Insurance: Abstracts and Reviews

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Organization of the Abstracts and Reviews section

Each abstract published in the Abstracts and Reviews section is characterized by the following features:

Serial number
By means of the serial number a reader will be able to locate an abstract in the 'Abstracts and Reviews' section of this journal. The first two figures of the serial number indicate the volume number; the third is the issue number. Thus, serial number 012054 refers to the 54th abstract of the 2nd issue of volume 1. But starting with Volume 22, the numbers correspond to the volume number of the journal. So abstracts in Vol. 23, 2nd issue have a number starting with 232.

Subject and insurance branch codes
These codes provide a first impression of the content of the paper which is abstracted and the specific branch of insurance it deals with.

The key to the codes can be found below. The subject codes themselves are subdivided into two major categories: insurance mathematics (codes starting with M) and insurance economics (codes starting with E). The B-codes are insurance branch codes. For a given abstract, the codes are listed in order of decreasing importance, subject code(s) first, then branch code(s).

If a paper does not deal with any branch of insurance in particular, the branch code is omitted but it always has at least one subject code. Thus, an abstract with codes (E22, M42, B77) deals with inflation and loss reserves in legal expenses insurance.

Keywords
To further identify the content of a paper, one or several keywords are given to its abstract, in order of decreasing importance. The keywords are used for indexing purposes in the keyword index.

The section Abstracts and Reviews is organized into five parts. These are 'Abstracts and Reviews', the Subject Index, the Insurance Branch Index, the Keyword Index and the Author Index. In the 'Abstract and Reviews' portion, the abstracts and reviews themselves are placed in order of their serial number. All information on a given paper such as title, English translation of title, author's name and address, subject and insurance branch codes and keywords can be found in this section.

In the Indexes, reference to an abstract is made by means of its serial number. In some indexes additional information, such as title or other codes, is given.

Unless specified otherwise, summaries were provided by the author(s).

Subject categories

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Insurance branch categories
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B76 legal expenses
B77 travel
B80 social insurance
B81 pension
B82 daily compensation
B83 permanent health (disability)
B84 sickness (medical expenses)
B85 unemployment
B90 reinsurance
B91 proportional reinsurance
B92 non-proportional reinsurance
M: INSURANCE MATHEMATICS

M01: MODELLING GENERAL

281001 (M01)
On the Strategy For Efficient Realisation of Statistical Reasoning.
Akaike H., XXXth International ASTIN Colloquium, 22-25 August 1999, 9th International AFIR Colloquium, 24-27 August 1999
Historical development of the logic of statistical reasoning is reviewed briefly and the informational view is discussed. The role of “true distribution” in the conventional statistics is explained and the necessity of considering alternative models is pointed out. The importance of the activity of constructing statistical models in the process of statistical reasoning is stressed and the use of the informational data set, composed of established knowledge, empirical findings, and observational data, is discussed. Utility of this constructive view is demonstrated by a realistic example of the golf swing analysis. The example shows that some strategic consideration is necessary for the construction of a practically useful model or image for the control of a complex autonomous system.
Keywords: Statistical model, Information criterion, Informational data set, Golf swing.

M10: PROBABILITY THEORY AND MATHEMATICAL STATISTICS IN INSURANCE, GENERAL AND MISCELLANEOUS

281002 (M10, M11)
Coherent Risk Measures on General Probability Spaces.
Delbaen F., XXXth International ASTIN Colloquium, 22-25 August 1999, 9th International AFIR Colloquium, 24-27 August 1999
The author extends the definition of coherent risk measures, as introduced by Artzner, Delbaen, Eber and Heath, to general probability spaces and the authors shows how to define such measures on the space of all random variables. This paper also gives examples that relates the theory of coherent risk measures to game theory and to distorted probability measures. The mathematics are based on the characterisation of closed convex sets P of probability measures that satisfy the property that every random variable is integrable for at least one probability measure in the set Pσ.
Keywords: Capital requirement, Coherent risk measure, Capacity theory, Convex games, Insurance premium principle measure of risk, Orlicz spaces, Quantile, Scenario, Shortfall, Sub additivity, Value at risk.

281003 (M10, M11)
Eine Verschärfung der Schranke von LeCam zur Poisson-Approximation von Gesamtschadenverteilungen im individuellen Modell
Weba M., Blätter, Band XXIV, Heft 3, April 2000
The aggregate claim distribution of a portfolio is frequently approximated by a compound Poisson distribution. If the portfolio has a small intensity an error bound due to LeCam is suitable to describe the total variation distance between both distributions. It is the purpose of the paper to derive a sharpened version of LeCam’s bound.
Keywords: Aggregate claim distribution, Compound Poisson distribution.

281004 (M10, M52)
A Simple Method to Estimate Parametric Claim Size Distributions From Grouped Data.
Brix J., Pfeifer D., Blätter, Band XXIV, Heft 3, April 2000
In the praxis of reinsurance the problem often occurs that claim size data are usually processed in grouped form, and mostly even only available for the larger claim size layers. The statistical estimation of appropriate claim size distributions for the total portfolio is then a difficult task which cannot be performed with the usual elementary statistical tools. In this paper, the authors want to show that such an analysis can, however, be simply performed for most parametric classes of claim size distributions using certain non-linear regression techniques for densities that are nowadays implemented in several statistical software packages. The powerfullness of this method is demonstrated using both artificial as well as real data from fire, windstorm and health care losses.
Keywords: Reinsurance, Grouped data, non linear regression techniques.

281005 (M10, M11)
On Multivariate Panjer Recursions.
In the present paper the author generalises Panjer’s (1981) recursion for compound distributions to a multivariate situation where each claim event generates
a random vector. Different situations within insurance where such models could be applicable, are discussed, and some special cases of the general algorithm are considered. Finally, the author deduces from the algorithm a multivariate extension of De Pril’s (1985) recursion for convolutions.

**Keywords:** Panjer’s recursion, De Pril’s recursion.

281006 (M10, M11)

**Recursive Evaluation of Some Bivariate Compound Distributions.**


In this paper the author considers compound distributions where the counting distribution is a bivariate distribution with a probability function that satisfies a recursion in a certain suitable form. He presents an algorithm for recursive evaluation of the corresponding compound distributions and some examples of distributions in this class.

**Keywords:** Recursions, Compound distributions, Bivariate distributions, Trinomial distributions bivariate Negative Binomial, Bivariate Poisson.

281007 (M10, M11)

**Compound Poisson approximations for individual models with dependent risks.**

Christian Genest C., Marceau E., Mesfioui M., Proceedings Fourth WME Congress Barcelona

This paper proposes compound Poisson approximations for the distribution of the total claim amount in various individual risk models whose contracts are stochastically dependent. Two types of dependence structures are considered, as described in Marceau et al. (2000). The impact of these approximations is compared via numerical examples.

**Keywords:** Compound Poisson approximation, Dependent risks, Individual risk model, Collective risk model.

281008 (M10, M11)

**An Integral Stochastic Dynamic Model of an Insurance Company.**

Montes J.M., Moreno A., Proceedings Fourth IME Congress Barcelona

This paper presents a stochastic mathematical model, based on Pentikäinen’s specifications, founded on the Theory of risk, aiming to the overall representation of the main aspects of the state of an insurance company during its regular operation over a period of time.

The difficulty of the formulations of Pentikäinen solving optimisation problems is that, assuming normality in the distribution of the amount of a claim, the net retention of reinsurance (stop-loss or maximum risk assumed by the company in a single claim) lies in the superior extreme of the proper integral that measures the average risk borne by the firm, and there is no known procedure to obtain an exact analytic solution. This prevents the model to be used as a support in corporate decisions. To solve this problem, a function has been developed that adjusts the integral result for the values of average, standard deviation and level totals of net retention of reinsurance in the company, keeping in mind the peculiarities of the firm, and its reinsurance policies. For an interval of values of these parameters, according to the claims of the company, one function is derived that, even in the case of a lineal specification, adjusts quite well to the analytic result of the previous integral. A quite difficult polynomial functional structure is also obtained that adjusts in a very precise way to the value of this integral, and therefore, the total average claim assumed by the company in a single claim. As a whole, the model is a dynamic system of twelve equations, twelve state variables, and four control variables (whose value is determined by the company) that can be used to describe and solve optimisation problems and aid in decision making.

**Keywords:** Stochastic dynamic model.

281009 (M10, M11)

**Recursive Moments of Compound Renewal Sums with Discounted Claims.**

Léveillé G., Garrido J., Proceedings Fourth IME Congress Barcelona

Andersen was the first to propose a compound ordinary renewal process as a generalisation of the classical risk model. Later, Taylor suggested to consider the effect of the claims cost inflation on a compound Poisson risk process.

In this paper, the authors incorporate both generalisations into a Compound Renewal Present Value Risk (CRPVR) process and, assuming regularity conditions, the authors use renewal theory arguments to get recursive formulas for all the moments of the CRPVR process. Some examples, extensions and limit theorems are also given.

**Keywords:** Finite time and asymptotic moments, Net interest rate, Present value risk process, Classical risk model, Renewal theory.
281010 (M10, M11)
Upper and Lower Bounds for Sums of Random Variables
Kaas R., Dhaene J., Goovaerts M.J., Proceedings Fourth IME Congress Barcelona
The upper bounds for sums of dependent random variables $X_1 + X_2 + ... + X_n$, derived using comonotonicity, are sharpened for the case when there exists a random variable $Z$ such that the distribution functions of the $X_i$, given $Z$, are known. By a similar technique, lower bounds are derived. A numerical application for the case of lognormal random variables is given.
Keywords: Upper bound, Lower bound, Random variables.

281011 (M10, M11)
Comparison of portfolios that depend on multivariate Bernoulli random variables with fixed marginals.
Frostig E., Proceedings Fourth IME Congress Barcelona
Consider portfolios which are a function of multivariate Bernoulli random variables, indicating if an insured did or did not have a claim in a certain reference period. The vector of the claims' size is independent of the indicators vector. For exchangeable Bernoulli random variables the author finds the one which is the minimal in super-modular ordering. Thus, she generalises the result of Hu, T. and Wu, Z (1999) and in Dhaene, J. and Goovaerts, M.J. (1997). For the general case, the author derives a partial ordering which compares between different portfolios with the same marginals. He applies this result to find the multivariate Bernoulli random vector of size 3 that minimises the sum of the claims in the reference period in convex ordering.
Keywords: Bernoulli random variables, Fixed marginals.

281012 (M10, B10)
Reputation Pricing of Life Insurer.
Levikson B., Yosef R., Proceedings Fourth IME Congress Barcelona
The authors evaluate the reputation of an insurer due to its life insurance portfolio, assuming a random arrival process of customers and their insurance contracts (such as whole life, assurance endowment etc.) Explicit expressions for future reserves are obtained for several management strategies. This is done using methods from stochastic processes such as queuing theory.
Keywords: Life insurance portfolio, Stochastic process, Queuing theory.

281013 (M10, M11)
Kernel density estimation of actuarial loss functions.
Bolané C., Guillén M., Perch Nielsen J., Proceedings Fourth IME Congress Barcelona
In this paper, the authors estimate actuarial loss functions based on a symmetrized version of the semiparametric transformation approach to kernel smoothing. They apply this method to an actuarial study of automobile claims. The method gives a good overall impression while estimating actuarial loss functions, since it is capable of estimating both the initial mode and the heavy tail that is so typical for actuarial and other economic loss distributions. They study the properties of the transformation kernel density estimation and show the differences with the multiplicative bias corrected estimator with variable bandwidth. The authors add insight into the kernel smoothing transformation method through an extensive simulation study with a particular view to the performance of the estimation at the tail.
Keywords: Loss models, Transformation, Skewness, Weighted integrated squared error.

281014 (M10, M11)
Rojas-Mujica O., Proceedings Fourth IME Congress Barcelona
The author considers Multivariate Economic Time Series in order to investigate cross-border effects. It is common to find that:
- Some countries do not provide information on all the economic variables;
- Those countries that do provide information on all variables supply series of different lengths.
This paper focuses on those countries that belong to set b.), which present series where gaps (missing data) are observed, thus reducing the set of measurable observations. The technique described in this paper deals with a process of filling such gaps. It is a markov chain Monte Carlo (MCMC) approach, based in the use of a Cointegrated Vector Autoregressive (VAR) Model. The approach comprises:
- A technique to choose a set of candidate VAR-model orders;
- The appliance of MCMC to estimate the parameters of each model;
- A stochastic procedure to determine the VAR-model to be used;
- A stochastic missing data filling process.

Keywords: Missing data, Markov Chain, Monte Carlo approach.

281015 (M10, E10)
Mazzoleni P., Proceedings Fourth IME Congress Barcelona
The great interest in risk measures has promoted new lines of search, combining results from the decision theory and from the probability theory. Recently, a new approach has been proposed to represent the subjective attitude towards risk by applying a suitable transformation to the probability distribution, thus leading to a direct comparison among alternatives, without passing necessarily through utility functions. This method allows us to introduce the difference between bid and ask behaviour also in a risky framework.

A prudential risk measure is based on the quantile measure, recently renamed Value at Risk (VaR), for the variety of its applications in the financial and actuarial problems, but it has been proved that VaR does not satisfy the minimal requirements for an appropriate risk measure and it has been overcome by the mean excess return, explicitly depending on a threshold. Therefore there is the opportunity to make this threshold depending on the different sides of the transaction. Such a mean value measure is related with the probability distribution under examination and allows us to distort it according to the subjective attitude. Such a threshold can be generalised to a moving reference random variable. This paper analyses a pseudo-order, originated by the bid-ask measure of risk and relying on an adaptive threshold, and applies it to the comparison of the probability distributions related with some life-insurance products.

Keywords: Risk measures, Bid-ask spread, Pseudo-orders.

281016 (M10, B10)
Convex order and multistate life insurance contracts.
Spreeuw J., Proceedings Fourth IME Congress Barcelona
The distribution function of the present value of a cash flow can be approximately by means of a distribution function of a random variable, which is also the present value of a sequence of payments, but has a simpler structure. The corresponding random variable has the same expectation as the random variable corresponding to the original distribution function and is a stochastic upper bound of convex order. In this paper it will be shown that such an approach can also be adopted for some multistate life insurance contracts under Markov assumptions. The quality of the approximation will be investigated by comparing the distribution obtained with the one derived from the algorithm presented in the paper by Hesselager & Norberg (1996).

Keywords: Convex order, Comonotonic joint distribution, Multistate life insurance contracts, Present value distributions.

281017 (M10, B20)
Modelling disability. Applications to personal accident insurance
Olivieri A., Pitacco E., Proceedings Fourth IME Congress Barcelona
Starting from a rather general structure for the disability process, the authors show that a reasonable approximation leads to the multistate model, widely used in actuarial practice (for example, in PHI and LTC business). The features of the multistate model allow for several disability degrees, hence meeting the requirements of a rigorous modelling for personal accident insurance. Moreover risk factors (and hence rating factors) can be represented by properly choosing the transitions intensities. So, an application of multistate modelling to personal accident insurance is proposed and some examples of practical interest are discussed.

Keywords: Disability, Multistate models, Personal accident insurance.

281018 (M10, M11)
Stochastic Accumulating and Discounting Laws - Equilibrium under Mean Criterion.
Alegre A., Mayoral R.M., Proceedings Fourth IME Congress Barcelona
In this paper, the authors start with the hypothesis that the force of interest, i.e. the price of the operation of finance, behaves stochastically in time. In the model, the authors have considered, the instantaneous interest rate is a constant perturbed by white noise volatility with constant parameter of intensity.

They consider accumulating and discounting with a period Δt in which the price has been determined by integration of the force of interest. So, in the stochastic model it results an additive brownian process. In both accumulating and discounting, the price is credited at
Once: in accumulating, the interest is credited at the end of each conversion period and in discounting, it is credited at the beginning of each conversion period. Anyway, no financial valuation of the previously described arrears or advance in the price credit is considered. Financial factors of accumulation and discount respectively, have been obtained as random variables resulting from the product of independent and normal distributed random variables. Their means and variances have been also determined. In order to define the discount factor, the authors firstly analyse the definitions given by some authors in the actuarial literature and the authors study their relationship with the capitalisation factor. In this paper, they give a new definition for the stochastic discount factor that is compatible with the capitalisation under mean criterion. Once accumulating and discounting have been studied in the discrete case, they extend the analysis to the continuous one by stating the respective stochastic differential equation.

