefit pension plans sponsored by publicly traded corporations should invest entirely in fixed income, 60% of assets are invested in equities. The existing theory makes a strong — but often unstated — assumption of transparency, implying that investors view the pension plan as a financial subsidiary of the operating parent and value it as a market portfolio. I explain the equity choice made by managers as a reaction to how investors perceive the opaque standard pension accounting model. Investors view the plan in operating terms and value it based on reported earnings. Defined benefit pension plans' earnings (expenses) are computed using actuarial methods and economic assumptions that anticipate expected equity returns and strongly dampen the volatility of actual equity returns. Thus, corporations whose plans invest in equities overstate the financial value of their earnings and understate the volatility of such earnings. Under the transparent model, managers who invest in equities may be confronted by arbitrage arguments that show equity investment injures shareholders. Under the opaque model, these arbitrage arguments are not available and managers who invest in equities enjoy premium returns to risk while those who invest in fixed income instruments are punished by higher costs without visible risk reduction.

GOOVAERTS, M. J., VAN DEN BORRE, E. & LAEVEN, R. J. A. *Managing economic and virtual economic capital within financial conglomerates.* 77-89. In this paper we show how the optimal amount of economic capital can be derived such that it minimises the economic cost of risk-bearing. The economic cost of risk-bearing takes into account the cost of the economic capital as well as the exposure to residual risk. In addition to the absolute problem of determining the amount of economic capital, we also consider the relative problem of how to establish the allocation of economic capital among subsidiaries. Because subsidiaries are juridical entities, they will also consider the absolute problem of economic capital allocation themselves. In an equilibrium situation, the relative allocation derived by the conglomerate and the absolute allocation derived by the subsidiaries coincide. We show that the diversification benefit that is

https://doi.org/10.1017/S1357321700003275 Published online by Cambridge University Press

typically obtained in a conglomerate construction creates a virtual economic capital for subsidiaries within the conglomerate. We show further that the approach we propose to solve the absolute problem of economic capital allocation also can be applied to the problem of optimal portfolio selection, extending the well-known Markowitz approach and providing a tool for management by economic capital.

NTZOUFRAS, I., KATSIS, A. & KARLIS, D. *Bayesian assessment of the distribution of insurance claim counts using reversible jump MCMC.* 90-108. The aim of this paper is to construct Bayesian model comparison tests between discrete distributions used for claim count modeling in the actuarial field. We use advanced computational techniques to estimate the posterior model odds among different distributions for claim counts. We construct flexible reversible jump Markov Chain Monte Carlo algorithms and implement them in various illustrated examples.

PETERTIL, J. *Aging curves for health care costs in retirement.* 22-49. This paper explores the relative significance of aging as a determinant of financial cost of health care beyond age fifty, with particular attention to the effect for ages 65 and over. The paper presents concepts of aging factors and aging curves, which define relative values between ages for utilisation or cost of health care services. General conclusions are drawn from Medicare data that utilisation and cost differ by age, but that aging factors vary across services and may be less significant at the very old ages. The author then turns to the question of measuring the significance of an aging curve assumption and what accuracy is lost in the simpler alternative of a single value across an age range. The practical effects of relative value aging curves are examined through hypothetical examples of increasing complexity in a retiree health valuation. A method to measure the impact is put forth. Three important variables are discussed in some detail. A survey to ascertain aging curve findings and preferences of health actuaries is introduced and discussed, with one representative curve presented. This curve is then measured to understand its impact vis-a-vis other curves. It may be important to note this is not a study deriving a recommended aging curve. Rather, it is an exploration of the significance of an assumption that has not received much public actuarial scrutiny. A conclusion places the paper's findings in a context of a dynamic health care economy in an aging society.

PROMISLOW, S. D. & YOUNG, V. R. *Minimising the probability of ruin when claims follow Brownian motion with drift.* 109-128. We extend the work of Browne (1995) and Schmidli (2001), in which they minimise the probability of ruin of an insurer facing a claim process modeled by a Brownian motion with drift. We consider two controls to minimise the probability of ruin: (1) investing in a risky asset and (2) purchasing quota-share reinsurance. We obtain an analytic expression for the minimum probability of ruin and the corresponding optimal controls, and we demonstrate our results with numerical examples.

