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## ASTIN Bulletin

Volume **34** (1), 2004

Butt, Z. & Haberman, S. *Application of frailty-based mortality models using generalised linear models.* 175-197. Two families of frailty models — Makeham/Gompertz-gamma and Gompertz-inverse Gaussian — have been considered to graduate insurance-based mortality data. The aims of this exercise are twofold. The first aim is to make use of generalised linear models and to evaluate these against traditional techniques. The second aim is to measure the scale of individual heterogeneity in insurance-based populations. The results indicate that (subject to issues of identifiability) there is evidence of frailty in these populations.

Cerbrián, A. C., Denuit, M. & Scaillet, O. *Testing for concordance ordering.* 151-173. We propose inference tools to analyse the concordance (or correlation) order of random vectors. The analysis in the bivariate case relies on tests for upper and lower quadrant dominance of the true distribution by a parametric or semiparametric model, ie for a parametric or semiparametric model to give a probability that two variables are simultaneously small or large at least as great as it would be were they left unspecified. Tests for its generalisation in higher dimensions, namely joint lower and upper orthant dominance, are also analysed. The parametric and semiparametric settings are based on the copula representation for multivariate distribution, which allows for disentangling behaviour of margins and dependence structure. A distance test and an intersection-union test for inequality constraints are developed depending on the definition of null and alternative hypotheses. An empirical illustration is given for US insurance claim data.

Cheung, K. A. & Chun, Y. H. *Asset allocation with regime-switching: discrete-time case.* 99-111. In this paper, we study the optimal asset allocation problem under a discrete regime switching model. Under the short-selling and leveraging constraints, the existence and uniqueness of the optimal trading strategy are obtained. We also obtain some natural properties of the optimal strategy. In particular, we show that if there exists a stochastic dominance order relationship between the random returns at different regimes, then we can order the optimal proportions we should invest in such regimes.

Dickson, D. C. M. & Waters, H. R. *Some optimal dividends problems.* 49-74. We consider a situation originally discussed by De Finetti (1957) in which a surplus process is modified by the introduction of a constant dividend barrier. We extend some known results relating to the distribution of the present value of dividend payments until ruin in the classical risk model and show how a discrete time risk model can be used to provide approximations when analytic results are unavailable. We extend the analysis by allowing the process to continue after ruin.

Gatto, R. *An accurate asymptotic approximation for experience rated premiums.* 113-124. In the Bayesian approach, the experience rated premium is the value which minimizes an expected loss with respect to a posterior distribution. The posterior distribution is conditioned on the claim experience of the risk insured, represented by a $n$-tuple of observations. An exact analytical calculation for the experience rated premium is possible under restrictive



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circumstances only, regarding the prior distribution, the likelihood function, and the loss function. In this article we provide an analytical asymptotic approximation as $n \to \infty$ for the experience rated premium. This approximation can be obtained under more general circumstances, it is simple to compute, and it inherits the good accuracy of the Laplace approximation on which it is based. In contrast with numerical methods, this approximation allows for analytical interpretations. When exact calculations are possible, some analytical comparisons confirm the good accuracy of this approximation, which can even lead to the exact experience rated premium.

HABERMAN, S., BUTT, Z. & RICKAYZEN, B. D. *Measuring process risk in income protection insurance.* 199-227. The main objective of this paper is to measure the process error for a portfolio of independent disability insurance policies in a multiple state modelling context. We consider the calculation of premiums for a portfolio of income protection insurance policies in a stochastic environment represented both by random transitions in the underlying multiple state model and random external economic factors in the form of stochastic investment returns and inflation. We also investigate the sensitivity of the process error to the level of volatility incorporated in a given model using suitably defined risk measures. We then draw conclusions and identify possible avenues for future research.

HALD, M. & SCHMIDLI, H. *On the maximisation of the adjustment coefficient under proportional reinsurance.* 75-83. In this note we consider how to maximise the adjustment coefficient in the case of proportional reinsurance. This complements some work of Waters (1983), where it was shown that there is a unique retention level maximising the adjustment coefficient. The advantage of our method is that only one implicit equation has to be solved.

KALUSZKA, M. *An extension of the Gerber-Bühlmann-Jewell conditions for optimal risk sharing.* 27-48. We provide necessary and sufficient conditions for optimality of mutual contracts for risk sharing under constraints on premiums or utility functions of participants of the agreement. These conditions are an extension of those of the Borch, Gerber and Bühlmann-Jewell ones. Some applications to optimal insurance contracts, optimal dividend sharing and optimal reinsurance are given.

SARABIA, J. M., GÓMEZ-DÉNIZ, E. & VÁZQUEZ-POLO, F. J. *On the use of conditional specification models in claim count distributions: an application to bonus-malus systems.* 85-98. In this paper a new methodology using the conditional specification technique introduced by Arnold *et al.* (1999) is used to obtain bonus-malus premiums. A Poisson distribution for which the parameter is a function of the classical structure parameter is used and a new class of prior distribution arises in a natural way. This model contains, as a particular case, the classical compound Poisson model and is found to be much more robust than earlier ones. An example is given to illustrate our ideas.