Keywords: Wiener process, Stochastic integral, Stochastic differential equation, Stochastic difference equation, Decision criteria.

M11: STOCHASTIC MODELS FOR CLAIMS FREQUENCY, CLAIM SIZE AND AGGREGATE CLAIMS

281019 (M11, B20)
Semi-stochastic Markov multistate modelling for disability.

Pociello E., Alegre A., Bosh M., Claramunt M., Ortuño B., Varea J., Proceedings Fourth IME Congress Barcelona

Multistate models for disability can be developed in a mathematical framework based on Markov and Semi-Markov stochastic processes which provides a unifying point of view. The Markov processes application has already been widely discussed an successfully applied. The Semi-Markov processes application is considerably more difficult because of the mathematic requirements. This paper aims to show how to apply a semi-Markov process to a multiple state model in a easily comprehensive way. The model proposed can be applied to any disability multistate model such as LTC (Long Term Care) or DD (Dread disease) covers. In order to obtain numerical results, the authors have focused on a PHI (Permanent Health Insurance) disability model which includes the recovery possibility.

Keywords: Continuous time semi-Markov stochastic process, General Equation, Integro-differential Volterra equations, PHI disability model.

281020 (M11, M10)
On the distribution of the Surplus Prior to and at Ruin.


Consider a classical compound Poisson model. The safety loading can be positive, negative or zero. Explicit expressions for the distributions of the surplus prior and at ruin are given in terms of the ruin probability. Moreover, the asymptotic behaviour of these distributions as the initial capital tends to infinity are obtained. In particular, for positive safety loading the Cramér case, the case of the subexponential distributions and some intermediate cases are discussed.

Keywords: Surplus distribution, Compound Poisson Model.

281021 (M11, M10)
Dependence notions in actuarial sciences.

Denuit M., Dhaene J., Proceedings Fourth IME Congress Barcelona

In many practical situations, individual risks are correlated, for instance because they are influenced by changes in their common environment. Nevertheless, the actuary often assumes that they are mutually independent, mainly for mathematical convenience. This talk is devoted to some positive dependence notions and their interest in actuarial sciences. Specifically, several notions of positive dependence among risks will be discussed, namely orthant dependence, linear quadrant dependence, cumulative dependence, conditional increasingness in sequence, association, multivariate total positivity of degree 2 and dependence by mixture, among others. It will be seen that these particular structures naturally appear in several classical problems of actuarial sciences. The effect of dependence on relevant risk quantities (like stop-loss premiums, for instance) will be measured with the aid of stochastic orderings.

Keywords: Dependency, Stochastic ordering.

281022 (M11, M10)
Stochastic Dominance And Conditional Expectation – An Insurance Theoretical Approach.

Borglin A., Keiding H., Proceedings Fourth IME Congress Barcelona
In this paper it is shown that the relation of second order stochastic dominance, which has found widespread use in models of economics under uncertainty, may be described in terms of conditional expectation: If random variable is stochastically dominated by another one, then the latter may be obtained from the first by iterated conditional expectation.

Keywords: Stochastic dominance.

281023 (M11, M10)
On finite-time survival probabilities in a risk model including interest rates.
Abrecher H., Tichy R.F., Proceedings Fourth IME Congress Barcelona
In the framework of the extended classical risk model including a constant real interest force i, the authors focus on the explicit calculation of the probability of survival U(x, t, i) up to time t, given an initial capital x>0, and derive a series expansion for U(x, t, i). Furthermore they investigate the structure of the Laplace-transform of U(x, t, i) w.r.t. x as well as w.r.t. t for several claim size distributions and compare their findings to some known results for the case of exponential claim size distributions.

Keywords: Interest rates, Risk model, Probability of survival.

M12: MODELLING OF PORTFOLIOS AND COLLECTIVES

281024 (M12, E60)
Anchoring and Acquiescence Bias in Measuring Assets in Household Surveys.
Cognitive psychology has identified and studied extensively a number of cognitive anomalies that may be important for the assessment of the economic status of individuals and households. In particular the use of brackets to elicit information about income and assets in surveys of households can interact with acquiescence bias and anchoring to cause bias in the estimates of the distributions of income and assets. This paper uses data from the Health and Retirement Study and the Asset and Health dynamics Study to find that, as predicted by psychology, bracketing can produce bias in population estimates of assets.

Keywords: Assets, Anchoring, Acquiescence.

281025 (M12, B13)
Anwartschaftsrenten
Pichler A., Blätter, Band XXIV, Heft 3, April 2000
The present value of a widows-pension can be written as E [\bar{a}(K_x, K_y)]. In the first part of the paper the author describe the density-function which has to be used to calculate the expectation; then the author describes \bar{a}(k,j); this function gives the present value of the annuity for y, provided that x survives exactly k years and y survives exactly j years; in the second part this concept is used to calculate the present value of a disability pension.

Keywords: Widows pension, Present value, Density function.

281026 (M12, M11)
Markov Chain Monte Carlo Estimation of Regime Switching Vector Autoregressions.
Financial time series data are typically found to possess leptokurtic frequency distributions, time varying volatilities, outliers and correlation structures inconsistent with linear generating processes, nonlinear dependence, and dependencies between series that are not stable over time. Regime Switching Vector Autoregressions are of interest because they are capable of explaining the observed features of the data, can capture a variety of interactions between series, appear intuitively reasonable, are vector processes, and are now tractable.

This paper considers a vector autoregression subject to periodic structural changes. The parameters of a vector autoregression are modelled as the outcome of an unobserved discrete Markov process with unknown transition probabilities, are determined in addition to the vector autoregression parameters within each regime. A Bayesian Markov Chain Monte Carlo estimation procedure is developed which efficiently generates the posterior joint density of the parameters and the regimes. The complete likelihood surface is generated at the same time, enabling estimation of posterior model probabilities for use in non-nested model selection. The procedure can readily be extended to produce joint prediction densities for the variables, incorporating both parameter and model uncertainty.

Results using simulated and real data are provided. A clear separation of the variance between a stable and an unstable regime was observed. Ignoring regime shifts is very likely to produce misleading volatility estimates and is unlikely to be robust to outliers. A comparison
with commonly used models suggests that Regime Switching Vector Autoregressions provide a particularly
good description of the observed data.
Keywords: Vector regime switching, Joint parameter
density, Outliers, Gibbs sampler, Metropolis-Hastings algorithm, Markov Chain Monte Carlo, Posterior model
probabilities, Model selection.

281027 (M12, E60)
Estimating the Value of the Wincat coupons of the
Winterthur Insurance Convertible Bond.
The three annual 2¼% interest coupons of the
Winterthur Insurance convertible bond (face value CHF
4700) will only be paid out if during their corresponding
observation periods no major storm or hail storm on one
single day damages at least 6000 motor vehicles insured
with Winterthur Insurance. Data for events, where storm
of hail damaged more than 1000 insured vehicles, are
available for the last ten years. Using a constant
parameter model, the estimated discounted value of the
three WINCAT coupons together is CHF 263.29.
However, fitting models which admit a trend or a
change-point leads to substantially higher knock-out
probabilities of the coupons. The estimated discount
values of the coupons can drop below the above
conservative value; a conservative evaluation as above
leads to substantially lower values. Hence, already the
model uncertainty is higher than the standard deviations
of the used estimators. This shows the dominance of the
model risk. Consistency, dispersion, robustness and
sensitivity of the models are analysed by a simulation
study.
Keywords: Convertible Bond, Constant parameter
model.

281028 (M12, B13)
Stochastic Pension Funding: Proportional Control
and Bilinear Processes.
The author finds explicit expressions for the moments of
the fund level and the value of the total contribution
when arithmetic or geometric rates of return are
modeled by a moving average process of order q and
when a proportional control is applied to the
contributions. The approach is based on the bilinear
Markovian representation.
Keywords: Bilinear Markovian representation,
Geometric bilinear processes, Moving average rate of
return, Pension funding.

281029 (M12, B10)
Multi-period Aggregate Loss Distributions for a Life
Portfolio.
Dickson D.C.M., Waters H.R., Astin Bulletin, 29.2,
November 1999
Algorithm for the calculation of the distribution of the
aggregate claims from a life insurance portfolio have
been derived by Kornya (1983), Hipp (1986) and De
Pril (1986-1989). All these authors considered the
distribution of the aggregate claims over a single period.
In this paper the authors derive algorithms for the
calculation of the joint distribution of the aggregate
claims from a life portfolio over several periods.
Keywords: Aggregate claim, Life portfolio.

281030 (M12, B21)
Estimating per Capita Expenses in Multiple State
Models of Permanent Health Insurance.
1999
The aim of this work is to present a method to compute
the expected amount of annual claims in the health
insurance. (A more detailed analysis of the method can
be found in Kovarova (1998)) The author is especially
concerned with the permanent health insurance and
compare the numerical results with those computed and
published for the permanent health insurance in the
C.M.I.R. (1991). At the same time the author gives a
general methodology applicable, not only to the
permanent health insurance but for other types of health
insurance as well.
The methods used today can be divided into three
groups: the method of the decrement tables, the
Manchester Unity method and the multiple state model.
The author describes a simple method to compute from
the data of the multiple state model the bases for the
Manchester United and for the decrement tables
methods.
Keywords: Permanent Health Insurance, Multiple State
Model, Transition Intensity, Claims, Manchester Unity
Models.

281031 (M12, M10)
The individual aggregate cost method within a
control theoretical framework.
Zimbidis A.A., Proceedings Fourth IME Congress
Barcelona
The paper investigates the individual aggregate cost
method (also known as the spread-gain method), which
is normally applicable in small pension funds or fully
contributory schemes, using a control theoretical framework. The original model is quite complicated, as the specific system is non-linear. The author constructs the difference equations describing the mechanisms of the respective funding method and then calculate the optimal control path of the contribution rate assuming (firstly) an unpredictable stochastic and (secondly) a predictable deterministic pattern for the future investment rates of return. For the first case the optimal solution is achieved through a linear approximation and using advanced optimisation techniques. It is finally proved that the contribution rate is (optimally) controlled through the control of the valuation rate (which is determined incorporating a certain feedback mechanism of the past contribution rate). The optimal solution for the deterministic case is obtained using standard calculus and the Lagrange multipliers.

**Keywords:** Individual aggregate funding, Linear approximation, Lagrange multipliers, Optimal control.

**281032 (M12, M10)**

**Bivariate Analysis of Survivorship and Persistency.**

Valdez E.A., Proceedings 4th IME Congress Barcelona

Voluntary non-payment of premiums leads to policy termination. When policies are terminated, it is costly to several parties of insurance contracts. These costs include the inability of the insurance company to recover acquisition expenses, loss of income from renewal premiums by the insurance agent, and loss of premiums paid and insurance coverage by the contract-holder. While most of these costs can be directly accounted for, there is the additional hidden cost resulting from mortality selection. This refers to the tendency of contractholders who are generally healthier to select against the insurance company by voluntary terminating their policies. This paper explores a methodology to quantify the cost of mortality selection and to examine for the presence of such selection. While standard actuarial models of survivorship and persistency consist of specifying distributions for times until death withdrawal, the typical assumption is that these random times are independent. The author uses a more general approach of specifying the bivariate distributions using copulas for these random times without having to assume independence. This paper demonstrates procedures to estimate parameters in the model, and shows how one can use these estimates to predict more accurate future cash flows.

**Keywords:** Policy termination, Cost analysis, Bivariate analysis.

**M13: RUIN AND OTHER STABILITY CRITERIA**

**281033 (M13, M10)**

**Computation of Compound Distributions I: Aliasing Errors and Exponential Tilting.**


Numerical evaluation of compound distributions is one of the central numerical tasks in insurance mathematics. Two widely used techniques are Panjer recursion and transform methods. Many authors have pointed out that aliasing errors imply the need to consider the whole distribution if transform methods are used, a potential drawback especially for heavy-tailed distributions. The authors investigate the magnitude of aliasing errors and show that this problem can be solved by a suitable change of measure.

**Keywords:** Total claim size distribution, Ruin probabilities, Random sums, Fourier transformation, Aliasing, Change of measure.

**281034 (M13, M10)**

**The Probability of ruin in a Discrete Semi-Markov Risk Model**

Reinhard J., Snoussi M., *Blätter, Band XXIV, Heft 3, April 2000*

In this paper, the authors introduce a discrete time semi-Markov risk model. They derive a recursive system for finding the probability of ruin in a particular case where the annual result may be positive only in years beginning in some given state.

**Keywords:** Semi Markov risk model, Probability of ruin.

**281035 (M13, M10)**

**Importance sampling of Ruin Probabilities for Risk Processes with Stochastic Compounded Assets.**

Paulsen J., Proceedings Fourth IME Congress Barcelona

The author uses importance sampling to calculate the probability of ultimate ruin for a Levy process compounded by another independent Levy process where both processes have a finite number of jumps on finite time intervals. A general class of measure transforms which guarantees that the Radon Nikodym derivative is a martingale is introduced, and numerical examples are given. It is well known that the quality of importance sampling can be very poor, and several methods to assess the accuracy of the numerical estimates obtained are discussed.

**Keywords:** Ruin probabilities, Levy process.
281036 (M13, M11)
Ruin Probability under Different Hypotheses for Risk Process
Márml M., Alegre A., Claramunt M.M., Proceedings Fourth IME Congress Barcelona
In this paper, the authors calculate ruin probability under different hypothesis for risk process. They assume a Compound Poisson Process and a diffusion model to model the aggregated cost. With the expressions obtained, the authors study the influence of security loading and the initial level of reserves on ruin probability.
Keywords: Solvency, Compound Poisson Process, Wiener Process. Stochastic differential equations.

M30: PREMIUM, PREMIUM PRINCIPLES, ORDERING OF RISKS

281037 (M30, B40)
Spatial Modeling Approaches for Geographical Premium Rating.
Verrall R.J., Dixon M., Kelsey R., Lee C., Proceedings Fourth IME Congress Barcelona
In this paper the authors evaluate the suitableness of the following two methodologies to measure geographical insurance risk for use in premium rating:
- a spatial modelling approach based on the Monte Carlo Markov Chain framework suggested by Boskov and Verrall (1994); and
- a kriging approach which is commonly used in geostatistics.
The authors have applied these methodologies for the analysis of an actual data-set based on UK motor insurance claim frequency at postcode district level. The methods are compared for both accuracy and smoothness of estimates.
Keywords: Geographical premium rating, Motor insurance.

281038 (M30, M10)
An Economic Premium Principle in Multi-period Time Horizon.
This paper considers a multi-period economic equilibrium model to derive the economic premium principle of Bühlmann (1980, 1983). To do this, the authors construct a consumption/portfolio model in which each agent characterised by his/her utility function and endowments can invest his/her wealth into insurance market as well as financial market to maximise the expected, discounted total utility consumption. The state price density in an equilibrium is obtained in terms of the Arrow-Pratt index of absolute risk aversion for the representative agent. As special cases, power and exponential utility functions are examined, and some comparative statics are derived.
Keywords: Equilibrium model, Economic premium principle.

281039 (M30, M10)
Higher Degree Stop-Loss Transforms and Stochastic Orders (I) Theory
Hürlimann W., Blätter, Band XXIV, Heft 3, April 2000
The higher degree stop-loss and their logarithmic derivatives, called higher degree stop-loss rate functions, are studied to get insight into the hierarchical theory of the higher degree stop-loss orders and related stochastic orders. Based on differential-integral recursive relationships, the author derives in a simple way two characterisation results by Gupta and Gupta (1983), which state that the higher degree stop-loss transforms and the higher degree stop-loss rate functions uniquely determine a distribution function. Classes ISLR (n) of distributions with an increasing stop-loss rate function of degree n are considered, and it is shown that ISLR (n) implies ISLR (n+1). This result generalises the well-known fact by Bryson and Siddiqui (1969) that a distribution with an increasing failure rate has necessarily a decreasing mean residual life. Necessary and sufficient conditions, which guarantee that ISLR (n+1) implies ISLR (n), are formulated. Using notions of higher degree stop-loss rate order and high degree stop-loss rate dangerousness order, sufficient conditions for a higher degree stop-loss order relation are established. Two new sign change characterisations of higher degree stop-loss order by means of higher degree stop-loss transforms and higher degree stop-loss rate functions are derived. Applications in actuarial mathematics follow in part II of the present work.
Keywords: Stop loss transform.