YUEN, K. C. & WANG, G. *Some ruin problems for a risk process with stochastic interest.* 129-142. As investment plays an increasingly important role in the insurance business, ruin analysis in the presence of stochastic interest (or stochastic return on investments) has become a key issue in modern risk theory, and the related results should be of interest to actuaries. Although the study of insurance risk models with stochastic interest has attracted a fair amount of attention in recent years, many significant ruin problems associated with these models remain to be investigated. In this paper we consider a risk process with stochastic interest in which the basic risk process is the classical risk process and the stochastic interest process (or the stochastic return-on-investment generating process) is a compound Poisson process with positive drift. Within this framework, we first derive an integro-differential equation for the Gerber-Shiu expected discounted penalty function, and then obtain an exact solution to the equation. We also obtain closed-form expressions for the expected discounted

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penalty function in some special cases. Finally, we examine a lower bound for the ruin probability of the risk process.

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SCANDINAVIAN ACTUARIAL JOURNAL

2005 (**4**)

BONSDORFF, H. *On asymptotic properties of Bonus-Malus systems based on the number and on the size of the claims.* 309-320. A general framework for a Bonus-Malus system (BMS) based on the number and the size of the claims is presented, the set of the bonus classes being an interval $[a, b]$, say $0 < a < 1 < b$. The BMS is interpreted as a general Markov chain with state space $[a, b]$. It turns out that, under certain assumptions, the Markov chain possesses an invariant limit distribution to which it converges with a geometric rate. We show how the invariant distribution can be evaluated by means of simulation. We also deal with the best possible convergence rate and show how it can be presented by means of the spectral theory of Banach spaces.

DECAMPS, M., DE SCHEPPER, A., GOOVAERTS, M. J. & SCHOUTENS, W. *A note on some new perpetuities.* 261-270. In a recent paper. Salminen and Yor [7] relate the distribution of the Dufresne's reflected perpetuity

$$I^{+} = \int_0^{+\infty} e^{-2B^{\mu}(s)} 1_{(B^{\mu}(s)>0)} ds$$

where B^{μ} is Brownian motion with drift $\mu > 0$, to the hitting time of a reflected Bessel process. In this contribution, we adapt the results of Salminen and Yor [7] in several ways. First, we use spectral theory to obtain a series expansion for the distribution of I^{+} that renders this quantity applicable to actuarial purposes. We also study the exponential functionals

$$I^{\alpha} = \int_0^{+\alpha} e^{-2X_{\alpha}^{\mu}(s)} ds$$

where X_{α}^{μ} is a skew Brownian motion with drift $\mu > 0$.

FRANGOS, N. E., VRONTOS, S. D. & YANNACOPOULOS, A. N. *Ruin probability at a given time for a model with liabilities of the fractional Brownian motion type: a partial differential equation approach.* 285-308. In this paper we study the ruin probability at a given time for liabilities of diffusion type, driven by fractional Brownian motion with Hurst exponent in the range (0.5, 1). Using fractional Itô calculus we derive a partial differential equation the solution of which provides the ruin probability. An analytical solution is found for this equation and the results obtained by this approach are compared with the results obtained by Monte-Carlo simulation.

LI, S. *Distributions of the surplus before ruin, the deficit at ruin and the claim causing ruin in a class of discrete time risk models.* 271-284. We consider a class of compound renewal (Sparre Andersen) risk process with claim inter-arrival times having a discrete K_m distribution, i.e. the probability generating function (p.g.f.) of its distribution function is a ratio of two polynomials of order $m \in \mathbb{N}^{+}$. The classical compound binomial risk model is a special case when $m = 1$. Li [16] gives a recursive formula for the Gerber-Shiu function. In this paper, an

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explicit formula for the Gerber-Shiu function is given in terms of a compound geometric distribution function, through which many ruin related quantities are analyzed, e.g. ruin probability, the p.g.f. of the time of ruin, joint and marginal distributions of the surplus before ruin, the deficit at ruin, and the claim causing ruin.
Detailed discussions are given in two special cases: claim sizes are rationally distributed, or the claim sizes distribution has a finite support.