SCHMITTER, H. *The sample size needed for the calculation of a GLM tariff.* 249-262. A simple upper bound for the variance of the frequency estimates in a multivariate tariff using class criteria is deduced. This upper bound is based exclusively on univariate statistics and can, therefore, be calculated before a GLM analysis is carried out. It can be used to estimate the number of claims that will be needed for a tariff calculation depending on the number of tariff criteria and the number of levels of each criterion. The article is a revised version of a paper presented at the XXXIst ASTIN Colloquium in Porto Cervo.

SCHNIEPER, R. *Robust Bayesian experience rating.* 125-150. Different rating methods which allow for exceptional large claims are discussed. A robust Bayesian statistical model is proposed which can cope with non negative, skewed data. An example from fire insurance is analysed. The performance of the posterior mean is compared to the performance of a robust credibility.

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STEFFENSEN, M. *On Merton's problem for life insurers.* 5-25. This paper deals with optimal investment and redistribution of the free reserves connected to life and pension insurance contracts in form of dividends and bonus. Formulated appropriately this problem can be viewed as a modification of Merton's problem of optimal consumption and investment with a very particular form of consumption and utility hereof. Both are linked to a finite state Markov chain. We distinguish between utility optimisation of dividends, where a semi-explicit result is obtained, and utility optimisation of bonus payments. The latter connects to the financial notion of durable goods and allows for an explicit solution only in very special cases.

VENTER, G. G. *Testing distributions of stochastically generated yield curves.* 229-247. A method is introduced for testing the distribution of yield curves that are produced by asset scenario generators. The method is based on historical relationships in the conditional distributions of yield spreads given the short-term rate. An illustration, this method is used to test a few selected models. To provide background, stochastic modelling for interest rates and fitting methods are briefly discussed.

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## AUSTRALIAN ACTUARIAL JOURNAL

Volume **9** (3), 2003

BARKER, M. D. *Forecasting the long-term return on equities.* 573-585. The paper addresses the question of what the long-term return on equities might be. Historical approaches by a number of researchers have been aimed at discovering the very long-term underlying rate, often expressed as an equity risk premium. Looking forward, an alternative method is discussed based on actuarial fundamentals. The conclusion reached in the paper is that the very long-term underlying rate of return is around 9% p.a., but that based on market data in April 2002 a more likely rate over the next ten to thirty years would be around 7.5%. Much lower figures are possible if corporate profitability and market conditions revert to the long-term averages more quickly than envisaged.

FITZHERBERT, R. *The identification and measurement of speculative risk*. 445-476; discussion 477-91. Recent falls in stock markets have once again exposed investors in superannuation and managed funds to negative rates of return. A common, and possibly self-interested, response from the managed funds industry is that such declines can only be anticipated in hindsight. While acknowledging that this is sometimes the case, stock market levels such as those reached in Australia in 1987, the UK in 1999 and the U.S.A. in 2000 can be shown to have involved a high degree of speculative risk — the chance that purchases at such levels were extremely unlikely to provide a reasonable return for long-term investors. Poor long-term performance from such levels could have been anticipated, even though the timing of any sharp decline could not. The thesis of this paper is that speculation can be identified using two quite different approaches to analysis. Given a definition that is relevant to investors with long-term

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objectives, speculative risk can then be measured. If speculation can be identified and speculative risk can be measured, then it can be avoided in investment decisions and taken into account when valuing actuarial liabilities. This is particularly relevant for defined benefit funds as demonstrated recently in UK pension schemes.

Institute of Actuaries of Australia, Accident Compensation Sub-Committee. *Submission to the Productivity Commission on the Inquiry into National Workers' Compensation and Occupational Health and Safety Frameworks.* 495-533.

Institute of Actuaries of Australia, International Accounting Standards Committee. *Submission to the Treasury on the Adoption of International Accounting Standards.* 551-563.

Institute of Actuaries of Australia, Medical Indemnity Taskforce. *Submission to Australian Prudential Regulation Authority: Comments on Draft FCR Guidelines for Medical Indemnity Insurance.* 565-569. In August 2003, the Institute of Actuaries of Australia made a submission to the Australian Regulation Authority (APRA) regarding draft guidelines that APRA had circulated for Financial Condition Reports (FCRs) for medical indemnity insurers. APRA had indicated its intention to require all medical indemnity insurers to provide FCRs to APRA annually, as part of its supervision process. The FCRs are being requested under APRA's general supervisory powers, rather tan as a specific item required by legislation, as in the case of life offices. Medical indemnity insurers are the first general insurance companies to be asked to provide FCRs, although it is anticipated that a more general requirement for FCRs may be introduced in the near future.