281040 (M30, M10)
Higher Degree Stop-Loss Transforms and Stochastic Orders (II) Applications.
Hürlimann W., Blätter, Band XXIV, Heft 3, April 2000
The usefulness of various results presented in the theoretical part I of the present work is illustrated. Some
typical applications within the theory of stochastic orders and statistical distributions are considered. The obtained results may be used in actuarial science and finance, and are of special significance in reinsurance.

Keywords: Stop loss transform, Stochastic order, Distribution functions.

281041 (M30, M10, B10)
Stochastic Analysis of Duplicates in Life Insurance Portfolios.
Denuit M., Blätter, Band XXIV, Heft 3, April 2000
The aim of this short note is to investigate the impact of duplicates in a life insurance portfolio by means of the supermodular order. Most classical results involving the variances are generalized using the stop-loss order.

Keywords: Life insurance, Duplicates, Supermodular order, Stop-loss order.

281042 (M30, M10)
The Exponential Premium Calculation principle Revisited.
In this paper, it is shown how to approximate theoretical premium calculations principles in order to make them useful in practice. The method relies on stochastic extrema in moment spaces and is illustrated with the aid of the exponential principle.

Keywords: Premium Calculation Principles, Moment Spaces, S-Convex Orderings, Stochastic Extrema.

281043 (M30, M10)
Postcode Insurance Rating - Spatial Modelling and Performance Evaluation
Dixon M.J., Kelsey R., Verrall R.J., Proceedings Fourth IME Congress Barcelona
This paper is concerned with spatial models for insurance rating. In particular, the study examines methods which aim to predict the underlying risk in a geographical region, using claims data which are near or relatively near to a region of interest. The geographical location is contained within the postcode for each policy. Previous work by Taylor (1989) and Boskov and Verrall (1994) has been successfully applied, but these methods contain some deficiencies, and have not been formally assessed for their performance. The authors propose and apply a procedure that can be used to compare different postcode rating models.

Keywords: Gibbs Sampler, Postcodes, Premium Rating, Spatial Statistics.

281044 (M30, M10)
Simulation Based Approach to Optimal Premium Pricing in a Competitive Insurance Environment – II.
Savouli L., Haberman S., Proceedings Fourth IME Congress Barcelona
This paper is an extension to an earlier paper (Savoulli and Haberman, 2000), which investigated optimal premium pricing policies in a competitive insurance environment using a simulation approach. Here, the authors change the model to incorporate stochastic variation for the breakeven premium, in order to represent the claims process. They model the market average premium and the breakeven premium as diffusion processes, with the premium as the control function and the maximisation of the expected utility of wealth, over a finite time horizon, as the objective. After estimating the market parameters, the authors simulate the stochastic processes followed by the market average premium and the breakeven premium and compute the corresponding demand and wealth processes for a given control function. On each simulated path, the authors compute the integral of the utility of wealth over the finite time horizon. Thus, after sufficient simulations, they compute the expected value of this integral i.e. the objective function. Ultimately, the authors optimise the control function by assuming it takes a particular functional form (e.g. a linear function of market average premium and breakeven premium) and hence optimise the objective function over the free parameters of the functional form.

Keywords: Optimal premium pricing, Stochastic variation, Breakeven premium.

281045 (M31, M10)
Chain-Ladder and Grossing-Up: Two Methods and One Result
Lorenz H., Schmidt K.D., Proceedings Fourth IME Congress Barcelona
The chain-ladder method and the grossing-up method are two algorithms of loss reserving for estimating the (expected) ultimate aggregate claims; both methods are described by numerical examples in the Claims Reserving Manual [1989]. Experience of actuaries in practise shows that both methods lead to similar results, but a recent paper of Kremer [1997] suggests that the
methods are different and the author even argues that the chain-ladder method should be preferred to the grossing-up method. In the present paper the authors show that the chain-ladder method and the grossing-up method, both with classical weights, yield the same estimates of ultimate aggregate claims; nevertheless, the numerical results provided by these methods may slightly differ due to the different nature of the algorithms. In addition, the authors show that to any choice of weights for the generalised chain-ladder method there corresponds a set of weights for the generalised grossing-up method yielding the same estimates, and conversely.

Keywords: Chain Ladder, Grossing up method.

281046 (M31, M10)
For the construction of bonus-malus systems, the authors propose to show how to apply, thanks to simple mathematics, a parametric method encompassing those encountered in the literature. They also compare this parametric method with a non-parametric one that has not yet been used in the actuarial literature and that however permits a simple formulation of the stationary and transition probabilities in a portfolio whenever to construct a bonus-malus system with finite number classes.

Keywords: Mixed Poisson processes, Non-parametric estimation, Hofmann’s distribution, Bayes theorem, Bonus-malus systems, Stationary distribution.

281047 (M31, M10)
Selection of Credibility Regression Models
The authors derive some decision rules to select best predictive regression models in a credibility context, that is, in a ‘random effects’ linear regression model with replicates. In contrast to usual model selection techniques on a collective level, the proposal allows to detect individual structures, even if they disappear in the collective.

The authors give exact, non-asymptotic results for the expected squared error loss for a predictor based on credibility estimation in different models. This involves correct accounting of random model parameters and the study of expected loss for shrinkage estimation. The authors support the theoretical properties of the new model selectors by a small simulation experiment.

Keywords: Bias-variance trade-off, Empirical Bayes, Random effects model, Shrinkage estimation, Squared prediction loss, Subset-regression.

281048 (M31, M10)
Accounting for Individual Over-Dispersion in a Bonus-Malus Automobile Insurance System.
Individual automobile insurance claims are characterised by over dispersion relative to the Poisson model. In addition, claim propensities vary among individuals in any insurance portfolio. This paper presents a model which takes account of both characteristics. The model employs the negative-binomial distribution as the distribution for individual-level claims and a Pareto distribution as the distribution for claim propensities within the portfolio. The paper shows that the resulting model is tractable and has a number of attractive properties which make it suitable for this application. The fit of the model to actual claim numbers for automobile third party liability insurance is examined and found acceptable. Bayes theorem is then applied to this model to calculate illustrative optimal premiums under the Bonus-Malus Systems (BMS).

Keywords: Bonus-Malus Systems, Automobile Insurance, Negative Binomial distribution.

281049 (M31, M10)
The Standard Error of Chain Ladder Reserve Estimates: Recursive Calculation and inclusion of a Tail Factor
In Mack (1993), a formula for the standard error of chain ladder reserve estimates has been derived. In the present communication, a very intuitive and easily programmable recursive way of calculating the formula is given. Moreover, this recursive way shows how a tail factor can be implemented in the calculation of the standard error.

Keywords: Chain ladder, Standard Errors, Recursive Calculation, Tail Factor.

281050 (M31, M10)
Linear credibility predictors for the pure premium of an insurance contract.
Piquet J., Proceedings Fourth IME Congress Barcelona
This paper aims at providing linear credibility predictors
for the pure premium of insurance contracts, from a
ing rating structure based on their individual characteristics.
A two equation model with random effects and
regression components is consistently estimated, jointly
with the computation of linear credibility predictors.
Empirical results are given, which are drawn from a
French data base of automobile insurance contracts.
**Keywords:** Fixed and random effects models, Residuals,
Pseudo-true value.

281051 (M31, M10)
A comparison between Bonus-Malus systems
including cost of claims.
Bermúdez L., Morillo I., Proceedings Fourth IME
Congress Barcelona
Most of bonus-malus analysis, only consider the number
of claims in order to determine automobile insurance
premiums in a heterogeneous portfolio. However, a
contract with two claims could be a less cost for
insurance company than a contract with one claim but
higher amount. In this paper the authors introduce the
cost of claims into the bonus-malus scheme. The authors
use different approximations and then the authors
compare them by a numerical example from a real
automobile portfolio. The authors apply, among others,
two-way credibility models and Panjer’s recursion
formula to calculate the distribution of the aggregate
claim amount.
**Keywords:** Bonus malus system, Claim cost.

281052 (M31, M10)
A comparison of Bonus-Malus Systems when using
the cost of claims.
Bolancé C., Guillén M., Artís M., Proceedings Fourth
IME Congress Barcelona
The authors study the behaviour of Bonus-Malus
Systems (BMS) when the cost of claims is taken into
account. They follow the method proposed by Lemaire
(1995), who considers separately the claims that include
medical expenses and the rest. Alternatively, the authors
consider cost thresholds for the claims amount, without
taking into account whether bodily injury occurred.
**Keywords:** Bonus malus system, Claim cost.

281053 (M31, M10)
The actual claim amount and frequency distributions
within a Bonus-Malus System.
Walthin J.F., Paris J., Proceedings Fourth IME
Congress Barcelona
The authors have applied the algorithm of Lemaire and
the non-parametric mixed Poisson fit to a motor
portfolio in order to find the actual claim amount and
frequency distributions that are affected by the presence
of a bonus-malus system due to the desire developed by
drivers for bonus.
**Keywords:** Mixed Poisson distribution, Non-parametric
fit, Bonus-malus system, Hunger for bonus, Claim
amount distribution, Frequency distribution, Censoring,
Maximum likelihood.

281054 (M31, M10)
On distribution-free sequential quasi-credibility.
Landsman Z., Makov U., Proceedings Fourth IME
Congress Barcelona
The traditional linear credibility formula provides an
exact expression for the predictive mean claim when the
conditional loss distributions belongs to the Exponential
Dispersion Family (EDF) (Kaas, Dannaenburg, Goovaerts
(1997), Nelder and Verrall (1997), Landsman and
Makov, (1998)). This credibility formula, which is only
based on the first two moments of the claims, is
universally used mainly due to its simplicity, and is
often regarded as a distribution-free method (Bühlmann,
1967) as it can be used for any claim data, regardless of
the nature of the claim distribution.
However, when the claim size follows a distribution
outside this family, the credibility formula offers an
inaccurate estimation of the mean future claim, because
it fails to take into consideration characteristics like the
extent of the asymmetry and kurtosis of the distribution,
which have shown to be so relevant in actuarial
analysis.
The established analogy between the credibility formula
and stochastic approximation (Landsman an Makov
(1999a,b)) offers a way of devising credibility
estimation for distributions which do not belong to the
EDF, provided that the nature of the distribution is
known. In this paper, the authors suggest a distribution-
free sequential credibility formula, based on the first two
moments plus the coefficients of asymmetry and
kurtosis. The comparison with the traditional credibility
formula demonstrates the improved accuracy of the
proposed method.
**Keywords:** Credibility theory, Distribution free model.

281055 (M31, M10)
Generalised least squares estimators for credibility
regression models with MA errors.
Cossette H., Luong A., Proceedings Fourth IME
Congress Barcelona
Weighted least squares methods are developed for the estimation of variance-covariance parameters of credibility regression models with moving average dependent errors. These models generalise the application of Hachemeister's regression model in the actuarial literature. The estimators proposed are shown to be useful for constructing empirical Bayes estimators, credibility type estimators. The performance of the estimators is examined via a simulation study.

Keywords: Credibility theory, Regression, Hachemeister.

281056 (M31, M10)
Boj F., Claramunt M.M., Vidiella A., Proceedings Fourth IME Congress Barcelona
In this paper, the authors apply two methodologies to select an initial group of tariff variables from a general set of potential risk factors as the first step in the rate making process. They obtain a set of predictors which are significative in the risk structure that the authors want to explain. The two applied selection processes are stepwise procedures, one uses generalised linear models and the other distance-based regression models. An optimal selection method does not exist, therefore, they consider all the proposed methods as alternative tools to assist the actuary, each one with its advantages and disadvantages. Methods are illustrated using a portfolio with real data from an Spanish automobile insurer.

Keywords: Non-life insurance, Rate making, Risk factors, Selection of predictors, Generalised linear model, Distance-based regression model.

M32: DEDUCTIBLES

281057 (M32, M10)
Analysing the Demand for Deductible Insurance.
This paper investigates aspects of insurance demand related to deductible insurance. In particular, an important issue concerning analysis of the optimal deductible level is resolved. A simple sufficient restriction on the pricing of insurance is given which ensures that the second order condition for choosing the expected utility maximising deductible level is met for any risk averse decision maker. This restriction is stated and its sufficiency is demonstrated using the level of expected indemnification rather than the level of the deductible as the choice variable in the decision model.

Keywords: Deductible insurance, Second order conditions.

M40: RESERVES, GENERAL AND MISCELLANEOUS

281058 (M40, M10)
Prediction of Outstanding Liabilities - II Model Variations and Extensions.
This is a follow-up of a previous paper by the author, where claims reserving in non-life insurance is treated in the framework of a marked Poisson claims process. A key result on decomposing of the process is generalised, and a number of related results are added. Their usefulness is demonstrated by examples and, in particular, the connection to the analogous discrete time model is clarified. The problem of predicting the outstanding part of reported but not settled claims is revisited and, by way of example, solved in a model where the partial payments are governed by a Dirichlet process. The process of reported claims is examined, and its dual relationship to the process of occurred claims is pointed out.

Keywords: Claims reserving, Marked Poisson process, Decomposition, Thinning, amalgamation, Dirichlet process, Discrete vs continuous time.

M42: LOSS RESERVES (INCL. I.B.N.R.)

281059 (M42, M10)
Recent Bayesian Methods for Claims Reserving
Hazan A., Makov U.E., Proceedings Fourth IME Congress Barcelona
One of the most important problems facing an actuary dealing with general insurance portfolios is the prediction of the total amount of outstanding claims. The most common technique is the chain ladder (CD), which is universally adopted, mainly due to its simplicity.

Over the last decade there have been attempts to break away from the CD technique and to estimate outstanding claims by means of Bayesian methods, most of which exploited the fact that the CD can be expressed as a linear model. Initially, only empirical Bayes techniques were suggested since complete Bayesian analysis was
computed as prohibited. The last few years saw a
proliferation in the application of Monte Carlo Markov
Chain (MCMC) techniques, which allow the full
implementation of Bayes models. (Hazar, A., 1999,
This paper will present hierarchical Bayes models for
claims reserving and their implementation using the
MCMC technique. The benefits of this approach will be
demonstrated through the analysis of real outstanding
claim data.
Keywords: Claim reserving, Bayesian methods.

M50: GAME THEORY AND DECISION THEORY
IN INSURANCE, GENERAL AND MISCELLANEOUS

281060 (M50, E60)
Informationsmangel im deregulierten
Kraftfahrzeugversicherungsmarkt Ergebnisse aus
einem Experiment mit Studenten.
Wein T., Zeitschrift für die gesamte
Versicherungswissenschaft, No. 1, 2000
Since 1994 the duty for the German insurers to file
contracts by the supervisory authority was abolished. In
automobile-, health- and life insurance the firms are now
able to calculate tariffs without any restrictions.
Especially in the motor vehicle insurance many insurers
introduce their own rating systems. Practical experts fear
that individuals are unable to find their best insurers.
This paper analyses what it means to choose the
appropriate insurer. Secondly, the author used this
concept in an experiment with students who had to
decide between 16 firms. Finally, the author employed
a Logit-model to evaluate the determinants of the
applicable decisions.
Keywords: Decision theory, Appropriate insurance.

M52: REINSURANCE, RETENTIONS

281061 (M52, M10)
Versicherungsmathematische Grundlagen und
Rückversicherungstechnische Aspekte von “Preferred
Lives”-Tarifen.
Pecheim M., Zietsch D., Zwiesler H.J., Blätter, Band
XXIV, Heft 3, April 2000
This article demonstrates the possibilities for the
development of differentiated premium structures for
term life insurance. This is achieved by dividing an
insurance portfolio into subclasses based on medical,
economic, and social factors. The actuarial methods and
assumptions for calculating “Preferred Lives” products
are outlined including a sample “Preferred/Standard”
mortality table. The authors illustrate this through an
example for a “Preferred Lives” tariff on which they
perform various sensitivity analyses. The article
concludes with a detailed description of the part played
by the reinsurer in the implementation of this type of
product.
Keywords: Differentiated premium structure, Term life
insurance.

281062 (M52, M10)
A New Class of Bayesian Estimators in Paretoian
Excess-of-Loss Reinsurance
Reiss R., Thomas M., Astin Bulletin, Vol. 29, No. 2,
November 1999
For estimating the shape parameter of Paretoian excess
claims, certain Bayesian estimators, which are closely
related to the Hill estimator, have been suggested in the
insurance literature. It turns out that these estimators
may have a poor performance – just as the Hill
estimator – if a certain location parameter is unequal to
zero in the Paretoian modelling. In an alternative
formulation this means that a scale parameter is unequal
to 1. Thus, it suggests itself to add the scale parameter
I to the modelling and to deal with Bayesian estimators of
the shape and scale parameters in a full Paretoian model.
These estimators will be illustrated by means of Monte
Carlo simulations.
Keywords: Excess claims, fire and motor reinsurance,
Full Pareto model, Generalized Pareto model, Bayesian
estimators, Hill estimator, Maximum likelihood
estimator.

