B.A.J. **8**, II, 399-405 (2002)

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Geneva Papers on Risk and Insurance Theory

Volume **26** (3), 2001

Di Mauro, C. & Maffioletti, A. *The valuation of insurance under uncertainty: does information about probability matter?* 195-224. In a laboratory experiment we test the hypothesis that consumers' valuation of insurance is sensitive to the amount of information available on the probability of a potential loss. In order to test this hypothesis we simulate a market in which we elicit individuals' willingness to pay to insure against a loss characterised either by known or else vague probabilities. We use two distinct treatments by providing subjects with different information over the vague probabilities of loss. In general we find that uncertainty about probabilities has a weak impact on consumers' valuation of insurance. However, additional information about probabilities tends to marginally increase the price individuals are willing to pay to insure themselves. Implications for the insurance market are derived.

Hindriks, J. *Public versus private insurance with dual theory: a political economy argument.* 225-241. This paper analyzes the political support for public insurance in the presence of a private insurance alternative. The public insurance is compulsory and offers a uniform insurance policy. The private insurance is voluntary and can offer different insurance policies. Adopting Yaari's [Econometrica, 55 (1987)] dual theory to expected utility (i.e. risk aversion without diminishing marginal utility of income), we show that adverse selection on the private insurance market may lead a majority of individuals to prefer public insurance over private insurance, even if the median risk is below the average risk (so that the median actually subsidizes high-risk individuals). We also show that risk aversion makes public insurance more attractive and that the dual theory is less favourable to a mixed insurance system than the expected utility framework. Lastly, we demonstrate how the use of genetic tests may threaten the political viability of public insurance.

Pedersen, C. S. & Satchell, S. E. *On the characterisation of investor preferences by changes in wealth.* 175-193. As wealth increases, preference of one fixed gamble over another typically changes once or not at all. A key question is whether certain assumptions on preferences, guarantee such behaviour. Bell [Management Science, 34 (1988); 41 (1995)] has addressed this difficult question and characterised the specific functional form of utility functions which allow a finite number of switches between two arbitrary gambles over the entire range of initial wealth. By extending this analysis, and linking the discussion to more recent works, the authors characterise conditions under which a large set of utility functions with respect to their switching characteristics, and discuss the results in the context of the classical notion of decreasing absolute risk aversion.

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https://doi.org/10.1017/S1357321700003779 Published online by Cambridge University Press

INSURANCE: MATHEMATICS & ECONOMICS

Volume **30** (2), 2002

BÄUERLE, N. *Risk management in credit risk portfolios with correlated assets.* 187-198. We consider a structural model of credit risk in the spirit of Merton [J.Finance 29 (1974)], where a firm defaults when its market value falls below the value of its debts or a certain given threshold level. Models of this type have extensively been used for valuing default-risky securities. Our research now focuses on the effect which positive dependence between credit risks in a portfolio has on the risk of the lending institute. In order to allow for unexpected defaults, we suppose that the firm's asset value follows a geometric Lévy process. The following two main results are obtained: a positive dependence in terms of association between the credit risks always leads to a higher risk for the lending institute than independent credit risks, where the risk of the institute can be measured by any of the following risk measures: variance, upper partial moments or risk sensitive measure. In a second part we investigate the influence of the portfolio structure. We suppose that a firm's asset value is influenced by an idiosyncratic risk, a sector specific risk and a systematic risk. Sectors can be defined, e.g., by the type of industry or geographic region. We show that whenever a sector structure majorizes another, the risk for the lending institute increases. This proves in particular a positive effect of diversification.

CARDOSO, R. M. R. & DOS REIS, A. D. E. *Recursive calculation of time to ruin distributions.* 219-230. In this paper we present a different approach on Dickson and Waters [Astin Bull. 21 (1991)] and De Vylder and Goovaerts [IME 7 (1988)] methods to approximate time to ruin probabilities. By means of Markov chain application we focus on the direct calculation of the distribution of time to ruin, and we find that the above recursions appear to be less efficient, although giving the same approximation figures. We show some graphs of the time to ruin distribution for some examples, comparing the different shapes of the densities for different values of the initial surplus. Furthermore, we consider the presence of an upper absorbing barrier and apply the proposed recursion to find ruin probabilities in this case.