Institute of Actuaries of Australia, Superannuation and Employee Benefits Practice Committee. *Submission on Exposure Draft Bill for Consultation: Superannuation Safety Amendment Bill 2003.* 543-549.

Institute of Actuaries of Australia, Superannuation and Employee Benefits Practice Committee. *Submission to the Treasury on Draft Portability Regulations for Superannuation.* 535-542.

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## Geneva Papers on Risk and Insurance Theory

Volume **29** (1), 2004

Ahlgrim, K. C., D'Arcy, S. P. & Gorvett, R. W. *The effective duration and convexity of liabilities for property-liability insurers under stochastic interest rates.* 75-108. Managing interest rate risk for property-liability insurers requires appropriate measurement of the sensitivity of liabilities to movements in interest rates. Most prior studies have assumed that interest rates shift in a parallel fashion and that the cash flows from liabilities are unaffected by interest rate changes. This article recognises that unpaid property-liability (P-L) insurance losses are inflation sensitive, that movements in interest rates are stochastic. The effective duration and convexity of P-L insurance liabilities calculated based on this approach are substantially lower than those measured using traditional approaches, which has important implications for asset-liability management by P-L insurers.

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GOURIEROUX, C. & MONFORT, A. *Infrequent extreme risks.* 5-22. The main tools and concepts of financial and actuarial theory are designed to handle standard, or even small risks. The aim of this paper is to reconsider some selected financial problems, in a setup including infrequent extreme risks. We first consider investors maximising the expected utility function of their future wealth, and we establish the necessary and sufficient conditions on the utility function to ensure the existence of a non degenerate demand for assets with extreme risks. This new class of utility functions, called LIRA, does not contain the classical HARA and CARA utility functions, which are not adequate in this framework. Then we discuss the corresponding asset supply-demand equilibrium model.

KOENIGER, W. *Labour income risk and car insurance in the UK.* 55-74. Microeconomic theory shows that only under certain conditions higher background risk increases the propensity to insure against independent marketable risks. We provide empirical evidence for the case of labour income risk and car insurance in the UK. The main result is that households with higher labour income risk spend more on insurance. This finding is consistent with microeconomic theory if the utility function is of the HARA type. Moreover, we find that households spend more on insurance if they participate in the stock market.

LUND, D. & NILSSEN, T. *Cream skimming, dregs skimming, and pooling: on the dynamics of competitive screening.* 23-41. We discuss the existence of a pooling equilibrium in a two-period model of an insurance market with asymmetric information. We solve the model numerically. We pay particular attention to the reasons for non-existence in cases where no pooling equilibrium exists. In addition to the phenomenon of cream skimming emphasised in earlier literature, we here point to the importance of the opposite: dregs skimming, whereby high-risk consumers are profitably detracted from the candidate pooling contract.

REY, B. & ROCHET, J.-C. *Health and wealth: how do they affect individual preferences?* 43-54. There is no consensus among health economists about the specification of individual preferences that best fits observed behaviours. One crucial point of disagreement concerns the sign of the interaction between health and wealth in individual utility functions. We propose here a simple, static, model where individuals have only one decision to make concerning their future health (say to get a flu shot). We derive very simple testable implications that allow to discriminate between three specifications that are commonly used in theoretical models: additive separability between health and consumption, multiplicative separability, and existence of a monetary equivalent of health. We also derive several implications on the pattern of the demand for health insurance.

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INSURANCE: MATHEMATICS & ECONOMICS

Volume **34** (2), 2004

CHU, C. C. & KWOK, Y.-K. *Reset and withdrawal rights in dynamic fund protection.* 273-295. We analyze the nature of the dynamic fund protection which provides an investment fund with a floor level of protection against a reference stock index (or stock price). The dynamic protection feature entitles the investor the right to reset the value of his investment fund to that of the reference stock index. The reset may occur automatically whenever the investment fund value falls below that of the reference stock index, or only allowed at pre-determined time instants. The protected funds may allow a finite number of resets throughout the life of the fund, where the reset times are chosen optimally by the investor. We examine the relation

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between the finite-reset funds and automatic-reset funds. We also analyze the premium and the associated exercise policy of the embedded withdrawal right in protected funds, where the investor has the right to withdraw the fund prematurely. The impact of proportional fees on the optimal withdrawal policies is also analyzed. The holder should optimally withdraw at a lower critical fund value when the rate of proportional fees increases. Under the assumption that the fund value and index value follow the Geometric Brownian processes, we compute the grant-date and mid-contract valuation of these protected funds. Pricing properties of the protected fund value and the cost to the sponsor are also discussed.