281063 (M52, M10)
Claiming deviation reinsurance.
Pociello y Javier Sarrasi E., Proceedings Fourth IME
Congress Barcelona
The paper proposes a reinsurance treaty the author has
called the claiming deviation reinsurance, under which
the reinsurer covers the risk of ruin caused by claiming
deviations affecting the insured collective. He considers
a multistate approach modelling in which the Markovian
assumption plays a central role.
By the claiming deviation reinsurance, the reinsurer
must provide annually the necessary amount in the case
the collective is not able to pay the benefits or to cover
the net premium reserve plus the solvency margin that
may be established at the end of the year. The reinsurance premium that must be paid by the insurers will take into account the collective structure. The more it is better, the less the reinsurance premium value is. In the paper the author has considered one special aspect of the structure: the size of the collective. The theoretical exposition is completed by a practical example that combines the claiming deviation reinsurance with the disability Dutch model. It enables numerical results to be obtained.

Keywords: Claiming deviation, Collective insured, Discrete-time Markov model for life contingencies, Disability Dutch model, Reinsurance, Monte Carlo simulation method, Claiming deviation reinsurance.

M54: CATASTROPHIC RISKS

281064 (M54, M10)
Ein Katastrophen-Gruppen-Lebensversicherungsvertrag
Kremer E., Blätter, Band XXIV, Heft 3, April 2000
A model of compartmental model-theory is applied and with it a new group-life-insurance contract on the death risk in rare, bigger events introduced and treated.

Keywords: Comportment model, Life insurance contract.

281065 (M54, M10)
Evolution of the loss ratio of the catastrophe insurance derivatives. The discrete model and the limit to the continuous model.
Pérez Fructuoso M., Alegre A., Devolder P., Proceedings Fourth IME Congress Barcelona
This paper develops, for the random discrete field, a method aimed at calculating the evolution of the underlying loss ratio in the CBOT's Catastrophe Insurance Derivatives. It is based in the system previously carried out for the continuous model in the article titled 'Critical analysis of models of underlying loss ratio of Catastrophe Insurance Derivatives. An alternative model' (Submitted to Insurance. Mathematics and Economics). The authors start considering that only a single K-severity catastrophe may occur in each period. The authors also assume that the probability of occurrence for the catastrophe can be represented by a dichotomic random variable, named $\delta(t)$. In order to calculate the variables which make possible to determine the total amount of losses ($R(t)$, numerator for the loss ratio), it has been considered that the nominal claim reporting rate is in each period a dichotomic random variable. As a result, the frequency of a certain claim reporting rate to happen has a binomial behaviour after $t$ periods.

Finally, the authors show that the continuous model based in a Wiener Process becomes the limit for the random discrete one if the wideness of the periods under consideration tends to 0.

Keywords: Wiener Process, Exponential Distribution, Dichotomic Claim Reporting Rate, Incurred but still not reported claim amount versus binomial, Claim Reporting Process, Limit on distribution.

E: INSURANCE ECONOMICS

281066 (E10)
Market Value of Insurance Liability.
Aazawa T., XXXth International ASTIN Colloquium, 22-25 August 1999, 9th International AFIR Colloquium, 24-27 August 1999
This paper suggests a method to calculate insurance liability as market value to be applied in the situation where management concern arises. Each building block is explained to calculate the market value of the insurance liability. Some key issues are specified.

Keywords: Insurance liability, Market value.

281067 (E10, E13)
Quantile Hedging for Defaaultable Securities in an Incomplete Market.
Sekine J., XXXth International ASTIN Colloquium, 22-25 August 1999, 9th International AFIR Colloquium, 24-27 August 1999
In this paper, the author aims at
- Giving formulas of prices and replicating-strategies of defaultable securities (e.g. bonds, swaps, derivatives) in incomplete market, and
- Giving solvable examples of quantile hedging strategies in incomplete market
Considering an incomplete market that consists of tradable assets and an unhedgeable defaultable security, whose non-predictable default time has stochastic intensity correlated with the tradable assets-price processes, the author treats the problem of pricing and hedging of the defaultable security on it. The author employs the quantile hedging strategy (cf. [F.L.]) to
replicate “the cumulative dividend process” of the defaultable security by an admissible strategy between the tradable assets. The strategy that maximise the success probability of hedge under the given initial capital and the strategy that minimise the success probability of hedge under the given initial capital and the strategy that minimise the initial capital under the given success probability of hedge are calculated explicitly.

Keywords: Quantile-hedging, Defaultable security, Incomplete market, Neyman-Pearson’s lemma.

281068 (E10, B13)
Asset-Liability Modelling for Pension Schemes.
Wilkie D., XXXth International ASTIN Colloquium, 22-25 August 1999, 9th International AFIR Colloquium, 24-27 August 1999

The background to this paper is that what are called “pension funds” in some Member States of the European Union (EU) are in effect specialised life insurance companies who write individual pension policies anyone who risks to subscribe to such a contract. They are sometimes referred to as “open pension funds” and they are quite different from the “closed pension funds”, common in the Anglo-Saxon countries and in the Netherlands (and elsewhere), which are sponsored by one employer for that employer’s employee only. Often the employer stands behind the closed pension fund, and guarantees (up to a point) the benefits that have been promised.

The regulations for supervising pension funds within the EU have not been harmonised, although the supervision of insurance companies has been through the Third Life and Non-Life Directives. There is some pressure on the one hand for it to be possible to arrange pension funds on a cross-border basis (which would help multinational employers) and on the other hand for pension funds to be supervised in a similar way in all Member States.

The European Federation for Retirement Provision (EFRP) represents the associations of pension funds in the separate Member States. Its officers were anxious that the form of regulation that is found for some of the open type of pension funds, some of which is quite appropriate for life insurance companies, should not be applied to closed pension funds, which are seen as being quite different.

In particular, in some Member States there are restrictions on the maximum proportion of the assets that an open pension fund may invest in “risky” securities, such as ordinary shares, and in some there are requirements that a certain minimum proportion of the assets should be invested in government bonds, which are seen as safer investments.

Keywords: Asset liability model, Pension schemes.

281069 (E10, E11)
The Aversion to the Sequential Resolution of Uncertainty.

This paper sets forth and offers an explanation for preferences for the form of the timing of resolution of uncertainty; namely for uncertainty to be resolved all at one time rather than sequentially. The explanation is based on a weakening of the independence axiom, in particular on the notion of disappointment aversion developed in Gul’s (1991) axiomatic model of preferences. Implications of this aversion are discussed for issues in finance, intertemporal decision making under uncertainty, high stakes risky situations and consumer self-regulation. The analysis encourages a formulation of preferences over all attributes of interest to the decision maker, including psychological satisfaction.

Keywords: Uncertainty resolution, Sequential timing, Anxiety, Disappointment, Expected utility axioms.

281070 (E10, E11)
Reanalysis of the Chechile-Cooke Experiment: Correcting for Mismatched Gambles.

Chechile and Cooke (1997) experimentally tested a broad class of utility models subsumed under the Miyamoto (1988, 1922) generic utility theory. The Chechile and Cooke study required participants to match on each trial, a fully specified reference gamble to a partially specified comparison gamble by adjusting the probability of a win on the comparison gamble. The Chechile and Cooke experiment however, contained a subset of trials which were intrinsically unmatchable. In such cases, the participants could only give an extreme probability (either 0 or 1). In this paper, those extreme trials were omitted and the results from the experiment reanalyzed. Despite the mismatch problem, the conclusions of the Chechile and Cooke experiment were again supported. For nine implementations of generic utility there is a model failure due to the systematic variation of a parameter that should be constant.

Keywords: Generic utility theory, Subjective equivalence
of gambles, Context-dependent utility scaling.

281071 (E10, E11)
Analysis of Choice Expectations in Incomplete Scenarios.
This paper studies the use of probabilistic expectations data to predict behaviour in incomplete scenarios posed by the researcher. The information that respondents have when replying to questions posing incomplete scenarios is a subset of the information that they would have in actual choice settings. Hence such questions do not elicit pure statement of preference; they elicit preferences mixed with expectations of future events that may affect choice behaviour. The analysis developed here assumes respondents recognise that their behaviour may depend on information they do not have when expectations are elicited, and that they answer coherently and honestly given the information provided. The objective in imagining such ideal respondents is to place a logical upper bound on the predictive content of elicited choice expectation.

Keywords: Hypothetical Choice, Intentions, Revealed preference, Scenarios.

281072 (E10)
Construal Processes in Preference Assessment.
Interpreting people’s preferences requires understanding how they have construed their tasks, interpreting the proposed alternatives in the context where the evaluation is being made. With stylised experimental or survey choices, researchers’ challenge is typically identifying the features that people add in order to make their task real enough to answer (i.e. how they read between the lines). With rich “real world” choices, researchers’ challenge is typical identifying the features that people neglect, as they reduce their task to manageable complexity (i.e. which lines they choose to read). In either case, if people misunderstand or mistrust the stated transaction, they may evaluate a different offer than the one that was proposed. Such misconstruals are a nuisance for investigators, insofar as dealing with them delays the measurements that motivated the research. However, they can also provide an opportunity, by focusing attention on how people give meaning to choice situations. This article describes procedures for studying construal processes, strategies for getting people to answer the questions that interest researchers, and options for interpreting responses when people construe questions differently than was intended.

Keywords: Preferences, Elicitation, Construal, Values, Environment.

281073 (E10)
Measuring Constructed Preferences: Towards a Building Code.
A “building code” for preference measurement is needed in a world in which many expressions of preference are constructed when people are asked a valuation question. Construction of preferences means that preference measurement is best viewed as architecture (building a set of values) rather than as archaeology (uncovering existing values). The authors describe potential faults in the process of preferences construction, other guidelines for measuring constructed preferences (a “building code”) to mitigate these defaults, and discuss how the code must be sensitive to the purpose of the valuation (design vs. prediction).

Keywords: Constructive preferences, Value measurement, Decision aiding.

281074 (E10)
The Affect Effect in Insurance Decisions.
The authors use insurance behaviour as a context to study affective influences in seemingly purely monetary decisions. The authors report two related findings. First, people are more willing to purchase insurance for an object at stake, the more affection they have for the object, holding the amount of compensation constant. Second, if the object is damaged, people are also more willing to go through the trouble of claiming a fixed amount of compensation, the more affection they have for the object. These effects are not predicted by standard decision theories. The authors explain these findings by a “consolation hypothesis”, according to which, people perceive insurance compensation as a token of consolation, and they discuss its implications for affective influences in other types of decisions.

Keywords: Affect, Insurance, Consolation.

281075 (E10)
Which Error Story is Best?
Carbone E., Hey J.D., Journal of Risk and Uncertainty,
Two recent papers, Harless and Camerer (1994) and Hey and Orme (1994) are both addressed to the same question: which is the ‘best’ theory of decision making under risk? As an essential part of their separate approaches to an answer to this question, both sets of authors had to make an assumption about the underlying stochastic nature of their data. In this context this implied an assumption about the ‘errors’ made by the subjects in the experiments generating the data under analysis. The two different sets of authors adopted different assumptions: the purpose of this current paper is to compare and contrast these two different error stories – in an attempt to discover which of the two is the ‘best’.

Keywords: Errors, Decision making under risk, Experiments.

281076 (E10, B13)
Scenario Generation for the assets-liabilities management of a pension fund.
Manuela Bosch Princep M., Dominguez Fabián I., Proceedings Fourth IME Congress Barcelona

For the management of a Pension Fund portfolio it is necessary to take account the evolution over the time as the assets to invest as the development of liabilities of a Pension Fund.
The authors analyse the assets returns and the factors to evaluate the liabilities. The past of these parameters is analysed statistically and the authors conclude with a Vector Error Correction Model (VECM) to modelling their own behaviours. They simulate different tracks of the each parameter with a probability of occurrence associated to each track. This process is the scenario generation and consists on define several tracks of future behaviour for each return and factor. The scenarios are generated in such a way that future states of the worlds reflect the intertemporal relationships between state parameters and the variety of the states of the world are enough to capture all future circumstances that one would want to reckon with. The objectives obtained with scenario generation are two: The first one is the forecast of the future tracks of the parameters and the second one is the risk analysis knowing the probability of adverse results.

Keywords: Asset-Liability Management (ALM), Scenario Generation, Forecast, Risk Analysis.

281077 (E10, B13)
More on the control of pension funds: optimal contribution and asset strategies.
Hong-Chih Huang, Cairns A.J.G., Proceedings Fourth IME Congress Barcelona

Conventionally, pension plan contribution rates have been set with reference to fund levels and without making allowance for current market interest rates; for example, on one-year bonds where rates of return on fund assets are not independent from one year to the next. The authors consider how to make use of market information to reduce contribution rate volatility. The purpose of this study is to provide a model for determining an appropriate contribution rate for defined benefit pension plans under stochastic rates of return.

In an attempt to make a more realistic allocation of the total assets for investment the authors consider using a variety of assets in the portfolio and, in this paper, the authors develop a method for calculating the necessary mathematical formulae. The authors build theoretical formulae and then discuss the efficiency of improving the variance of fund size and contribution rate.

Furthermore, they investigate the optimal contribution rate and investment strategies for various objective functions and constraints.

For the purpose of considering more realistic assumptions and using realistic investment model (for example, the Wilkie Model) in a pension scheme, in this paper the authors also investigate the optimal control of the contribution rate by means of stochastic simulation.

Keywords: Pension schemes, Asset management, Contributions.

281078 (E10, B13)
On the Demographic and Economic Risks of a Pension Plan.
Bilodeau C., Proceedings Fourth IME Congress Barcelona

The economic risk is the risk by random rates of return.
The demographic risk is the uncertainty associated with the number of people changing status each year.

Whereas the demographic risk is diversifiable, the economic risk is not. In the case of life insurance, with death as the only decrement, Parker (1997) has shown that the economic risk quickly surpasses the demographic risk as the number of insureds increases.
The author extends the work to pension plans, with multiple decrements, and examine the rate at which the economic risk gains in importance over the demographic risk.

Keywords: Pension schemes, Demographic risk.
281079 (E10, B13)
Pension Metrics - Stochastic Pension Plan Design and Value-at-Risk during the Accumulation Phase.
Blake D., Cairns A., Dowd K., Proceedings Fourth IME Congress Barcelona
The authors estimate values-at-risk in the accumulation phase of defined contribution pension plans. They examine a range of cost return models (including stationary moments, fundamentals and regime switching models) and a range of asset allocation strategies (including lifestyle and threshold). They draw three conclusions from the investigations. First, the authors find that DC plans can be extremely risky relative to a defined benefit benchmark (far more so than most pension plan professionals would be likely to admit). Second, the authors find that the VaR estimates are, to some extent, sensitive to the asset-return model used, and more so to the parameter values used in the individual asset return models. Third, the static, pension-fund-average asset strategy delivers substantially better results than any of the dynamic strategies investigated over the long term (40 years) of the sample policy. This is important given that lifestyle strategies are the cornerstone of many DC plans.

Keywords: Pension Schemes, Value at risk.

281080 (E10, E13)
Optimal Insurance Trading: Full Insurance with Unfair Prices and Asymmetric Information.
Penalva Zuasti J.S., Proceedings Fourth IME Congress Barcelona
In this paper, the author analyses trading behaviour in an economy with substantial individual heterogeneity and individual agent-specific endowment risks. The author establishes that markets can be made effectively complete with a very small number of assets. In particular, if full insurance contracts are available, agents will only actively trade in two assets: a mutual fund and a bond. The author also establish that contrary to standard results in the insurance demand literature, agents’ optimal insurance demand can include in equilibrium full insurance in the presence of insurance prices which are actuarially unfair and that this demand will be independent of the correlation of insurance payments and the payments of other assets. Finally, the author introduces asymmetric information concerning agents’ risks into the economy and he show that adding a restriction on agents’ possible insurance trades rather than introduce additional inefficiencies serves to ensure the attainability of efficient net trades.

Keywords: Insurance trading, Asymmetric information.