CHARUPAT, N. & MILEVSKY, M. A. *Optimal asset allocation in life annuities: a note.* 199-209. In this note, we derive the optimal utility-maximizing asset allocation between a risky and risk-free asset within a variable annuity (VA) contract, which is a US-based savings and decumulation investment product. We are interested in the interaction between financial risk, mortality risk and consumption, towards the end of the life cycle. Our main result is that for constant relative risk aversion (CRRA) preferences and geometric Brownian motion (GBM) dynamics, the optimal asset allocation during the annuity decumulation (payout) phase is identical to the accumulation (savings) phase, which is the classical Merton [J. Econ. Theory 3 (1971)] solution.

CORDEIRO, I. M. F. *A multiple state model for the analysis of permanent health insurance claims by cause of disability.* 167-186. In this paper, we present a multiple state model for permanent health insurance (PHI) which enables us to analyse PHI claims by cause of disability. This new model, which is a generalisation of the model proposed in Continuous Mortality Investigation Reports [CMIR 12 (1991)] is very useful in the underwriting and claims control stages of PHI business. In the last sections of the paper, we use the model mentioned above to calculate the average duration of a claim and claim inception rates by cause of disability. For that purpose, we use the approximations to the transition intensities obtained by Cordeiro [PhD Thesis, 1998] and numerical algorithms which make possible an efficient evaluation of basic probabilities. We also make general comments on the results obtained.

https://doi.org/10.1017/S1357321700003779 Published online by Cambridge University Press

COSSETTE, H., GAILLARDETZ, P., MARCEAU, É. & ROUX, J. *On two dependent individual risk models.* 153-166. In this paper, we propose two constructions which allow dependence between the risks of an insurance portfolio in the individual risk model. In the first construction, each risk's experience is influenced by an individual and a collective risk factor, as well as a class factor if the portfolio is divided into different classes. The second construction uses copulas. The impact on the cumulative distribution function of the aggregate claim amount and on the stop-loss premium is presented via numerical examples.

DOKUCHAEV, N. G. & SAVKIN, A. V. *A bounded risk strategy for a market with non-observable parameters.* 243-254. This paper investigates a problem of bounded risk portfolio selection for a multi-period market in the case when only historical prices are available, and all market parameters are not observable. We present a strategy which bounds risk closely to a risk-free investment and guarantees at the same time a positive average gain for any non-risk-neutral probability measure.

GAIER, J. & GRANDITS, P. *Ruin probabilities in the presence of regularly varying tails and optimal investment.* 211-217. We study the infinite time ruin probability in the classical Cramer–Lundberg model, where the company is allowed to invest their money in a stock, which is described by geometric Brownian motion. Starting from an integro-differential equation for the maximal survival probability, we analyze the case of claim sizes, which have distribution functions F with regularly varying tails. Our result is: if $1 - F$ is regularly varying with index $\rho < -1$, then the ruin probability ψ is also regularly varying with index $\rho < -1$. This holds under the assumption of zero interest rates.

LUONG, A. & DORAY, L. G. *General quadratic distance methods for discrete distributions definable recursively.* 255-267. Quadratic distance (QD) methods for inference and hypothesis testing are developed for discrete distributions definable recursively. The methods are general and applicable to many families of discrete distributions including those with complicated probability mass functions (pmfs). Even if no explicit expression for the pmf of some distributions exists, QD methods are relatively simple to implement: the QD estimator can be computed numerically using a non-linear least-squares method. The asymptotic properties of the QD estimator are studied. Test statistics for goodness-of-fit are formulated and shown to follow asymptotically a chi-square distribution under the null hypothesis. Estimation and model testing are treated in a unified way. Simulation results presented indicate that the QDE protects against a certain form of mis-specification of the distribution, which makes the maximum likelihood estimator (MLE) biased, while keeping the QDE unbiased.