Cox, S. H., Fairchild, J. R. & Pedersen, H. W. *Valuation of structured risk management products.* 259-272. This paper applies valuation theory to structured risk management products. We specialize the theoretical model to two representative products, a 'double trigger' put option and a property insurance with a retention which is a function of a commodity price. The double trigger refers to the fact that the option has to satisfy two conditions in order to be in the money: the underlying equity must be below the strike price and, in addition, a specified catastrophic event must have occurred and affected the insured firm. These examples illustrate how the standard valuation theory for pricing risk in an arbitrage-free market should be applied to products engineered to manage multiple risks within the firm.

Gajek, L. & Zagrodny, D. *Optimal reinsurance under general risk measures.* 227-240. The paper concerns the problem of purchasing the best risk protection from a reinsurance company. The question of choosing the risk measure is discussed and several choices of nonsymmetric risk measures are examined. Sufficient conditions for optimality of a reinsurance contract are given for arbitrary risk measure within any restricted class of admissible contracts. Explicit forms of optimal contracts are derived in the case of absolute deviation and truncated variance risk measures.

Gourieroux, C. & Jasiak, J. *Heterogeneous INAR(1) model with application to car insurance.* 177-192. The bonus-malus scheme shows how the history of claim arrivals determines the dynamics of insurance premium. It is important to distinguish to what extent changes in the insurance premium are explained by lagged claim counts introduced among explanatory variables and by unobservable heterogeneity included in the model, which needs to be regularly updated. For this purpose, we introduce the integer valued autoregressive (INAR) model with unobserved heterogeneity. The model is applied to premium updating in car insurance and compared to the standard method based on the negative binomial distribution. We find that the premium depends on the claim history and that the timing of claim arrivals matters. This result is different from the outcome of the standard framework in which the average number of claims per year is the only relevant factor.

Grandits, P. *A Karamata-type theorem and ruin probabilities for an insurer investing proportionally in the stock market.* 297-305. We study the infinite time ruin probability in the classical Cramér–Lundberg model, where the company invests a constant fraction of its money in a stock, which is described by geometric Brownian motion. We prove that a certain integro-differential equation describes the ruin probability under weak regularity and integrability assumptions on the claim size distribution. Furthermore we show that, within the class of subexponential distributions, the claim size distributions with regularly varying tail distribution are the only ones, for which the ruin probability is proportional to the tail distribution.

Hubalek, F. & Schachermayer, W. *Optimizing expected utility of dividend payments for a Brownian risk process and a peculiar nonlinear ODE.* 193-225. We consider the problem of maximizing the expected utility of discounted dividend payments of an insurance company. The risk process, describing the insurance business of the company, is modeled as Brownian

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motion with drift. We mainly consider power utility and special emphasis is given to the limiting behavior when the coefficient of risk aversion tends to zero. We then find convergence of the corresponding dividend strategies to the classical case of maximizing the expected dividend payments.

MACCI, C. & TORRISI, G. L. *Asymptotic results for perturbed risk processes with delayed claims.* 307-320. The object of this paper is the study of some asymptotic properties of the perturbed risk process with delayed claims $(X_t)$, which is the sum of a Brownian motion with drift and a shot-noise whose underlying point process is a doubly stochastic Poisson process. More in particular, under suitable hypotheses, we show that $(X_t)$ satisfies a large deviation principle, and we give asymptotic estimates of the corresponding ruin probabilities. Moreover, we introduce two suitable processes $(L_t^{(X)})$ and $(R_t^{(X)})$, which can be seen as simplified versions of $(X_t)$, and we show some inequalities between the rate function and the Lundberg parameter concerning $(X_t)$, and the rate functions and the Lundberg parameters concerning$(L_t^{(X)})$ and $(R_t^{(X)})$, respectively.

WEI, W. & YATRACOS, Y. *A stop-loss risk index.* 241-250. An index related with the Dutch premium calculation principle [*IME* **11** (1992)] and the tail conditional expectation [*Math. Finance*, **9** (1999)] is proposed to measure the right-tail insurance risk. The index agrees with pure-tail ordering, is superadditive for comonotonic losses and is compared in examples with Wang's [*NAAJ* **2** (1998)] index.

WILLMOT, G. E. *A note on a class of delayed renewal risk processes.* 251-257. The Gerber-Shiu discounted penalty function is considered for a class of delayed renewal risk processes. Special cases of the model include the stationary renewal risk model and the situation where the time until the first claim is exponentially distributed. A mathematically tractable formula is derived for the Gerber-Shiu function, and consequently for quantities associated with the deficit at ruin, the surplus immediately prior to ruin, and the time of ruin.

## INSURANCE: MATHEMATICS & ECONOMICS

Volume **34** (3), 2004

COSSETTE, H., LANDRIAULT, D. & MARCEAU, É. *Exact expressions and upper bound for ruin probabilities in the compound Markov binomial model.* 449-466. The compound Markov binomial model was first proposed by Cossette *et al.* [SAJ 2003] to introduce time-dependence in the aggregate claim amount increments. As pointed out, this model can be seen as an extension to Gerber's compound binomial model. In this paper, we pursue the analysis of the compound Markov binomial model by first showing that the conditional infinite-time ruin probability is a compound geometric tail. Based on this property, an upper bound and asymptotic expression for ruin probabilities are then provided. Finally, special cases of claim amount distributions are considered which allow the exact calculation of ruin probabilities.