281081 (E10)
Financial Engineering of Property/Casualty Insurance Cash Flows
Mutenga S., Dinenis E., Punter A., Proceedings Fourth IME Congress Barcelona
This paper delves into the issue of insurance company financial structures. The capital structure puzzle affects insurance companies on a grand scale than it does any other enterprise, so the study uses risk engineering techniques to show that optimal capital structures are a function the costs embedded in transacting risk. Insurance cash flows need to be engineered in order to optimise portfolio profitability and insurance companies’ financial structure. Techniques used in the study assess cash flow behavioural characteristics and then match them to risk financing instruments that best explain underlying cash flow behaviour. Cash flow peculiarities at each level of the collective risk distribution are dealt with and localised according to their attributes with the ultimate goal of optimising insurance company financial structures.

Keywords: Property insurance, Casualty insurance, Cash flows.

281082 (E10, B10)
A Finite Difference Approach to the Valuation of Path Dependent Life Insurance Liabilities.
Jensen B., Locht Jorgensen P., Grosen A., Proceedings Fourth IME Congress Barcelona
This paper sets up a model for the financial valuation of traditional participating life insurance policies. These claims are characterised by their explicit interest rate guarantees and by various embedded option elements, such as bonus and surrender options. Owing to the structure of these contracts, the theory of contingent claims pricing is a particularly well-suited framework for the analysis of their valuation. The eventual pay-offs from the contracts considered crucially depend on the history of returns on the insurance company’s assets during the contract period. This path-dependence prohibits the derivation of closed-form valuation formulas but the authors demonstrate that the dimensionality of the problem can be reduced to allow for the development and implementation of a finite difference algorithm for fast and accurate numerical evaluation of the contracts.

Keywords: Financial valuation, Participating Life
insurance policies.

**E12: UTILITY THEORY**

**281083 (E12, E10)**
Choice Bracketing.
When making many choices, a person can broadly bracket them by assessing the consequences of all of them taken together, or narrowly bracket them by making each choice in isolation. The authors integrate research conducted in a wide range of decision context which shows that choice bracketing is an important determinant of behaviour. Because broad bracketing allows people to take into account all the consequences of their actions, it generally leads to choices that yield higher utility. The evidence that the authors review, however, shows that people often fail to bracket broadly when it would be feasible for them to do so. In addition to documenting the diverse effects of bracketing, they also discuss factors that determine whether people bracket narrowly or broadly. The authors conclude with a discussion of normative aspects of bracketing and argue that there are some situations in which narrower bracketing results in superior decision making.

**Keywords:** Decision framing, Simultaneous and sequential choice addiction, Procrastination, Risk attitude.

**281084 (E12, E10)**
Economic preferences or Attitude Expressions: An Analysis of Dollar Responses to Public Issues.
Participants in contingent valuation surveys and jurors setting punitive damages in civil trials provide answer denominated in dollars. These answers are better understood as expressions of attitudes than as indications of economic preferences. Well-established characteristics of attitudes and of the core process of affective valuation explain several robust features of dollar responses: high correlations with other measures of attractiveness or aversiveness, insensitivity to scope, preference reversals, and the high variability of dollar responses relative to other measures of the same attitude.

**Keywords:** Preferences, Attitudes, Contingent valuation, Psychology and economics, Utility assessment.

**281085 (E12, E10)**
Utility Function for Wealth.

The authors specify all utility functions on wealth implied by four special conditions on preferences between risky prospects in four theories of utility, under the presumption that preference increases in wealth. The theories are von Neumann-Morgenstern expected utility (EU), rank dependent utility (RDU), weighted linear utility (WLU), and skew-symmetric bilinear utility (SSBU). The special conditions are a weak version of risk neutrality, Pfanzagl’s consistency axiom, Bell’s one-switch condition, and a contextual uncertainty condition. Previous research has identified the functional forms for utility of wealth for all four conditions under EU, and for risk neutrality and Pfanzagl’s consistency axiom under WLU and SSBU. The functional forms for the other condition-theory combinations are derived in this paper.

**Keywords:** Expected utility, Rank dependent utility, Weighted utility, Skew-symmetric bilinear utility, Consistency axiom, One-switch condition, Contextual uncertainty.

**281086 (E12, E10)**
The Construction of a Simple Book
A book is made for a horse race, and punters place their bets. The problem considered here is how the bookmaker should construct his book. Before this can be solved, it has to be determined how the punters will react to any proposed book. Much of the detailed discussion is confined to a race with two horses, though some results apply in the general case; The punters’ problem is solved using a utility function, special attention being paid to the case of constant risk-aversion. Two solution are provided for the bookmaker’s problem, dependent on whether it is desired to maximize expected gain, or achieve the same gain whatever horse wins.

**Keywords:** Book, Risk-aversion, Over-round, Personal probability, Price-utility, Minimax.

**281087 (E12, E10)**
Just Who are You Calling Risk Averse?
This paper estimates individual risk preferences based
upon data that are generated by the same individuals acting in different institutions. The results show that the (estimated) numerical values of individuals’ implied risk parameters are not stable within individuals across institutions. Furthermore, the ranking across subjects of the numerical values of individuals’ implied risk parameters is not preserved across institutions.

Keywords: Risk aversion, Laboratory experiments.

281088 (E12, E10)  
Is “Generic Utility Theory” a Suitable Theory of Choice Behaviour for Gambles with Mixed Gains and Losses?  
Miyamoto’s (1988,1992) generic utility theory (GUT) subsumes a broad class of bilinear utility models. Chechile and Cooke (1997) tested the GUT class of models and found model failure due to the systematic variation of a parameter that should be a positive constant across a range of contexts. In the current study, an improved experimental design is employed to evaluate utility theory. The current study provides further evidence against the GUT class of models for mixed gambles. Moreover, evidence is also provided to demonstrate individual behaviour that is incompatible with coherent bilinear utility theory of choice behaviour in the context of mixed gambles with gains and losses.

Keywords: Generic utility theory, Theory of choice behaviour, Context dependent utility scaling.

281089 (E12, E10)  
The Economics of Insurance: A Review and Some Recent Developments.  
Denuit M., Dhaene J., van Wouwe M., Schweizerische Akuarverein, Mitteilungen, Heft 2, 1999  
The present paper is devoted to different methods of choice under risks in an actuarial setting. The classical expected utility theory is first presented, and its drawbacks are underlined. A second approach based on the so-called distorted expectation hypothesis is then described. It will be seen that the well-known stochastic dominance as well as the stop-loss order have common interpretations in both theories, while defining higher degree stochastic orders leads to different concepts. The aim of this paper is to emphasise the similarities of the two approaches of choice under risk as well as to point out their major differences.

Keywords: Utility Theory, Distorted expectation hypothesis.

281090 (E12, B10)  
Iwaki H., Kijima M., Komoribayashi K., Proceedings Fourth IIE Congress Barcelona  
This paper considers an optimal life insurance for a householder subject to mortality risk. The household receives a wage income continuously, which is terminated by either the householder’s death of retirement, whichever happens first. In order to hedge the risk to lose the income by an unpredictable death, the household enters a life insurance contract by paying a premium to an insurance company. The household may also invest their wealth into a financial market. The problem is to determine an optimal insurance/investment strategy in order to maximise the expected total discounted utility from consumption and terminal wealth. To their best knowledge, such a model is new in the insurance literature. It is shown that an optimal solution exists under a fairly general situation, and the optimal insurance is, in general, a stochastic process in contrast to practical situations. The case of exponential utilities is considered in detail to derive an explicit solution with numerical experiments.

Keywords: Life Insurance, Investment/Consumption Model, Martingale, Exponential Utility.

E13: PORTFOLIO THEORY

281091 (E13, E10)  
Generalised Expected Utility, Heteroscedastic Error, and Path Dependence in Risky Choice.  
The authors evaluate the fit of several generalised expected utility models under homoscedasticity and three different heteroscedastic error structures for the data set first reported in Hey and Orme (1994). Standard chi-squared tests are used for nested test, and both the Akaike (1973) information criterion and its consistent version (Hurvich and Tsai 1989) are used for non-nested ranking of these models. A testing framework is developed that explicitly accounts for the path-dependent on the error structure assumed, but the reverse is also true: the selection of the error structure depends on the preference structure assumed.

Keywords: Generalised-expected utility, Heteroscedastic error, Path-dependence.
281092 (E13, M10)
HJB equations with stochastic interest rates and HARA utility functions.
Grasselli M., Proceedings Fourth IME Congress Barcelona
The author studies an investment problem in a continuous-time framework where the interest rates follow the Cox-Ingersoll-Ross and extended Vasicek dynamics. The optimal investment strategy is obtained in explicit form under the hypothesis that financial markets are complete and that utility functions belong the HARA, exponential and extended logarithmic class. Moreover, he find a stability result of the HARA utility class: the optimal investment strategy and wealth process corresponding to the exponential (resp. extended logarithmic) utility function are the $P - a.e.$ limit of the optimal strategy and wealth corresponding to HARA utility function as its parameter $\gamma$ goes to $-\infty$ (resp. to 0).
Keywords: Stochastic optimisation complete markets, Stochastic interest rates.

281093 (E13, M10)
Factorial Duration under a Three Factor Model of the Term Structure.
Galisteo M., Fontanals H., Proceedings Fourth IME Congress Barcelona
In this paper, the authors present a risk management application under a three factor model of the term structure of interest rate. The factors of the model are two spreads and the long-term interest rate. The spreads are modelled by a Ornstein-Uhlenbeck process that it let negatives values and the long-term interest rate follows a square root process with mean reverting to preclude negative rates. Applying the non-arbitrage condition and including a non-constant but simple definition for the premium risk, the authors obtain a closed form solution for the price of a discount bond. The discount function expression lets us to obtain the closed-form solution for factorial durations and convexities. These expressions are associated to parallels, slope and curvature shifts, so the authors have information about the market risk (parallels shifts) and the coupon zero curve risk (associated to non-parallel variations of the curve).
Keywords: Term Structure of interest rates, Factorial duration, Factorial convexity, Stochastic Process, Three factor model.

281094 (E13, E50)
On the Relevance of Modelling Volatility for Pricing
Purposes
Moreno M., Proceedings Fourth IME Congress Barcelona
This paper presents a two-factor (Vasicek-CIR) model of the term structure of interest rates and develops its pricing and empirical properties. It assumes that default free discount bond prices are determined by the time to maturity and two factors, the long-term interest rate and the spread. Assuming a certain process for both factors, a general bond pricing equation is derived and a closed-form expression for bond prices is obtained. Empirical evidence of the model’s performance in comparison with a double Vasicek model is presented. The main conclusion is that the modelling of the volatility in the long-term rate process can help (in a large amount) to fit the observed data and van improve – in a reasonable quantity – the prediction of the future movements in the medium- and long-term interest rates. However, for the shortest maturities, it is shown that the pricing errors are, basically, negligible and it is not so clear which is the best model to be used.
Keywords: Term Structure of Interest Rates, Bond Pricing Equation, Two-Factor Models, Ornstein-Uhlenbeck Process, CIR Process.

E20: MACRO-ECONOMIC INFLUENCES, GENERAL AND MISCELLANEOUS

281095 (E20, E40)
Cost Perceptions and Voter Demands for Environmental Risk Regulation: The Double Effect of Hidden Costs
This paper reports the first detailed empirical examination of the effects of voter cost perceptions on demand for environmental risk regulations. Using a statewide random sample of Washington’s electorate, I examine voting behaviour for a proposed regulation of gasoline stations under varying cost and distributional assumptions. Results suggest normative concerns are as important in explaining support as are expected risk reduction benefits. These norms include making polluters pay, imposing larger burdens on polluters with higher ability to pay, and enforcing public property rights. In contrast, potential price increases as a result of regulation have negligible effects on voter support.
Keywords: Environmental regulation, Norms, Efficiency, Voter perceptions, Distribution, Information.
281096 (E20, B10)
Workers’ Compensation and Family and Medical Leave Act Claim Contagion.
At $60 billion per year, the workers’ compensation system has come under increased scrutiny as firms, insurers, and researchers study the dynamics of claim filing. The Family and Medical Leave Act also covers most workers, and there has been very little research concerning the effects of FMLA legislation on employment. One hitherto neglected research area in both workers’ compensation and FMLA is claim contagion. That is, as a claim is filed within a workgroup, does this increase the likelihood that others within the same workgroup will also file claims? The authors find the answer to be yes. The authors also find that this contagion effect is subject to diminishing returns to scale, however, in the sense that the claims probability increases at a decreasing rate as fellow employees’ claims frequency increases. They argue that this is consistent with a model in which workers learn about filing a workers’ compensation or FMLA claim from other workers.
Keywords: Moral hazard, Contagion, FMLA.

E24: EMPLOYMENT

281097 (E24)
Do Wages Compensate for Risk of Unemployment - Parametric and Semiparametric Evidence from Seasonal Jobs.
Due to unique institutional and technological factors seasonal agricultural jobs are characterised by much higher risk of unemployment than similar permanent jobs. The author estimates compensating differentials for risk of unemployment insurance benefits provided by the government. Two sets of estimators are used. First, the author calculates parametric estimates with Heckman correction. Second, he computes three versions of a distribution-free semiparametric estimator which is robust to misspecification of the residual distribution. The main finding of the paper is that there exists a positive compensating differential of 15.5% of the average wage. This corresponds to an implicit replacement rate significantly larger than the typical unemployment benefit.

281098 (E40, B40)
Patterns of Auditing in Markets with Fraud: Some Empirical Results from Automobile Insurance.
Pau Salsas-Forn, Tennyson S., Proceedings Fourth IME Congress Barcelona
Optimal audit strategies for an insurer faced with potentially fraudulent or exaggerated claims have been extensively studied from a theoretical perspective. While the theoretical models differ in their assumptions regarding the nature of fraud, the insurer’s information set, and the ability of the insurer to precommit to an audit strategy, many common predictions about optimal insurer behaviour arise. This paper provides an empirical assessment of insurer’s audit and payment strategies in an automobile insurance market, using a detailed data set on the disposition of over 1200 first party personal injury protection (PIP) claims settled in the state of Massachusetts. The paper analyses insurer audit and payment practices to shed light on the relationship of observed practice to theoretical predictions.
Keywords: Fraud, Motor Insurance.

281099 (E40, B40)
Detection of automobile insurance fraud with discrete choice models and misclassified claims.
Artis M., Ayuso M., Guillén M., Proceedings Fourth IME Congress Barcelona
The insurance industry is concerned with the active detection of fraud behaviour. The quantity of automobile claims involving some kind of suspicious circumstances is large and has become a subject of major interest among companies. Several methodologies have already been used to establish alert indicators for new claims. The aim is to use discrete choice models that can be helpful to predict the probability of fraud and, therefore, insurers may increase the number of fraud claims that are detected. The explanatory nature of this kind of models also serves to identify alert indicators. The approach of the paper uses binary choice models to analyse the probability of fraud. In this work, the authors also use the concept of misclassification. Some databases that can be analysed for fraud detection contain claims in which fraud was detected and claims
that were considered as honest. Those claims that were classified as honest can certainly be undetected frauds; therefore an omission error could have been committed. The work shows the performance of binary choice models in this context and implements the model for misclassification in the response variable. The authors use a database from the Spanish insurance market, that contains honest and fraud claims. The results show that parameter estimates differ slightly when the omission error is taken into account. The estimation of the probability of omission provides an estimate of the percentage of fraud claims that are not detected by the logistic regression model. They implement several robust parameter estimators, which are also useful to identify outlying claims.

Keywords: Motor insurance, Fraud.

E42: MARKETING, PUBLICITY

281101 (E42, E61)
Kundenbindung in der Versicherungswirtschaft - Neo-Institutioneneökonomische Analyse und Marketingpolitische Ansatzpunkte.
Schäfer H., Zeitschrift für die gesamte Versicherungswissenschaft, No. 1, 2000
In the 90s a shift from a supply-driven to a demand-driven insurance market has taken place in Germany, and insurance companies have started to create customer loyalty by orientating their marketing policies towards the creation of and maintenance of long-term relationships. However, in the case of insurance services, uncertainty and the 'information' factor play an important role. Therefore this article develops the characteristics of insurance services by using the paradigm of information economics and subsequently demonstrates the importance of trust in creating and maintaining long term insurer customer collaboration. Finally the economic implications of relational effects on customer and insurers are set forth. It can be shown that customer loyalty is mainly the result of successful management of customer relation.

Keywords: Marketing, Insurance services.