WANG, N. & POLITIS, K. *Some characteristics of a surplus process in the presence of an upper barrier.* 231-241. For the classical model of risk theory, we consider the time until the insurer's surplus reaches an upper barrier a. We consider some properties of hitting times, first unconditionally and then conditional on the event that ruin does not occur before the surplus exceeds a. For the latter case, we obtain an upper bound for the expected time to reach a given that ruin has not occurred. We also study the more general case where the insurer's target profit is not constant but varies with time. By considering the random walk associated with the surplus process, we show that the distribution of the overshoot over a general barrier is always exponential and we obtain expressions for the moments of first passage times for a non-constant barrier.

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https://doi.org/10.1017/S1357321700003779 Published online by Cambridge University Press

JOURNAL OF RISK AND INSURANCE

Volume **69** (2), 2002

BOYCE, S. & IPPOLITO, R. A. *The cost of pension insurance.* 121-170. This article estimates the cost of the federal pension insurance program. Pension insurance claims have an important market-risk component, which means that the cost of the exposure cannot be estimated by discounting future claims by the risk-free rate. Moreover, owing to the complexity of the insurance contract, its price cannot be estimated with known options formulas without introducing an error of nonquantifiable magnitude. To circumvent these problems, we model the insurance program in its full complexity and use a Monte Carlo method. By hedging the exposure with a dynamic premium policy that offloads the market risk to the insureds, one can calculate the risk-free, or actuarial, cost of that policy. One can also characterize the nature of the subsidy and its structure across insured plans. Finally, we provide an estimate of the implicit cost of the hedge function that taxpayers currently are providing for zero remuneration. The model shows that simple contingent claims models of pension insurance, and that pension insurance models that ignore market risk understate the cost by half. The solution demonstrates the broad characteristics that might characterize a credible private-sector version of pension insurance.

CHANG, S.-C. & CHENG, H.-Y. *Pension valuation under uncertainties: implementation of a stochastic and dynamic monitoring system.* 171-192. Financial soundness and funding stability are two critical issues in pension fund management. First, we construct a generalized stochastic model to monitor the solvency risk and cash flow dynamics of the defined benefit pension plan. A semi-Markov process proposed by Dominicis et al (1991) and Janssen and Manca (1997) is employed in structuring the transition pattern of the plan's population, and the economic-based factors are generated through plausible stochastic processes. Modifications according to classification and movements of the plan member and the plan's turnover pattern are also employed to improve its practical usefulness. Then the actuarial valuations, cash flow analyses, and workforce projection are performed and investigated. Second, we explicitly formulate the plan dynamics and implement the proposed mechanism into a risk management framework for pension management. By employing the stochastic and dynamic approach, the cost factors can be monitored throughout the valuation process. Third, we outline the procedure of implementing the proposed methodology into a monitoring system. Finally, the Taiwan Public Employees Retirement System is simplified to illustrate techniques in achieving risk management goals.

ELDER, E. & HOLLAND, L. *Implications of social security reform on interest rates: theory and evidence.* 225-244. This article investigates the potential effect that Social Security reform may have on bond and equity returns. We specifically focus on the effect of proposals to shift a portion of the investment of the US Social Security Trust Fund to the equities market. Models are developed to demonstrate the relationship between returns and both the relative size of the Social Security Trust Fund and the portfolio allocation of the Trust Fund. Using these two models, we then show that interest rates will increase from either a decrease in the size of the Social Security Trust Fund or a shifting in the investment mix from bonds to equities. We derive an adjustment factor that relates the magnitude of change in interest rates from either source and use this adjustment factor in conjunction with estimates of the relationship between government debt and interest rates to forecast the potential effect on interest rates from shifting part of the Trust Fund to the equity market. The estimates herein suggest that investing some of the Social Security funds in equities is not a painless cure-all for the Social Security system and may even have some adverse effects in terms of income transfers from American taxpayers to foreign bondholders.