DOKUCHAEV, N. G. & SAVKIN, A. V. *Universal strategies for diffusion markets and possibility of asymptotic arbitrage.* 409-419. The paper investigates the investment problem in a generic diffusion stochastic market model. Volatilities and appreciation rates are allowed to be random and unknown, with unknown prior distributions. We study 'universal' strategies that use price observation only and do not require any knowledge on prior distributions of market parameters, i.e., where market parameters are not available. We define bounded risk strategies in this class that ensure a positive average gain for all random volatilities and appreciation rates from a wide class. Moreover, the strategies ensure a strengthened form of asymptotic arbitrage as the diversification of the portfolio increases: a given positive gain is ensured with probability arbitrarily close to 1.

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GOOVAERTS, M. J., KAAS, R., DHAENE, J. & TANG, Q. *Some new classes of consistent risk measures.* 505-516. Many types of insurance premium principles and/or risk measures can be characterized by means of a set of axioms, which in many cases are rather arbitrarily chosen and not always in accordance with economic reality. In the present paper we generalize Yaari's risk measure by relaxing his axioms. In addition, we derive translation invariant minimal Orlicz risk measures, which we call Haezendonck risk measures, and obtain sufficient conditions on the risk measure of Bernoulli risks to fulfil additivity and superadditivity properties for Orlicz premium principles.

HUANG, H., MILEVSKY, M. A. & WANG, J. *Ruined moments in your life: how good are the approximations?* 421-447. In this paper we implement numerical PDE solution techniques to compute the *probability of lifetime ruin* which is the probability that a fixed retirement consumption strategy will lead to financial insolvency under stochastic investment returns and lifetime distribution. This problem is a variant of the classical and illustrious ruin problem in insurance, but adapted to individual circumstances.

Using equity market parameters derived from US-based financial data we conclude that a 65-year-old retiree requires 30 times their desired annual (real) consumption to generate a 95% probability of sustainability, which is equivalent to a 5% probability of lifetime ruin, if the funds are invested in a well-diversified portfolio. The 30-to-1 margin of safety contrasts with the relevant annuity factor for an inflation-linked pension which would generate a *zero* probability of lifetime ruin.

Our paper then goes on to compare the PDE-based values with moment matching and comonotonic-based approximations that have been proposed in the literature. Our results indicate that the *Reciprocal Gamma* approximation provides an accurate fit as long as the volatility of the underlying investment return does not exceed $\sigma = 30\%$ per annum, which is consistent with capital market history. At higher levels of volatility the moment matching approximations break down. We also confirm that the comonotonic-based lower bound approximation provides remarkably accurate results when the time steps are small though.

Our results should be of interest to academics, practitioners and software developers who are interested in computing sustainable consumption and withdrawal rates towards the end of the human life-cycle, but without resorting to crude simulations.

JOSA-FOMBELLIDA, R. & RINCÓN-ZAPATERO, J. P. *Optimal risk management in defined benefit stochastic pension funds.* 489-503. We consider a continuous time dynamic pension funding model in a defined benefit plan of an employment system. The benefits liabilities are random, given by a geometric Brownian process. Three different situations are studied regarding the investment decisions taken by the sponsoring employer: in the first, the fund is invested at a constant, risk-free rate of interest; in the second, the promoter invests in a portfolio with $n$ risky assets and a risk-free security; finally, it is supposed that the rate of return is stochastic. Modelling the preferences of the manager such that the main objective is to minimize both the contribution rate risk and the solvency risk, we study cases where the optimal behavior leads to a spread method of funding.

LI, S. & GARRIDO, J. *On ruin for the Erlang (n) process.* 391-408. A defective renewal equation is derived for the expected discounted penalty due at ruin,

$$\phi_\delta(u) = E[\mathrm{e}^{-\delta T} w(U(T^-), |U(T)|) I(T < \infty) | U(0) = u],$$

in a risk model with Erlang($n$) claim inter-arrival times. The approach used is similar to that of Gerber and Shiu (1998), repeatedly integrating an $n$th order integro-differential equation for $\phi$, $n$ times. The joint distribution of three random variables is obtained, the ruin time, the surplus just before ruin and the deficit at ruin.