E50: FINANCE, GENERAL AND MISCELLANEOUS

281102 (E50, E10)
Die Asset Management Gesellschaft im Versicherungswesen - Gestaltungsmöglichkeiten, Problemfelder.
Müller U., Zeitschrift für die gesamte Versicherungswissenschaft, No. 1, 2000
The first part of the paper deals with the basic legal and organisational conditions, which are important in the case of insurance matters when founding an Asset Management. Its main emphasis deals with criteria which must be met when assuming the taking over of functions in the sense of § 5 subparagraph 3 no. 4 VAG. The author holds the opinion that insurance companies which hand over the above mentioned functions to an Asset Management company, exercise certain rights to advise this company.

The second part is concerned with practical problems which arise in terms of organisational matters whenever a handing over of functions takes place from a legal point of view as mentioned in the first part of the paper.

Finally, the opinion is taken that due to the remaining responsibility of the financial executive officers in insurance companies, Asset Management companies dealing with the assets of insurance companies have limited power.

Keywords: Asset management.
that a hazard of the defined severity – such as a flood or an earthquake – has occurred at the locality.
The pure-risk initial price is derived, as a function of the anticipated payment frequency and the compound investment rate achievable on the accumulated funds. Also derived are expressions for the variance and coefficient of variation of the present worth of payment for a single bond or aggregation of bonds. Funds which support ‘perpetual’ bonds diverge, to either a very large positive or negative value. An Edgeworth expansion of the probability distribution function of the Present Worth of payments in terms of the first five moments is used to derive the probability of a deficit; this is verified by simulation, as is an expression for the maximum time for which the fund is vulnerable to a deficit on the first payment. ‘Perpetual’ bonds would need a feedback mechanism to stabilise the fund.
Because payments (for a single locality and payments frequency) are perfectly correlated, bonds are feasible as a means of financing disaster losses only if: (1) the fund can borrow against future income whenever in deficit; and/or (2) funds are pooled from locations with small (or, better, negative) correlation of payment-events. Despite these disadvantages, bonds may be a feasible mechanism for overcoming a shortage of risk capital for catastrophe insurance in particular regions.

**Keywords:** Disaster bonds, Pricing.

**281104 (E50, E10)**


C. Giraldi C., Susinno C.F., Berti G., Brunello J., Buttazzoni S., Cenciarelli G., Daroda C., Stamegna G., *Proceedings Fourth IME Congress Barcelona*

In this paper, the authors describe life insurance contracts as a portfolio of financial options. This formalisation is justified by a close examination of a typical life insurance contract which reveals an exchange of options between policy holders and the insurance company. The latter is short a floor option (the minimum guaranteed return) on the fund and long a call on the fund excess return relative to the floor. From an insurance company’s point of view, this amounts to holding a portfolio of financial options vis-à-vis the client (the most common types of options included in insurance contracts are the *standard European* and *cliquet options*). This framework van be successfully used to support strategic decisions at a firm-wide level: return on risk capital, product design and innovation, risk management, asset benchmark selection and hedging strategies.

**Keywords:** Asset Liability Management, Financial Options.

**281105 (E50, B10)**

*Mortality Derivatives and the Option to Annuitize.*

Milevsky M.A., Promislow S.D., *Proceedings Fourth IME Congress Barcelona*

Many U.S.-based insurance companies offer holders of their tax-sheltered savings plans the long-term option to annuitise their policy at a pre-determined rate over a pre-specified period of time. The authors argue that the insurance company has essentially granted the policyholder an option on two underlying stochastic variables: future interest rates and future mortality rates. Consequently, in this paper the authors value mortality-contingent claims, by stochastically modelling the future *hazard plus interest* rate. Heuristically, the authors treat the underlying life annuity as a defaultable coupon-bearing bond, where the default occurs at the exogenous time of death. This framework lets us employ a reduced-form model for the term structure of corporate bonds. From an actuarial perspective, rather than considering the force of mortality, (hazard rate) at time *t* for a person now age *x*, as a number *μ*(t), the authors view it as a random variable *μ*(t), whose expectation is the force of mortality in the classical sense: *(μ*(t) = *E*[*μ*(t)]). The main observation is that both mortality and interest rate risk can be hedged, and the option to annuitise can be priced by locating a replicating portfolio involving insurance, annuities and default-free bonds. The authors provide both a discrete and continuous-time pricing framework, and then calibrate the model using observed annuity prices from a Canadian database that the authors have compiled.

**Keywords:** Mortality derivatives, Life annuity.

**281106 (E50, E61)**

*An Option Pricing Approach to Pricing Guarantees given under UK Untised With- Profit Policies.*

Willder M., *Proceedings Fourth IME Congress Barcelona*

Untised with-profit policies in the UK guarantee that the unit price will increase at a guaranteed rate up to maturity (or at least the units are guaranteed not to fall in value). In this paper the author show how these guarantees can be matched by put options. Further, the author shows how the maturity proceeds of untised with-profit policies using the option pricing approach compare with unit-linked policies with no guarantees.
under a number of stochastic simulations.
Keywords: Option pricing, Put options, Unit linked policies.

E60: SURVEYS, GENERAL AND MISCELLANEOUS

281107 (E60, E10)
Matsuyama N., XXXth International ASTIN Colloquium, 22-25 August 1999, 9th International AFIR Colloquium, 24-27 August 1999
Japanese life insurers are often requested by their corporate pension customers to disclose their baseline portfolios for general accounts. In current low yield and negative spread situation for life insurers, baseline portfolio strategies would be, if possible, different from immunised portfolio and result in more risky asset mix. As a feasibility study of the optimal asset mix for general account, the author refers to implications of basic financial theory, Merton’s problem and option theory, numerical techniques for financial modelling and its fitness to algorithm for dynamic optimisation.
Keywords: ALM, Baseline Portfolio, Dynamic Programming, Option Theory, Utility theory.

281108 (E60, E20)
Pretrial Bargaining in the Face of a Random Court Decision: Evidence from Laboratory Games.
If negotiations over ownership of an asset is unsuccessful, agents go to court to determine possession. Experiments examine how the presence of a stochastic court decision affects pretrial bargaining behaviour. Two players have private information over the value of an asset, owned by one player. If there is no acceptable trade price, a random court decision assigns ownership. The impact of a second stage court decision on bargaining outcomes and the efficiency of trades is measured. Court reduce the total earnings of players and the frequency of efficient trades. Relative earnings and bargaining behaviour depend on which agent proposes the trade price.
Keywords: Bargaining, litigation, experiments.

281109 (E60, E10)
The Effects of Financial Incentives in Experiments:
A Review and Capital-Labor-Production Framework
The authors review 74 experiments with no, low, or high performance-based financial incentives. The modal result is no effect on mean performance (though variance is usually reduced by higher payment). Higher incentive does improve performance often, typically judgement tasks that are responsive to better effort. Incentives also reduce “presentation” effects (e.g., generosity and risk-seeking). Incentive effects are comparable to effects of other variables, particularly “cognitive capital” and task “production” demands, and interact with those variables, so a narrow-minded focus on incentives alone is misguided. They also note that no replicated study has made rationality violations disappear purely by raising incentives.
Keywords: Experimental economics, Rationality, Bounded rationality, Judgement, Incentives, Experimental methodology.

281110 (E60)
Rationality for Economists?
Rationality is a complex behavioural theory that can be parsed into statements about preferences, perceptions and process. This paper looks at the evidence on rationality that is provided by behavioural experiments, and argues that most cognitive anomalies operate through errors in perception that arise from the way information is stored, retrieved, and processed, or through errors in process that lead to formulation of choice problems as cognitive tasks that are inconsistent at least with rationality narrowly defined. The paper discusses how these cognitive anomalies influence economic behaviour and measurement, and their implications for economic analysis.
Keywords: Rationality, Behavioural decision theory, Preferences, cognition.

E61: NATIONAL SURVEYS

281111 (E61, E40)
Kariya T., XXXth International ASTIN Colloquium, 22-25 August 1999, 9th International AFIR Colloquium, 24-27 August 1999
From a viewpoint of a financial engineering paradigm, the author develops an argument on recent movements in finance and insurance in Japan. The argument is made in view of risk and functional finance for the efficiency of capital. Among others, the author foresees a convergence of finance and insurance to “finurance” in the near future, in which households and firms optimise their overall risk positions in life-cycle and business. It is also argued that financial technology together with information technology accelerates the trend of functional finance and will provide products to complete an incomplete system for risk optimisation. Analytically the author observes that a discrete time approach to credit risk analysis in financial engineering makes a bridge between finance and insurance and demonstrate the valuation of the premium of a life insurance and the price of an earthquake bond via the no-arbitrage concept.

Keywords: Financial technology, Insurance, Japan.

281112 (E61, E40)
The impact of Institutional Change on Compensating Wage Differentials for Accident Risk: South Korea, 1984-1990.
Institutional change can lead to substantial changes in the size of compensating differentials for workplace accident risk. The South Korean labor market experienced two major institutional changes between 1984 and 1990. First, a relaxation of restrictions on Korean labor unions in 1987 led to a sharp jump in the extent of strike activity and bargaining rounds which was associated with a reduction in the size of compensating differences. Second, reform of Korean workers’ compensation in 1989 led to a substantial rise in benefits that also served to reduce the extent of compensating differentials.

Keywords: Compensating differentials, Institutional change, Unions, Workplace accident risk, Workers’ compensation.

281113 (E61, M12)
Insurance Risk Assessment on Building and Structures Around Peninsular India Against Hurricane.
Sarkar D., Proceedings Fourth IME Congress Barcelona
India is open now for International Insurance Sector to operate and play. The need has now come to develop a sensible “Risk Assessment Model” for the Insurance Sector, based on the local data available. Huge data is available to build a very accurate Risk Model, but none is available in India or for India.

This paper describes the various steps involved in developing such a tool. This includes data acquisition; development of the risk assessment methodology for structures effected by Hurricane wind. Risk assessment has three separate but related modules viz., Hazard, Vulnerability and Loss Analysis. Estimated damage is measured in terms of a Mean Damage Ratio (MDR) and a deviation around the mean represented by the Coefficient of Variation (CV). Loss analysis determines loss to a particular location of portfolio of locations, loss to entire study region, losses by administrative divisions etc.

Keywords: Hurricane risk, Indian market.

281114 (E61, B13)
A tri-model of Canadian inflation with an application to the valuation of indexed pension plan benefits.
Adam L., Proceedings Fourth IME Congress Barcelona
This paper presents a model for projecting the inflation rate in Canada, as defined by the annual change in the Consumer’s Price Index (CPI). Using monthly CPI data from 1949 to 1999 inclusive, the author proposes the use of an inflation model allowing for three distinct conditional distributions, one for each of the low, medium and high inflation periods. A monthly 3×3 discrete transition from one inflation level to another. Various indexation formulas are chosen to present the cost of providing for deductible, coinsurance and maximum indexation. Using a constant real rate of return of 4% per year, the expected cash flows from an annuity are discounted to obtain the present value of an indexed pension under each indexation formula and thus the cost of indexation. Percentiles of empirical results obtained from simulations are shown. A weighted indexation cost index is proposed to determine the cost of providing for indexation of benefits. The index value is influenced by the initial level of inflation on the valuation date. The results should be of interest to those wishing to investigate the cost of using a specific indexation formula when a deterministic, unimodal or mean-reverting model is deemed unsatisfactory.

Keywords: Inflation, Pension schemes, Canada.

281115 (E61, E13)
ARFIMA models for interest rates in the Spanish market.
Espinosa F., Vives J., *Proceedings Fourth IME Congress Barcelona*

In this article the authors perform an empirical analysis on the MIBOR. The authors analyse a time series provided by the “Banco de España” from 4th January 1985 to 31st December 1998, with interest rates corresponding to 1 day, 1 week, 15 day, 1 month, 2 month, 3 month, 6 month and 1 year operations. The greater part of previous studies on time series analysis, specially on economic events, considers that different observations, at separate times, are independent variables. However, the authors propose that in some cases, dependence, on each other, exists, although small, and it should not be overlooked. The objective of this paper is, first of all, to contrast the existence of memory inside the series. In order to reach this, the authors have applied new tools provided by Chaos Theory and Fractal Analysis. Among all the existing tests, the authors have chosen the R/S analysis, based on a first proposal by Hurst (1951) and recently improved and applied in the Financial field by Peters (1994). The second tool they use is, with a view to contrast the IID Hypothesis, the BDS test, created by W. Brock, W. Deckert and J. Scheinkman. Finally, the purpose is, using all the information obtained, to model the behaviour adjusting an ARFIMA model, as proposed in Hosking (1981).

*Keywords: Interest rates, Spanish market, Chaos Theory, Fractal Analysis.*

281117 (E61, B10)

A Note on Interest Rate Guarantees and Bonus: The Norwegian Case.

Miltersen K.R., Persson S., *Proceedings Fourth IME Congress Barcelona*

Interest rate guarantees, or more precisely, annual minimum rate of return guarantees, seem to be included in life insurance products in most countries. In the companion paper Miltersen and Persson (2000) a model of interest guarantees which includes a surplus distribution mechanism between the insurance company and the customer, is presented.

The goal of this paper is to extend this model to capture more characteristics of real-world insurance markets. More specifically, two different levels of the annual guaranteed rate of return are allowed, one level for the initial investment amount, another level (typically lower) for surplus credited during the contract period. Moreover, the effect of the requirement of a strictly non-negative bonus account by the end of each year throughout the contract period is analysed.

*Keywords: Interest rate guarantees, Life insurance.*

281118 (E61, E10)

Default Risk Estimation and Stochastic Calculus: Application to French Industrial Firms.

Refait C., *Proceedings Fourth IME Congress Barcelona*

An alternative method is proposed to estimate corporate default risk and to predict bankruptcy, beside
multivariate models such as multiple discriminant analysis or neural networks. The author uses an Asset Liability Management method of risk estimation. This method is based on corporate bond valuation models. Whereas ALM is quite exclusively used by banks and insurance companies, the author assesses probabilities of default for French industrial firms. Following Janssen [1992], the author supposes that the dynamics for the total assets and the total liabilities can be described by geometric Brownian motions. The probability of insolvency – i.e. the probability that net worth is negative – is then estimated and analysed as the probability of default. A repartition of the firms into two groups is done from the computed probabilities. A threshold is chosen: any firm whose probability is lower than the threshold is classified in the group of the non-failed companies. Any firm whose probability is higher than the threshold is classified in the group of the failed companies. Rate of correct classifications is assessed from bootstrap samples and compared to other business failure prediction models. The assessed probabilities discriminate the firms that filed for bankruptcy from the healthy firms one year but also two and three years prior to failure. The study provides a simple and accurate indicator of corporate bankruptcy risk and proves that empirical applications of stochastic calculus to industrial firms allow to obtain good results.

*Keywords:* Corporate bankruptcy, Default risk estimation, Asset-liability management, Diffusion process.

281119 (F61, F41)

**New Executives Compensation Packages: Economic and Financial Effects The Spanish Case.**

**González A.M., Pociello García E., Varea Soler J.,**

*Proceedings Fourth IME Congress Barcelona*

In this paper, the authors make a critical analysis of the new compensation systems of the company’s managers and its relationship with the value making. The agency problems demand mechanisms to line up the managers objectives with the shareholder’s interests. The aim of the shareholder had been expressed like maximise the value of the firm like a way to maximise his wealth. Mathematically this increase of value has expressed like the net value of the cash flows generated by the firm. The shareholder’s value had to be the alicuota of this net value, but in modern finance is expressed like the price increase of the share in the stock market. Starting from this concept of value the firms have designed new retribution systems for managers and CEO.

The authors analyse for a sample of big Spanish firms by one side the new manager’s retribution system and its fit in the requirements pointed out by modern finance.