https://doi.org/10.1017/S1357321700003779 Published online by Cambridge University Press

FONG, W. M. *On the cost of adverse selection in individual annuity markets: evidence from Singapore.* 193-207. New evidence is presented on the cost of adverse selection in individual annuity markets using Singapore data. The Singapore annuity market is an interesting setting to examine the cost of adverse selection for three reasons. First, unlike many Western countries, the Singapore government provides very limited public financial assistance for retirees. Second, while social security contributions mandated under the Central Provident Fund (CPF) result in a high forced savings rate, a large proportion of CPF savings, are used up for housing. Third, to ensure that retirees have sufficient funds to meet basic needs, individuals who reach age 55 are required to set aside a minimum amount of their CPF savings, which can be withdrawn at age 62. The CPF Board allows various options for investing the minimum sum, but the most attractive option is to purchase an annuity. The institutional setting in Singapore in effect provides insurers with a large captive market for annuities. It is conjectured that this should be reflected in a significantly lower cost of adverse selection for annuities sold in Singapore as compared with other countries. The results herein, using data for CPF-approved insurers, are strongly consistent with this conjecture. On average, money's worth of annuities is higher than annuities sold to a similar age-gender mix in the United States, United Kingdom, and Australia. Adverse selection accounts for less than 13 percent of the cost of longevity insurance compared to 30-50 percent documented in many previous studies. These results suggest that one way to resolve the adverse selection problem is to adopt a universal individual defined contribution pension scheme that mandates or provides strong incentives for retirees to purchase annuities.

GRAY, B. M. & SELDEN, T. M. *Adverse selection and the capped premium subsidy in the Federal Employees Health Benefits Program.* 209-224. This article examines the relationship between adverse selection and the capped premium subsidy in the Federal Employees Health Benefit Program (FEHBP). Understanding this relationship is important, not only because the FEHBP is the largest employer-sponsored health program in the United States, but also because it has been proposed as a market-based model for the reform of both Medicare and the market for nongroup private coverage. We present a theoretical model of the FEHBP that we then test using enrollee data. In particular, we exploit the natural experiment that arises from variation in the premium subsidy cap across Metropolitan Statistical Areas (MSAs). Although the nominal subsidy cap is constant across MSAs, its real value varies greatly across MSAs with different price levels. The empirical analysis herein supports the contention that the premium subsidy in the FEHBP helps reduce adverse selection.

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NORTH AMERICAN ACTUARIAL JOURNAL

Volume **6** (1), 2002

BABBEL, D. F., GOLD, J. & MERRILL, C. *Fair value of liabilities: The financial economics perspective.* 12-27. In this paper we present the fundamental approaches of financial economics to valuation. Three methods are demonstrated by which financial economists account for risk. We illustrate how these methods relate to one another and how they can be applied in the valuation of risky corporate bonds, guaranteed investment contracts (GICs) with and without interest rate contingencies, and whole life insurance. Next, we discuss how these models treat orthogonal risks, such as the kind often covered by insurance contracts. Demand side and supply side diversification are treated, and liquidity risk is then considered. We conclude with a summary of the benefits of decomposition and transparency.

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GUTTERMAN, S. *The coming revolution in insurance accounting.* 1-11. This paper briefly examines some trends that could affect future financial reporting for insurance companies and will explore some of the fundamental issues being discussed. Topics covered include: what needs to be fixed at the national and international level, the factors that contribute to the changes, evaluation of a new or enhanced financial reporting system, and the big issues in financial reporting of insurance.

KHORASANEE, M. Z. *A cash-flow approach to pension funding.* 137-165. The problem of how to fund a defined-benefit pension plan is detached from the problem of how the cost of such a plan should be recognized. An approach to funding based on the projection of aggregate cash-flows and the explicit modeling of new entrants is presented. It is shown that commonly used funding methods can be derived from the cash-flow approach. A generalized funding method for a plan subject to a stationary distribution of new entrants is derived. It is concluded that plan actuaries might need to modify existing funding methods to incorporate useful information about the expected number and distribution of future entrants.