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MATTHYS, G., DELAFOSSE, E., GUILLOU, A. & BEIRLANT, J. *Estimating catastrophe quantile levels for heavy-tailed distributions.* 517-537. Estimation of the occurrence of extreme events is of prime interest for actuaries. Heavy-tailed distributions are used to model large claims and losses. Within this setting we present a new extreme quantile estimator based on an exponential regression model that was introduced by Feuerverger and Hall [*Ann. Stat.* **27** (1999) 760] and Beirlant *et al.* [*Extremes*, **2** (1999) 177]. We also discuss how this approach is to be adjusted in the presence of right censoring. This adaptation can also be linked to robust quantile estimation as this solution is based on a Winsorized mean of extreme order statistics which replaces the classical Hill estimator. We also propose adaptive threshold selection procedures for Weissman's [*J. Am. Stat. Assoc.* **73** (1978) 812] quantile estimator which can be used both with and without censoring. Finally some asymptotic results are presented, while small sample properties are compared in a simulation study.

WRÓBLEWSKA-JANIC, A., KALLENBERG, W. C. M. & LEDWINA, T. *Detecting positive quadrant dependence and positive function dependence.* 467-487. There is a lot of interest in positive dependence going beyond linear correlation. In this paper three new rank tests for testing independence against positive dependence are introduced. The first one is directed on positive quadrant dependence, the second and third one concentrate on positive function dependence. The new testing procedures are not only sensitive for positive grade linear correlation, but also for positive grade correlations of higher order. They are based on the principle of data driven tests, which consists of three steps. Firstly, parametric families are introduced spanning up the space of null hypothesis and alternatives; secondly, within the families good tests are used; thirdly, a selection rule determines the appropriate model. The new tests improve standard tests for linear correlation as Spearman's rank correlation test substantially in case some proper higher order correlations are exhibited by the data, while the loss in power under alternatives with dominating linear correlation is not very high. Monte Carlo results clearly show this behavior.

ZHANG, B. *What kind of new asset will push up the CML?* 539-545. This paper is to give a necessary and sufficient condition for the CML to be push up after a new asset is introduced into the capital market which improves the result in Cox *et al.* [*Astin Bull.* **30** (1) (2000) 157].

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JOURNAL OF RISK AND INSURANCE

Volume **71** (2), 2004

CHAVEZ-DEMOULIN, V. & EMBRECHTS, P. *Smooth extremal models in finance and insurance.* 183-199. This article describes smooth nonstationary generalized additive modeling for sample extremes, in which spline smoothers are incorporated into models for exceedances over high thresholds. We summarize the smoothing methodology as a new tool for practical extreme value exploration in finance and insurance.

CUMMINS, J. D. & MAHUL, O. *The demand for insurance with an upper limit on coverage.* 253-264. The demand for insurance is examined when the indemnity schedule is subject to an upper limit. The optimal contract is shown to display full insurance above a deductible up to the cap. Some results derived in the standard model with no upper limit on coverage turn out to be invalid; the optimal deductible of an actuarially fair policy is positive and insurance may be a normal good under decreasing absolute risk aversion. An increase in the upper limit would

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induce the policyholder with constant absolute risk aversion to reduce his or her optimal deductible and therefore this would increase the demand for insurance against small losses.

ESHO, N., KIRIEVSKY, A., WARD, D. & ZURBRUEGG, R. *Law and the determinants of property-casualty insurance.* 265-283. This article examines the importance of legal rights and enforcement in influencing property-casualty insurance (PCI) consumption. We extend the existing literature by examining the role of legal factors in determining insurance density across countries. Also, measures of risk aversion, loss probability, and price, which overcome limitations of proxies used in the existing literature on insurance demand, are analyzed. Using a panel data set, we apply a generalized methods of moments dynamic system estimator, which relaxes the assumption of strict exogeneity of the regressors and produces unbiased and efficient estimates. The results show a strong positive relationship between the protection of property rights and insurance consumption, which is robust to various model specifications and estimation techniques. Moreover, the results show the purchase of PCI is significantly and positively related to loss probability and income, as well as providing weaker evidence of a negative relationship with price.

GRACE, E. *Contracting incentives and compensation for property-liability insurer executives.* 285-307. This article examines several hypotheses about the structure and level of compensation for 103 property-liability chief executive officers (CEOs) from 1995 through 1997. The greater the level of firm risk and the larger the firm, the greater the use of incentive compensation. Insurers subject to more regulatory attention and those whose CEOs have greater stock ownership make less use of incentive compensation. There is some evidence that option grants and restricted stock awards provide CEOs with differing incentives. This article finds that corporate governance structures, managers' stock ownership, and regulatory attention are not adequate to prevent CEOs from receiving compensation levels in excess of what economic factors predict. Contrary to findings in prior studies, there is little evidence that use of incentive compensation or level of total compensation paid increases with insurer investment opportunities, as traditionally measured.