*Keywords:* Shareholder, Managers, Agency costs, Performance, Compensation packages, Stock options, Shares.
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281060 Appropriate insurance (M50; E60)
Decomposition
281058 Claims reserving; Marked Poisson process; Thinning; amalgamation; Dirichlet process; Discrete vs continuous time (M40; M10)
Deductible insurance
281057 Second order conditions (M32; M10)
Default risk estimation
281118 Corporate bankruptcy; Asset-liability management; Diffusion process (E61; E10)
Defaultable security
281067 Quantile-hedging; Incomplete market; Neyman-Pearson’s lemma (E10; E13)
Demographic risk
281078 Pension schemes (E10; B13)
Density function
281025 Widows pension; Present value (M12; B13)
Dependency
281021 Stochastic ordering (M11; M10)
Dependent risks
281007 Compound Poisson approximation; Individual risk model; Collective risk model (M10; M11)
Dichotomic Claim Reporting Rate
281065 Wiener Process; Exponential Distribution; Incurred but still not reported claim amount versus binomial; Claim Reporting Process; Limit on distribution (M54; M10)
Differentiated premium structure
281061 Term life insurance (M52; M10)
Diffusion process
281118 Corporate bankruptcy; Default risk estimation; Asset-liability management (E61; E10)
Dirichlet process
281058 Claims reserving; Marked Poisson process; Decomposition; Thinning; amalgamation; Discrete vs continuous time (M40; M10)
Disability dutch model
281063 Claiming deviation; Collective insured; Discrete-time Markov model for life contingencies; Reinsurance; Monte Carlo simulation method; Claiming deviation reinsurance (M52; M10)
Disability
281017 Multistate models; Personal accident insurance (M10; B20)
Disappointment
281069 Uncertainty resolution; Sequential timing; Anxiety; Expected utility axioms (E10; E11)
Disaster bonds
281103 Pricing (E50; E10)
Discrete vs continuous time
281058 Claims reserving; Marked Poisson process; Decomposition; Thinning; amalgamation; Dirichlet process (M40; M10)
Discrete-time Markov model for life contingencies
281063 Claiming deviation; Collective insured; Disability dutch model; Reinsurance; Monte Carlo simulation method; Claiming deviation reinsurance (M52; M10)
Distance-based regression model
281056 Non-life insurance; Rate making; Risk factors; Selection of predictors; Generalised linear model (M31; M10)
Distorted expectation hypothesis
281089 Utility Theory (E12; E10)
Distribution free model
281054 Credibility theory (M31; M10)
Distribution functions
281040 Stop loss transform; Stochastic order (M30; M10)
Distribution
281095 Environmental regulation; Norms; Efficiency; Voter perceptions; Information (E20; E40)
Duplicates
281041 Life insurance; Supermodular order; Stop-loss order (M30; M10; B10)
Dynamic Programming
281107 ALM; Baseline Portfolio; Option Theory; Utility theory (E60; E10)
Economic premium principle
281038 Equilibrium model (M30; M10)
Efficiency
281095 Environmental regulation; Norms; Voter perceptions; Distribution; Information (E20; E40)
Elicitation
281072 Preferences; Construal; Values; Environment (E10)

Empirical Bayes
281047 Bias-variance trade-off; Random effects model; Shrinkage estimation; Squared prediction loss; Subset-regression (M31; M10)

Empirical study
281116 Insurance demand; Life insurance; CHAID algorithm; Consumer’s profile; Segmentation techniques; Statistical analysis (E61; B10)

Environmental
281072 Preferences; Elicitation; Construal; Values (E10)

Environmental regulation
281095 Norms; Efficiency; Voter perceptions; Distribution; Information (E20; E40)

Equilibrium model
281038 Economic premium principle (M30; M10)

Errors
281075 Decision making under risk; Experiments (E10)

Excess claims
281062 fire and motor reinsurance; Full Pareto Model; Generalized Pareto model; Bayesian estimators; Hill estimator; Maximum likelihood estimator (M52; M10)

Expected utility axioms
281069 Uncertainty resolution; Sequential timing; Anxiety; Disappointment (E10; E11)

Expected utility
281085 Rank dependent utility; Weighted utility; Skew-symmetric bilinear utility; Consistency axiom; One-switch condition; Contextual uncertainty (E12; E10)

Experimental economics
281109 Rationality; Bounded rationality; Judgement; Incentives; Experimental methodology (E60; E10)

Experimental methodology
281109 Experimental economics; Rationality; Bounded rationality; Judgement; Incentives (E60; E10)

Experiments
281075 Errors; Decision making under risk (E10)
281108 Bargaining; litigation (E60; E20)

Exponential Distribution
281065 Wiener Process; Dichotomous Claim Reporting Rate; Incurred but not reported claim amount versus binomial; Claim Reporting Process; Limit on distribution (M54; M10)

Exponential Utility
281090 Life Insurance; Investment/Consumption Model; Martingale (E12; B10)

Factorial convexity
281093 Term Structure of interest rates; Factorial duration; Stochastic Process; Three factor model (E13; M10)

Factorial duration
281093 Term Structure of interest rates; Factorial convexity; Stochastic Process; Three factor model (E13; M10)

Financial Options
281104 Asset Liability Management (E50; E10)

Financial technology
281111 Insurance; Japan (E61; E40)

Financial valuation
281082 Participating Life insurance policies (E10; B10)

Finite time and asymptotic moments
281009 Net interest rate; Present value risk process; Classical risk model; Renewal theory (M10; M11)

Fire and motor reinsurance
281062 Excess claims; Full Pareto Model; Generalized Pareto model; Bayesian estimators; Hill estimator; Maximum likelihood estimator (M52; M10)

Fixed and random effects models
281050 Residuals; Pseudo-true value (M31; M10)

Fixed marginals
281011 Bernoulli random variables (M10; M11)

FMLA
281096 Moral hazard; Contagion (E20; B10)

Forecast
281076 Asset-Liability Management (ALM); Scenario Generation; Risk Analysis (E10; B13)

Fourier transformation
281033 Total claim size distribution; Ruin probabilities; Random sums; Aliasing; Change of measure (M13; M10)

Fractal Analysis
281115 Interest rates; Spanish market; Chaos Theory (E61; E13)

Fraud
281098 Motor Insurance (E40; B40)
281099 Motor insurance (E40; B40)

Frequency distribution
281053 Mixed Poisson distribution; Non-parametric fit; Bonus-malus system; Hunger for bonus; Claim amount distribution; Censoring; Maximum likelihood (M31; M10)
Full Pareto Model
281062 Excess claims; fire and motor reinsurance; Generalized Pareto model; Bayesian estimators; Hill estimator; Maximum likelihood estimator (M52; M10)

General Equation
281019 Continuous time semi-Markov stochastic process; Integro-differential Volterra equations; PHI disability model (M11; B20)

Generalised linear model
281056 Non-life insurance; Rate making; Risk factors; Selection of predictors; Distance-based regression model (M31; M10)

Generalised-expectation utility
281091 Heteroscedastic error; Path-dependence (E13; E10)

Generalized Pareto model
281062 Excess claims; fire and motor reinsurance; Full Pareto Model; Bayesian estimators; Hill estimator; Maximum likelihood estimator (M52; M10)

Generic utility theory
281070 Subjective equivalence of gambles; Context-dependent utility scaling (E10; E11)
281088 Theory of choice behaviour; Context dependent utility scaling (E12; E10)

Geographical premium rating
281037 Motor insurance (M30; B40)

Geometric bilinear processes
281028 Bilinear Markovian representation; Moving average rate of return; Pension funding (M12; B13)

Gibbs sampler
281026 Vector regime switching; Joint parameter density; Outliers; Metropolis-Hastings algorithm; Markov Chain Monte Carlo; Posterior model probabilities; Model selection (M12; M11)
281043 Postcodes; Premium Rating; Spatial Statistics (M30; M10)

Golf swing
281001 Statistical model; Information criterion; Informational data set (M01)

Grossing up method
281045 Chain Ladder (M31; M10)

Grouped data
281004 Reinsurance; non linear regression techniques (M10; M52)

Hachemeister
281055 Credibility theory; Regression (M31; M10)

Health insurance
281100 Regulated competition; Nash competition; Risk adjustment (E40; B20)

Heteroscedastic error
281091 Generalised-expectation utility; Path-dependence (E13; E10)

Hill estimator
281062 Excess claims; fire and motor reinsurance; Full Pareto Model; Generalized Pareto model; Bayesian estimators; Maximum likelihood estimator (M52; M10)

Hofmann’s distribution
281046 Mixed Poisson processes; Non-parametric estimation; Bayes theorem; Bonus-malus systems; Stationary distribution (M31; M10)

Hunger for bonus
281053 Mixed Poisson distribution; Non-parametric fit; Bonus-malus system; Claim amount distribution; Frequency distribution; Censoring; Maximum likelihood (M31; M10)

Hurricane risk
281113 Indian market (E61; M12)

Hypothetical Choice
281071 Intentions; Revealed preference; Scenarios (E10; E11)

Incentives
281109 Experimental economics; Rationality; Bounded rationality; Judgement; Experimental methodology (E60; E10)

Incomplete market
281067 Quantile-hedging; Defaultable security; Neyman-Pearson’s lemma (E10; E13)

Incurred but still not reported claim amount versus binomial
281065 Wiener Process; Exponential Distribution; Dichotomic Claim Reporting Rate; Claim Reporting Process; Limit on distribution (M54; M10)

Indian market
281113 Hurricane risk (E61; M12)

Individual aggregate funding
281031 Linear approximation; Lagrange multipliers; Optimal control (M12; M10)

Individual risk model
281007 Compound Poisson approximation; Dependent risks; Collective risk model (M10; M11)

Inflation
281114 Pension schemes; Canada (E61; B13)

Information criterion
281001 Statistical model; Informational data set; Golf swing (M01)

Information
281095 Environmental regulation; Norms; Efficiency; Voter perceptions; Distribution (E20; E40)
Informational data set
281001 Statistical model; Information criterion; Golf
swing (M01)

Institutional change
281112 Compensating differentials; Unions;
Workplace accident risk; Workers’compensation
(E61; E40)

Insurance demand
281116 Life insurance; CHAID algorithm;
Consumer’s profile; Empirical study;
Segmentation techniques; Statistical analysis (E61;
B10)

Insurance liability
281066 Market value (E10)

Insurance premium principle measure of risk
281002 Capital requirement; Coherent risk measure;
Capacity theory; Convex games; Orlicz spaces;
Quantile; Scenario (M10; M11)

Insurance services
281101 Marketing (E42; E61)

Insurance trading
281080 Asymmetric information (E10; E13)

Insurance
281074 Affect; Consolation (E10)
281111 Financial technology; Japan (E61; E40)

Intensity of Volterra equations
281019 Continuous time semi-Markov stochastic
process; General Equation; PHI disability model
(M11; B20)

Intentions
281071 Hypothetical Choice; Revealed preference;
Scenarios (E10; E11)

Interest rate guarantees
281117 Life insurance (E61; B10)

Interest rates
281023 Risk model; Probability of survival (M11;
M10)
281115 Spanish market; Chaos Theory; Fractal
Analysis (E61; E13)

Investment/Consumption Model
281090 Life Insurance; Martingale; Exponential
Utility (E12; B10)

Japan
281111 Financial technology; Insurance (E61; E40)

Joint parameter density
281026 Vector regime switching; Outliers; Gibbs
sampler; Metropolis-Hastings algorithm; Markov
Chain Monte Carlo; Posterior model probabilities;
Model selection (M12; M11)

Judgement
281109 Experimental economics; Rationality;
Bounded rationality; Incentives; Experimental
methodology (E60; E10)

Laboratory experiments
281087 Risk aversion (E12; E10)

Lagrange multipliers
281031 Individual aggregate funding; Linear
approximation; Optimal control (M12; M10)

Levy process
281035 Ruin probabilities (M13; M10)

Life annuity
281105 Mortality derivatives (E50; B10)

Life insurance contract
281064 Compartment model (M54; M10)

Life insurance portfolio
281012 Stochastic process; Queuing theory (M10;
B10)

Life insurance
281041 Duplicates; Supermodular order; Stop-loss
order (M30; M10; B10)
281090 Investment/Consumption Model; Martingale;
Exponential Utility (E12; B10)
281116 Insurance demand; CHAID algorithm;
Consumer’s profile; Empirical study; Segmen-
tation techniques; Statistical analysis (E61; B10)
281117 Interest rate guarantees (E61; B10)

Life portfolio
281029 Aggregate claim (M12; B10)

Limit on distribution
281065 Wiener Process; Exponential Distribution;
Dichotomic Claim Reporting Rate; Incurred but
still not reported claim amount versus binomial;
Claim Reporting Process (M54; M10)

Linear approximation
281031 Individual aggregate funding; Lagrange
multipliers; Optimal control (M12; M10)

Litigation
281108 Bargaining; experiments (E60; E20)

Loss models
281013 Transformation; Skewness; Weighted
integrated squared error (M10; M11)

Lower bound
281010 Upper bound; Random variables (M10; M11)

Managers
281119 Shareholder; Agency costs; Performance;
Compensation packages; Stock options; Shares
(E61; E41)

Manchester Unity Models
281030 Permanent Health Insurance; Multiple State
Model; Transition Intensity; Claims (M12; B21)
Marked Poisson process
- Claims reserving; Decomposition; Thinning; amalgamation; Dirichlet process; Discrete vs continuous time (M40; M10)

Market value
- Insurance liability (E10)

Marketing
- Insurance services (E42; E61)

Markov Chain Monte Carlo
- Vector regime switching; Joint parameter density; Outliers; Gibbs sampler; Metropolis-Hastings algorithm; Posterior model probabilities; Model selection (M12; M11)

Markov Chain
- Missing data; Monte Carlo approach (M10; M11)

Martingale
- Life Insurance; Investment/Consumption Model; Exponential Utility (E12; B10)

Maximum likelihood
- Mixed Poisson distribution; Non-parametric fit; Bonus-malus system; Hunger for bonus; Claim amount distribution; Frequency distribution; Censoring (M31; M10)
- Excess claims; fire and motor reinsurance; Full Pareto Model; Generalized Pareto model; Bayesian estimators; Hill estimator (M52; M10)

Metropolis-Hastings algorithm
- Vector regime switching; Joint parameter density; Outliers; Gibbs sampler; Markov Chain Monte Carlo; Posterior model probabilities; Model selection (M12; M11)

Minimax
- Book; Risk-aversion; Over-round; Personal probability; Price-utility (E12; E10)

Missing data
- Markov Chain; Monte Carlo approach (M10; M11)

Mixed Poisson distribution
- Non-parametric fit; Bonus-malus system; Hunger for bonus; Claim amount distribution; Frequency distribution; Censoring; Maximum likelihood (M31; M10)

Mixed Poisson processes
- Non-parametric estimation; Hofmann’s distribution; Bayes theorem; Bonus-malus systems; Stationary distribution (M31; M10)

Model selection
- Vector regime switching; Joint parameter density; Outliers; Gibbs sampler; Metropolis-Hastings algorithm; Markov Chain Monte Carlo; Posterior model probabilities (M12; M11)

Moment Spaces
- Premium Calculation Principles; S-Convex Orderings; Stochastic Extrema (M30; M10)

Monte Carlo approach
- Missing data; Markov Chain (M10; M11)

Monte Carlo simulation method
- Claiming deviation; Collective insured; Discrete-time Markov model for life contingencies; Disability Dutch model; Reinsurance; Claiming deviation reinsurance (M52; M10)

Moral hazard
- Contagion; FMLA (E20; B10)

Mortality derivatives
- Life annuity (E50; B10)

Motor insurance
- Geographical premium rating (M30; B40)
- Fraud (E40; B40)

Moving average rate of return
- Geometric bilinear processes; Pension funding (M12; B13)

Multiple State Model
- Permanent Health Insurance; Transition Intensity; Claims; Manchester Unity Models (M12; B21)

Multistate life insurance contracts
- Convex order; Comonotonic joint distribution; Present value distributions (M10; B10)

Multistate models
- Disability; Personal accident insurance (M10; B20)

Nash competition
- Health insurance; Regulated competition; Risk adjustment (E40; B20)

Negative Binomial distribution
- Bonus Malus Systems; Automobile Insurance (M31; M10)

Net interest rate
- Finite time and asymptotic moments; Present value risk process; Classical risk model; Renewal theory (M10; M11)

Neyman-Pearson’s lemma
- Quantile-hedging; Defaultable security; Incomplete market (E10; E13)

Non linear regression techniques
- Reinsurance; Grouped data (M10; M52)

Non-life insurance
- Rate making; Risk factors; Selection of predictors; Generalised linear model; Distance-based regression model (M31; M10)
Non-parametric estimation
281046 Mixed Poisson processes; Hofmann’s distribution; Bayes theorem; Bonus-malus systems; Stationary distribution (M31; M10)

Non-parametric fit
281053 Mixed Poisson distribution; Bonus-malus system; Hunger for bonus; Claim amount distribution; Frequency distribution; Censoring; Maximum likelihood (M31; M10)