KLEIN, G. E. *A regime-switching model of long-term stock returns by Mary Hardy, April 2001.* 171-173.

NTZOUFRAS, I. & DELLAPORTAS, P. *Bayesian modelling of outstanding liabilities incorporating claim count uncertainty.* 113-136. This paper deals with the prediction of the amount of outstanding automobile claims that an insurance company will pay in the near future. We consider various competing models using Bayesian theory and Markov chain Monte Carlo methods. Claim counts are used to add a further hierarchical stage in the model with log-normally distributed claim amounts and its corresponding state space version. This way, we incorporate information from both the outstanding claim amounts and counts data resulting in new model formulations. Implementation details and illustrations with real insurance data are provided.

PERROTT, G. & HINES, W. *Fair value accounting compared to other accounting systems.* 62-90. It is well known that the total profit generated from an insurance product is fixed (unless the accounting system affects the product management), but the incidence of reported profit varies depending on the accounting system used and the way that assumptions are set and reset. The purpose of this paper is to take a very simple product (a single-premium deferred annuity (SPDA) with no special features) and follow its earnings over a 15-year period. We will examine the volatility of earnings under Fair Value (FV) accounting as proposed by the International Accounting Standards Committee (IASC), as we understand it, and US GAAP and US Statutory accounting. Additionally, we will examine how each of the accounting systems is impacted by the choice of a lapse assumption. We have the additional objective of simplicity, to produce a model that the reader can relate to and whose calculations can be reproduced with nominal effort.

WALLACE, M. *Performance reporting under fair value accounting.* 28-61. This paper compares performance measurement under fair value accounting vs. U.S. GAAP accounting. As illustrated in the paper, the main difference between fair value accounting and U.S. GAAP accounting lies in the treatment of gains and losses on both assets and liabilities. Fair value accounting would report all gains and losses on both assets and liabilities in the period in which they arise. U.S. GAAP on the other hand, recognizes gains and losses over the life of the block of business (or at the time of a transaction). When net gains and losses on assets and liabilities are immaterial, the pattern of earnings under both systems can be quite similar. However, if a company is generating significant gains or losses on its net book of business (such as in the case of an asset/liability mismatch), fair value accounting will reveal this much sooner than U.S. GAAP. When the full impact of its actions (including gains and losses) is

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reported in the current period, management is in a better position to understand how the value of the company is changing and adjust its decisions accordingly. This is one of the main reasons for moving to a fair value system and is expected to be a major benefit if fair value accounting is ultimately adopted.

WONG, J. *A comparison of solvency requirements and early warning systems for life insurance companies in China with representative world practices.* 91-112. The People's Republic of China has experienced substantial growth in insurance demand over the last decade. However, development of the related laws and regulations has not kept pace with the development of the insurance industry there. This paper reports on a pioneering study comparing different statutory reserve, solvency, and early warning systems in a sample of countries and regions in three of the world's important economic regions — Asia, North America, and Europe. It begins with the construction of a model office applicable to the People's Republic of China's regulatory framework and unique market environment. Reserve standards and solvency measurement systems in different supervisory frameworks then are applied to the model office. The results are analyzed as a comparative study of the People's Republic of China's total assets required for the reserves and solvency margins under the practices of other jurisdictions. Early warning systems also are discussed.

YOUN, H., SHEMYAKIN, S. & HERMAN, E. *A re-examination of the joint mortality functions.* 166-170. Mortality analysis involving multiple lives is easily one of the more complicated aspects in the theory of life contingencies. In this paper, we re-investigate joint mortality functions and in particular, we examine an assertion that relates the joint-life and last-survivor random variables. This common assertion states that the sum of the lifetimes of the joint-life and the last-survivor statuses is equal to the sum of the lifetimes of the single statuses. However, we show that this assertion is not precisely correct. We therefore offer a modification to the statuses definitions so that this common assertion holds.

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