HSIEH, P.-H. *A data-analytic method for forecasting next record catastrophe loss.* 309-322. We develop in this article a data-analytic method to forecast the severity of next record insured loss to property caused by natural catastrophic events. The method requires and employs the knowledge of an expert and accounts for uncertainty in parameter estimation. Both considerations are essential for the task at hand because the available data are typically scarce in extreme value analysis. In addition, we consider three-parameter Gamma priors for the parameter in the model and thus provide simple analytical solutions to several key elements of interest, such as the predictive moments of record value. As a result, the model enables practitioners to gain insights into the behavior of such predictive moments without concerning themselves with the computational issues that are often associated with a complex Bayesian analysis. A data set consisting of catastrophe losses occurring in the United States between 1990 and 1999 is analyzed, and the forecasts of next record loss are made under various prior assumptions. We demonstrate that the proposed method provides more reliable and theoretically sound forecasts, whereas the conditional mean approach, which does not account for either prior information or uncertainty in parameter estimation, may provide inadmissible forecasts.

JANG, J.-W. *Martingale approach for moments of discounted aggregate claims.* 201-211. We examine the Laplace transform of the distribution of the shot noise process using the martingale. Applying the piecewise deterministic Markov processes theory and using the relationship between the shot noise process and the accumulated/discounted aggregate claims process, the Laplace transform of the distribution of the accumulated aggregate claims is obtained. Assuming that the claim arrival process follows the Poisson process and claim sizes

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are assumed to be exponential and mixture of exponential, we derive the explicit expressions of the actuarial net premiums and variances of the discounted aggregate claims, which are the annuities paid continuously. Numerical examples are also provided based on them.

MAYERS, D. & SMITH, C. W., JNR. *Incentives for managing accounting information: property-liability insurer*. 213-251. Incentives to manage accounting information are examined within 63 property-liability insurance company conversions from mutual ownership to common stock charter. In the conversion process, policyholders' embedded equity claims must be valued. Since mutuals have no separately traded equity, accounting numbers are a critical input in this valuation. Incentives for surplus management vary across firms; the strongest evidence of surplus management is observed among firms where the mutual's executives become the firm's principal stockholders following conversion. The evidence suggests that converting firms manage accounting information primarily by adjusting liabilities and selectively establishing investment losses not by altering claims settlement policy.

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DERRIG, R. A. & ORR, E. D. *Equity risk premium: expectations great and small.* 45-69. The Equity Risk Premium (ERP) is an essential building block of the market value of risk. In theory, the collective action of all investors results in an equilibrium expectation for the return on the market portfolio excess of the risk-free return, the equity risk premium. The ability of the valuation actuary to choose a sensible value for the ERP, whether as a required input to CAPM valuation, or any of its descendants, is as important as choosing risk-free rates and risk relatives (betas) to the ERP for the asset at hand.

In 1985, Mehra and Prescott published their work on the so-called Equity Risk Premium Puzzle: The fact that the historical realized ERP for the stock market 1889-1978 appeared to be at odds with and, relative to Treasury bills, far in excess of asset pricing theory values based on investors with reasonable risk aversion parameters. Since then, there has been a constant stream of research, each of which reviews theories of estimating market returns, examines historical data periods, or both. Those ERP value estimates vary widely from about minus one percent to about nine percent, based on a geometric or arithmetic averaging, short or long horizon, short or long-run expectation, unconditional or conditional, domestic or international data, data period, and real or nominal returns.

This paper will examine the principal strains of the recent research on ERP and catalogue the empirical values of ERP implied by that research. In addition, the paper will supply several time series analyses of the standard Ibbotson Associates 1926-2002 ERP data using short Treasuries for the risk-free rate. Recommendations for ERP values to use in common actuarial valuation problems will be offered.

GERBER, H. U. & SHIU, E. S. W. *Optimal dividends: analysis with Brownian motion.* 1-20. In the absence of dividends, the surplus of a company is modeled by a Wiener process (or Brownian motion) with positive drift. Now dividends are paid according to a barrier strategy: Whenever the (modified) surplus attains the level $b$, the "overflow" is paid as dividends to shareholders. An explicit expression for the moment-generating function of the time of ruin is given. let $D$ denote the sum of the discounted dividends until ruin. Explicit expressions for the expectation and the moment-generating function of $D$ are given; furthermore, the limiting distribution of $D$ is determined when the variance parameter of the surplus process tends

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toward infinity. It is shown that the sum of the (undiscounted) dividends until ruin is a compound geometric random variable with exponentially distributed summands.
The optimal level $b^*$ is the value of $b$ for which the expectation of $D$ is maximal. It is shown that $b^*$ is an increasing function of the variance parameter; as the variance parameter tends toward infinity, $b^*$ tends toward the ratio of the drift parameter and the valuation force of interest, which can be interpreted as the present value of a perpetuity. The leverage ratio is the expectation of $D$ divided by the initial surplus invested; it is observed that this leverage ratio is a decreasing function of the initial surplus. For $b = b^*$, the expectation of $D$, considered as a function of the initial surplus, has the properties of a risk-averse utility function, as long as the initial surplus is less than $b^*$. The expected utility of $D$ is calculated for quadratic and exponential utility functions. In the appendix, the original discrete model of De Finetti (1957) is explained and a probabilistic identity is derived.