Norms
281095 Environmental regulation; Efficiency; Voter perceptions; Distribution; Information (E20; E40)

One-switch condition
281085 Expected utility; Rank dependent utility; Weighted utility; Skew-symmetric bilinear utility; Consistency axiom; Contextual uncertainty (E12; E10)

Optimal control
281031 Individual aggregate funding; Linear approximation; Lagrange multipliers (M12; M10)

Optimal premium pricing
281044 Stochastic variation; Breakeven premium (M30; M10)

Option pricing
281106 Put options; Unit linked policies (E50; E61)

Option Theory
281107 ALM; Baseline Portfolio; Dynamic Programming; Utility theory (E60; E10)

Orlicz spaces
281002 Capital requirement; Coherent risk measure; Capacity theory; Convex games; Insurance premium principle measure of risk; Quantile; Scenario (M10; M11)

Ornstein-Uhlenbeck Process
281094 Term Structure of Interest Rates; Bond Pricing Equation; Two-Factor Models; CIR Process (E13; E50)

Outliers
281026 Vector regime switching; Joint parameter density; Gibbs sampler; Metropolis-Hastings algorithm; Markov Chain Monte Carlo; Posterior model probabilities; Model selection (M12; M11)

Over-round
281086 Book; Risk-aversion; Personal probability; Price-utility; Minimax (E12; E10)

Panjer’s recursion
281005 De Pril’s recursion (M10; M11)

Participating Life insurance policies
281082 Financial valuation (E10; B10)

Path-dependence
281091 Generalised-expected utility; Heteroscedastic error (E13; E10)

Pension funding
281028 Bilinear Markovian representation; Geometric bilinear processes; Moving average rate of return (M12; B13)

Pension schemes
281068 Asset liability model (E10; B13)
281077 Asset management; Contributions (E10; B13)
281078 Demographic risk (E10; B13)

Pension Schemes
281079 Value at risk (E10; B13)

Pension schemes
281114 Inflation; Canada (E61; B13)

Performance
281119 Shareholder; Managers; Agency costs; Compensation packages; Stock options; Shares (E61; E41)

Permanent Health Insurance
281030 Multiple State Model; Transition Intensity; Claims; Manchester Unity Models (M12; B21)

Personal accident insurance
281017 Disability; Multistate models (M10; B20)

Personal probability
281086 Book; Risk-aversion; Over-round; Price-utility; Minimax (E12; E10)

PHI disability model
281019 Continuous time semi-Markov stochastic process; General Equation; Integro-differential Volterra equations (M11; B20)

Policy termination
281032 Cost analysis; Bivariate analysis (M12; M10)

Postcodes
281043 Gibbs Sampler; Premium Rating; Spatial Statistics (M30; M10)

Posterior model probabilities
281026 Vector regime switching; Joint parameter density; Outliers; Gibbs sampler; Metropolis-Hastings algorithm; Markov Chain Monte Carlo; Model selection (M12; M11)

Preferences
281072 Elicitation; Construal; Values; Environment (E10)
281084 Attitudes; Contingent valuation; Psychology and economics; Utility assessment (E12; E10)
281110 Rationality; Behavioural decision theory; cognition (E60)

Premium Calculation Principles
281042 Moment Spaces; S-Convex Orderings; Stochastic Extrema (M30; M10)

Premium Rating
281043 Gibbs Sampler; Postcodes; Spatial Statistics (M30; M10)
Present value distributions
281016 Convex order; Comonotonic joint distribution; Multistate life insurance contracts (M10; B10)

Present value risk process
281009 Finite time and asymptotic moments; Net interest rate; Classical risk model; Renewal theory (M10; M11)

Present value
281025 Widows pension; Density function (M12; B13)

Price-utility
281086 Book; Risk-aversion; Over-round; Personal probability; Minimax (E12; E10)

Pricing
281103 Disaster bonds (E50; E10)

Probability of ruin
281034 Semi Markov risk model (M13; M10)

Probability of survival
281023 Interest rates; Risk model (M11; M10)

Procrastination
281083 Decision framing; Simultaneous and sequential choice addiction; Risk attitude (E12; E10)

Property insurance
281081 Casualty insurance; Cash flows (E10)

Pseudo-orders
281015 Risk measures; Bid-ask spread (M10; E10)

Pseudo-tr�
tue value
281050 Fixed and random effects models; Residuals (M31; M10)

Psychology and economics
281084 Preferences; Attitudes; Contingent valuation; Utility assessment (E12; E10)

Put options
281106 Option pricing; Unit linked policies (E50; E61)

Quartile
281002 Capital requirement; Coherent risk measure; Capacity theory; Convex games; Insurance premium principle measure of risk; Orlicz spaces; Scenario (M10; M11)

Quartile-hedging
281067 Defaultable security; Incomplete market; Neyman-Pearson’s lemma (E10; E13)

Queueing theory
281012 Life insurance portfolio; Stochastic process (M10; B10)

Random effects model
281047 Bias-variance trade-off; Empirical Bayes; Shrinkage estimation; Squared prediction loss; Subset-regression (M31; M10)

Random sums
281033 Total claim size distribution; Ruin probabilities; Fourier transformation; Aliasing; Change of measure (M13; M10)

Random variables
281010 Upper bound; Lower bound (M10; M11)

Rank dependent utility
281085 Expected utility; Weighted utility; Skew-symmetric bilinear utility; Consistency axiom; One-switch condition; Contextual uncertainty (E12; E10)

Rate making
281056 Non-life insurance; Risk factors; Selection of predictors; Generalised linear model; Distance-based regression model (M31; M10)

Rationality
281109 Experimental economics; Bounded rationality; Judgement; Incentives; Experimental methodology (E60; E10)
281110 Behavioural decision theory; Preferences; cognition (E60)

Recursions
281006 Compound distributions; Bivariate distributions; Trinomial distributions bivariate Negative Binomial; Bivariate Poisson (M10; M11)

Recursive Calculation
281049 Chain ladder; Standard Errors; Tail Factor (M31; M10)

Regression
281055 Credibility theory; Hachemeister (M31; M10)

Regulated competition
281100 Health insurance; Nash competition; Risk adjustment (E40; B20)

Reinsurance
281004 Grouped data; non linear regression techniques (M10; M52)
281063 Claiming deviation; Collective insured; Discrete-time Markov model for life contingencies; Disability dutch model; Monte Carlo simulation method; Claiming deviation reinsurance (M52; M10)

Renewal theory
281009 Finite time and asymptotic moments; Net interest rate; Present value risk process; Classical risk model (M10; M11)

Residuals
281050 Fixed and random effects models; Pseudo-true value (M31; M10)

Revealed preference
281071 Hypothetical Choice; Intentions; Scenarios (E10; E11)
Risk adjustment  
28100 Health insurance; Regulated competition; Nash competition (E40; B20)

Risk Analysis 
281076 Asset-Liability Management (ALM); Scenario Generation; Forecast (E10; B13)

Risk attitude 
281083 Decision framing; Simultaneous and sequential choice addiction; Procrastination (E12; E10)

Risk aversion 
281087 Laboratory experiments (E12; E10)  
281086 Book; Over-round; Personal probability; Price-utility; Minimax (E12; E10)

Risk factors 
281056 Non-life insurance; Rate making; Selection of predictors; Generalised linear model; Distance-based regression model (M31; M10)

Risk measures 
281015 Bid-ask spread; Pseudo-orders (M10; E10)

Risk model 
281023 Interest rates; Probability of survival (M11; M10)

Ruin probabilities 
281033 Total claim size distribution; Random sums; Fourier transformation; Aliasing; Change of measure (M13; M10)  
281035 Levy process (M13; M10)

Scenario Generation 
281076 Asset-Liability Management (ALM); Forecast; Risk Analysis (E10; B13)

Scenarios 
281002 Capital requirement; Coherent risk measure; Capacity theory; Convex games; Insurance premium principle measure of risk; Orlicz spaces; Quantile (M10; M11)  
281071 Hypothetical Choice; Intentions; Revealed preference (E10; E11)

S-Convex Orderings 
281042 Premium Calculation Principles; Moment Spaces; Stochastic Extrema (M30; M10)

Second order conditions 
281057 Deductible insurance (M32; M10)

Segmentation techniques 
281116 Insurance demand; Life insurance; CHAID algorithm; Consumer’s profile; Empirical study; Statistical analysis (E61; B10)

Selection of predictors 
281056 Non-life insurance; Rate making; Risk factors; Generalised linear model; Distance-based regression model (M31; M10)

Semi Markov risk model 
281034 Probability of ruin (M13; M10)

Semiparametric estimation 
281097 Compensating differentials (E24)

Sequential timing 
281069 Uncertainty resolution; Anxiety; Disappointment; Expected utility axioms (E10; E11)

Shareholder 
281119 Managers; Agency costs; Performance; Compensation packages; Stock options; Shares (E61; E41)

Shares 
281119 Shareholder; Managers; Agency costs; Performance; Compensation packages; Stock options (E61; E41)

Shortfall 
281002 Capital requirement; Coherent risk measure; Capacity theory; Convex games; Insurance premium principle measure of risk; Orlicz spaces; Quantile; Scenario (M10; M11)

Shrinkage estimation 
281047 Bias-variance trade-off; Empirical Bayes; Random effects model; Squared prediction loss; Subset-regression (M31; M10)

Simultaneous and sequential choice addiction 
281083 Decision framing; Procrastination; Risk attitude (E12; E10)

Skewness 
281013 Loss models; Transformation; Weighted integrated squared error (M10; M11)

Skew-symmetric bilinear utility 
281085 Expected utility; Rank dependent utility; Weighted utility; Consistency axiom; One-switch condition; Contextual uncertainty (E12; E10)

Solvency 
281036 Compound Poisson Process; Wiener Process; Stochastic differential equations (M13; M11)

Spanish market 
281115 Interest rates; Chaos Theory; Fractal Analysis (E61; E13)

Spatial Statistics 
281043 Gibbs Sampler; Postcodes; Premium Rating (M30; M10)

Squared prediction loss 
281047 Bias-variance trade-off; Empirical Bayes; Random effects model; Shrinkage estimation; Subset-regression (M31; M10)

Standard Errors 
281049 Chain ladder; Recursive Calculation; Tail Factor (M31; M10)
Stationary distribution
281046 Mixed Poisson processes; Non-parametric estimation; Hofmann’s distribution; Bayes theorem; Bonus-malus systems (M31; M10)

Statistical analysis
281116 Insurance demand; Life insurance; CHAID algorithm; Consumer’s profile; Empirical study; Segmentation techniques (E61; B10)

Statistical model
281001 Information criterion; Informational data set; Golf swing (M01)

Stochastic difference equation
281018 Wiener process; Stochastic integral; Stochastic differential equation; Decision criteria (M10; M11)

Stochastic differential equations
281036 Solvency; Compound Poisson Process; Wiener Process (M13; M11)

Stochastic dominance
281022 (M14; M10)

Stochastic dynamic model
281008 (M10; M11)

Stochastic Extrema
281042 Premium Calculation Principles; Moment Spaces; S-Convex Orderings (M30; M10)

Stochastic integral
281018 Wiener process; Stochastic differential equation; Stochastic difference equation; Decision criteria (M10; M11)

Stochastic interest rates
281092 Stochastic optimisation complete markets (E13; M10)

Stochastic optimisation complete markets
281092 Stochastic interest rates (E13; M10)

Stochastic order
281040 Stop loss transform; Distribution functions (M30; M10)

Stochastic ordering
281021 Dependency (M11; M10)

Stochastic process
281012 Life insurance portfolio; Queuing theory (M10; B10)

Stochastic Process
281093 Term Structure of interest rates; Factorial duration; Factorial convexity; Three factor model (E13; M10)

Stochastic variation
281044 Optimal premium pricing; Breakeven premium (M30; M10)

Stock options
281119 Shareholder; Managers; Agency costs; Performance; Compensation packages; Shares (E51; E41)

Stop loss transform
281039 (M30; M10)
281040 Stochastic order; Distribution functions (M30; M10)

Stop-loss order
281041 Life insurance; Duplicates; Supermodular order (M30; M10; B10)

Sub additivity
281002 Capital requirement; Coherent risk measure; Capacity theory; Convex games; Insurance premium principle measure of risk; Orlicz spaces; Quantile; Scenario (M10; M11)

Subjective equivalence of gambles
281070 Generic utility theory; Context-dependent utility scaling (E10; E11)

Subset-regression
281047 Bias-variance trade-off; Empirical Bayes; Random effects model; Shrinkage estimation; Squared prediction loss (M31; M10)

Supermodular order
281041 Life insurance; Duplicates; Stop-loss order (M30; M10; B10)

Surplus distribution
281020 Compound Poisson Model (M11; M10)

Tail Factor
281049 Chain ladder; Standard Errors; Recursive Calculation (M31; M10)

Term life insurance
281061 Differentiated premium structure (M52; M10)

Term Structure of interest rates
281093 Factorial duration; Factorial convexity; Stochastic Process; Three factor model (E13; M10)

Term Structure of Interest Rates
281094 Bond Pricing Equation; Two-Factor Models; Ornstein-Uhlenbeck Process; CIR Process (E13; E50)

Theory of choice behaviour
281088 Generic utility theory; Context dependent utility scaling (E12; E10)

Thinning
281058 Claims reserving; Marked Poisson process; Decomposition; amalgamation; Dirichlet process; Discrete vs continuous time (M40; M10)

Three factor model
281093 Term Structure of interest rates; Factorial duration; Factorial convexity; Stochastic Process (E13; M10)
Total claim size distribution
281033 Ruin probabilities; Random sums; Fourier transformation; Aliasing; Change of measure (M13; M10)

Transformation
281013 Loss models; Skewness; Weighted integrated squared error (M10; M11)

Transition Intensity
281030 Permanent Health Insurance; Multiple State Model; Claims; Manchester Unity Models (M12; B21)

Trinomial distributions bivariate Negative Binomial
281006 Recursions; Compound distributions; Bivariate distributions; Bivariate Poisson (M10; M11)

Two-Factor Models
281094 Term Structure of Interest Rates; Bond Pricing Equation; Ornstein-Uhlenbeck Process; CIR Process (E13; E50)

Uncertainty resolution
281069 Sequential timing; Anxiety; Disappointment; Expected utility axioms (E10; E11)

Unions
281112 Compensating differentials; Institutional change; Workplace accident risk; Workers'compensation (E51; E40)

Unit linked policies
281106 Option pricing; Put options (E50; E61)

Upper bound
281010 Lower bound; Random variables (M10; M11)

Utility assessment
281084 Preferences; Attitudes; Contingent valuation; Psychology and economics (E12; E10)

Utility Theory
281089 Distorted expectation hypothesis (E12; E10)

Utility theory
281107 ALM; Baseline Portfolio; Dynamic Programming; Option Theory (E60; E10)

Value at risk
281002 Capital requirement; Coherent risk measure; Capacity theory; Convex games; Insurance premium principle measure of risk; Orlicz spaces; Quantile; Scenario (M10; M11)
281079 Pension Schemes (E10; B13)

Value measurement
281073 Constructive preferences; Decision aiding (E10)

Values
281072 Preferences; Elicitation; Construal; Environment (E10)

Vector regime switching
281026 Joint parameter density; Outliers; Gibbs sampler; Metropolis-Hastings algorithm; Markov Chain Monte Carlo; Posterior model probabilities; Model selection (M12; M11)

Voter perceptions
281095 Environmental regulation; Norms; Efficiency; Distribution; Information (E20; E40)

Weighted integrated squared error
281013 Loss models; Transformation; Skewness (M10; M11)

Weighted utility
281085 Expected utility; Rank dependent utility; Skew-symmetric bilinear utility; Consistency axiom; One-switch condition; Contextual uncertainty (E12; E10)

Widows pension
281025 Present value; Density function (M12; B13)

Wiener process
281018 Stochastic integral; Stochastic differential equation; Stochastic difference equation; Decision criteria (M10; M11)
281036 Solvency; Compound Poisson Process; Stochastic differential equations (M13; M11)
281065 Exponential Distribution; Dichotomic Claim Reporting Rate; Incurred but still not reported claim amount versus binomial; Claim Reporting Process; Limit on distribution (M54; M10)

Workers'compensation
281112 Compensating differentials; Institutional change; Unions; Workplace accident risk (E61; E40)

Workplace accident risk
281112 Compensating differentials; Institutional change; Unions; Workers'compensation (E61; E40)