Li, S. *On a class of discrete time renewal risk models.* 241-260. We consider a class of compound renewal (Sparre Andersen) risk process with claim waiting times having a discrete K_m distribution, i.e. the probability generating function (p.g.f.) of the distribution function is a ratio of two polynomials of order $m \in \mathbb{N}^+$. The classical compound binomial risk model is a special case when $m = 1$. A recursive formula is derived for the expected discounted penalty (Gerber-Shiu) function, which can be used to analyze many quantities associated with the time of ruin, e.g. the surplus before ruin, the deficit at ruin, and the claim causing ruin.
Detailed discussions are given in two special cases: claim sizes are rationally distributed, or the claim sizes distribution has a finite support.

Scandinavian Actuarial Journal

2005 (**5**)

Chadjiconstantinidis, S. & Politis, K. *Non-exponential bounds for stop-loss premiums and ruin probabilities.* 335-357. We present an inventory of non-exponential bounds for ruin probabilities and stop-loss premiums in the general Sparre-Andersen model (renewal model) of risk theory. Various additional bounds are given if one assumes that the ladder height distribution F associated with the risk process belongs to a certain class of distributions, in particular if it is concave or it exhibits a (positive or negative) aging property. In most cases, these bounds are shown to improve existing ones in the literature and/or possess the correct asymptotic behaviour when the distribution F is subexponential. Since in the classical (compound Poisson) risk model the ladder height distribution is always concave, all the bounds given in the paper are also valid for this model. Finally, in many cases the results of the paper are also valid for any compound geometric distribution.

Cooray, K. & Ananda, M. M. *Modelling actuarial data with a composite lognormal-Pareto model.* 321-334. The actuarial and insurance industries frequently use the lognormal and the Pareto distributions to model their payments data. These types of payment data are typically very highly positively skewed. Pareto model with a longer and thicker upper tail is used to model the larger loss data, while the larger data with lower frequencies as well as smaller data with higher frequencies are usually modeled by the lognormal distribution. Even though the lognormal model covers larger data with lower frequencies, it fades away to zero more quickly than the Pareto model. Furthermore, the Pareto model does not provide a reasonable parametric fit for smaller data due to its monotonic decreasing shape of the density. Therefore, taking into account the tail behaviour of both small and large losses, we were motivated to look for a new avenue to remedy the situation. Here we introduce a two-parameter smooth continuous composite lognormal-Pareto model that is a two-parameter lognormal density up to an unknown threshold value and a two-parameter Pareto density for the remainder. The resulting two-parameter smooth density is similar in shape to the lognormal density, yet its upper tail is larger than the lognormal density and the tail behaviour is quite similar to the Pareto density. Parameter estimation techniques and properties of this new composite lognormal-Pareto model are discussed and we compare its performance with the other commonly used models. A simulated example and a well-known fire insurance data set are analyzed to show the importance and applicability of this newly proposed composite lognormal-Pareto model.

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DICKSON, D. C. M., HUGHES, B. D. & ZHANG, L. *The density of the time to ruin for a Sparre Andersen process with Erlang arrivals and exponential claims.* 358-376. We derive expressions for the density of the time to ruin given that ruin occurs in a Sparre Andersen model in which individual claim amounts are exponentially distributed and inter-arrival times are distributed as Erlang(n, ß). We provide numerical illustrations of finite time ruin probabilities, as well as illustrating features of the density functions.

DJEHICHE, B. & HÖRFELT, P. *Standard approaches to asset & liability risk.* 377-400. We compare two different models for assets and liabilities for an insurance company that can be considered in the standard approach to solvency assessment and in particular, in determining the required target capital. The first model is suggested by a joint working party by members in CEA, Comité Européen des Assurances, and is based on the duration concept and the second one is an application of ideas by Samuelson and Vasicek.

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