HECKMAN, P. E. *Credit standing and the fair value of liabilities: a critique.* 70-85. We review the positions of major accounting and actuarial bodies on the issue of whether the holder's own credit standing should be reflected in the fair value of its liabilities, identifying certain anomalies, both in the current GAAP treatment of debt and in the FASB approach to the fair valuation of liabilities. We also examine the treatment in financial theory of risk capital in the case of unsecured debt. An alternative approach is proposed, stressing the need for an objective valuation standard, based solely on contractual terms and ambient economic conditions, and yielding readily interpretable public information. Finally we review the probable consequences if, as seems likely, the FASB approach prevails, or, as seems unlikely, the views advocated here prevail.

HÜRLIMANN, W. *Distortion risk measures and economic capital.* 86-95. To provide incentive for active risk management, it is argued that a sound coherent distortion risk measure should preserve some higher degree stop-loss orders, at least the degree-three convex order. Such risk measures are called tail-preserving risk measures. It is shown that, under some common axioms and other plausible conditions, a tail-preserving coherent distortion risk measure identifies necessarily with the Wang right-tail measure or the expected value measure. This main result is applied to derive an optimal economic capital formula.

OWADALLY, M. I. & HABERMAN, S. *Efficient gain and loss amortization and optimal funding in pension plans.* 21-36. Efficient methods of amortizing actuarial gains and losses in defined benefit pension plans are considered. In the context of a simple model where asset gains and losses emerge as a consequence of random (independent and identically distributed) rates of investment return, it has been shown that direct amortization of such gains and losses leads to more variable funding levels and contribution rates compared with an indirect and proportional form of amortization which "spreads" the gains and losses. Stochastic simulations are performed and they indicate that spreading remains more efficient than amortization with simple AR(1) and MA(1) rates of return. Similar results are obtained when a more comprehensive actuarial stochastic investment model (which includes economic wage inflation) is simulated. Proportional spreading is rationalized as the contribution control that optimizes mean square deviations in the contributions and fund levels when the funding process is Markovian and the fund is invested in two assets (a random risky and a riskfree asset). Efficient spreading and amortization periods are suggested for the U.S., the U.K. and Canada.

TAYLOR, G. C. *Risk and discounted loss reserves.* 37-44. The discounting of loss reserves for investment income is placed within a financial economics context. This enables the evaluation of a loss reserve containing a security margin such as to produce p% confidence in adequacy, taking account of both asset and liability risks. This loss reserve is expressed as a multiple of the economic value of the liabilities. If the security margin is defined as the difference between

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these two quantities, it is found to increase (decrease) with increasing asset risk for high (low) values of p. Finally, the author provides a numerical example.

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Antzoulakos, D. L. & Chadjiconstantinidis, S. *On mixed and compound mixed Poisson distributions.* 161-188. Recursive formulae are derived for the evaluation of the $t$-th order cumulative distribution function and the $t$-th order tail probability of compound mixed Poisson distributions in the case where the derivative of the logarithm of the mixing density can be written as a ratio of polynomials. Also, some general results are derived for the evaluation of the $t$-th order moments of stop-loss transforms. The recursions can be applied for the exact evaluation of the probability function, distribution function, tail probability and stop-loss premium of compound mixed Poisson distributions and the corresponding mixed Poisson distributions. Several examples are also presented.

Schäl, M. *On discrete-time dynamic programming in insurance: exponential utility and minimizing the ruin probability.* 189-210. This paper studies an insurance model where the risk process can be controlled by reinsurance and by investment in a financial market. The performance criterion is either the expected exponential utility of the terminal surplus or the ruin probability. It is shown that the problems can be imbedded in the framework of discrete-time stochastic dynamic programming but with some special features. A short introduction to control theory with infinite state space is provided which avoids the measure-theoretic apparatus by use of the so-called structure assumption. Moreover, in order to treat models without discount factor, a weak contraction property is derived. Explicit conditions are obtained for the optimality of employing no reinsurance.

Tang, Q. *The ruin probability of a discrete time risk model under constant interest rate with heavy tails.* 229-240. This paper investigates the ultimate ruin probability of a discrete time risk model with a positive constant interest rate. Under the assumption that the gross loss of the company within one year is subexponentially distributed, a simple asymptotic relation for the ruin probability is derived and compared to existing results.

Wüthrich, M. V. *Extreme value theory and archimedean copulas.* 211-228. Using the language of copulas, we generalize the famous Fisher-Tippett Theorem of extreme value theory to the case with sequences of dependent random variables. The dependence structure is modelled using archimedean copulas. This generalization enables to study the behaviour of the maxima of dependent random sequences.

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