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Competing Risks Model for Corporate Exit Analysis : Discrete Hazard Model and Extension with Stochastic Frailties

Taehan Bae and Reg J. Kulperger
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Abstract: Publicly traded companies can leave a public system by bankruptcy or an exit due to merger. Discrete sub-hazard functions are modeled with a multinomial logit model. For 12,571 U.S. industrial firms spanning 1980 to 2004, quarterly firm specific financial variables and macroeconomic variables are available. Time-varying baseline hazard functions may capture unobservable or missing macroeconomic information. We examine the relationship between the effect of smoothing baseline hazard estimators and inclusion of macroeconomic variables. Smoothed nonparametric estimates of previous quarters baseline hazard functions are used for one step ahead predictions. A prediction power association methods are used currently in the literature. We propose a more direct method that yields an estimate of the probability of bankruptcy/merger for each company and hence a prediction of bankruptcy/merger in the next quarter. Optimal roughness penalties are chosen to minimize the sum of Shannon's entropies for all prediction periods.

On the regulator-insurer interaction in a structural model.

Carole Bernard, University of Waterloo
An Chen, University of Amsterdam

Abstract: In this paper, we provide a new insight of previous works of Briys and de Varenne [1997] and Grosen and Jørgensen [2002]. Firstly, we investigate the impact of regulatory authorities' rules on the fair value of company's liabilities and assets. In particular, we study how to choose regulation intervention levels in order to control for instance the shortfall probability of the issuing company. But market values of (long term) liabilities and regulators' rules are determined by assuming a constant volatility and no management of the insurer's portfolio. However, insurance companies follow dynamic investment strategies. Therefore, secondly, we study the interaction between the regulator who determines the regulation rule and the insurance company's risk management. Following the recent work of Ballotta, Haberman and Wang [2005] and the guidelines of the IASB, we develop an analysis of the model error when the insurance company is informed of regulators' rules and trades according to a certain discrete risk management hedging strategy instead of staying passive until the contract's maturity.

A nonparametric test for comparing the riskiness of portfolios

Vytaras Brazauskas
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Abstract: Inspired by the problem of testing hypotheses about the equality of several risk measure values, we find that the "nested L-statistic" -- a notion introduced herein -- is natural and particularly convenient. Indeed, the test statistic that we explore in this paper is a nested L-statistic. We discuss large-sample properties of the statistic, investigate its performance using a simulation study, and consider an example involving the comparison of risk measure values where the risks of interest are those associated with tornado damage in different time periods and different regions.

Moments of a Regime-Switching Stochastic Interest Rate Model with Randomized Regimes

James G. Bridgeman
University of Connecticut

Abstract: A regime-switching stochastic model with randomized regime parameters creates a more plausible set of extreme paths than do the usual stochastic interest rate models. Generalizing the Black-Karasinski model by randomizing the mean reversion target provides an example. Better to understand such models, as well as to calibrate their parameters without trial and error runs of stochastic model, we use an asymptotic expansion to estimate the moments of the integrated stochastic process over time.

Modeling mortality with jumps: transitory effects and pricing implication to mortality securitization

Hua Chen, Georgia State University
Samuel Cox, University of Manitoba

Abstract: In this paper, we incorporate a jump-diffusion process into the original Lee-Carter model, and use it to forecast mortality rates and analyze mortality securitization. Mortality jumps must be modeled explicitly in mortality securitization, because the rationale behind the design of mortality securities is to hedge mortality risks. We examine the outlier-adjusted Lee-Carter model to provide further evidence of mortality jumps. We also explore alternative models with transitory jump effects versus permanent jump effects, and find that modeling the mortality via permanent jump effects induces errors in parameter estimation and distortions in security valuation consequently. We use the Swiss Re mortality bond as an example to show how to apply our model and the distortion measure approach to value mortality-linked securities. Pricing the Swiss Re mortality bond is difficult because the mortality index is correlated across countries and over time. Cox, Lin and Wang (2006) employ the normalized multivariate exponential tilting to take into account correlations across countries. We show in this paper how to account for correlations of the mortality index over time by simulating the mortality index and changing the measure on paths.

An option-based operational risk management on pandemics

Hua Chen, Georgia State University
Samuel Cox, University of Manitoba

Abstract: An enormous literature on the dynamics of epidemics has been developed in epidemiology and mathematical biology, but little has been studied about epidemic risks for private enterprises. To plan for the possible outbreak of an influenza pandemic evolving from the current avian flu, the CDC has provided guidelines for large businesses and instructed firms to set triggers for activating and terminating optimal response policies, including shutting down parts of their businesses in affected areas. In this paper, we develop a two-stage model to help firms determine these triggers in the event of an influenza pandemic. In the first stage, we present a stochastic model to simulate the spread of the virus, depending on the regime that the firm is currently in. In the second stage, we view the reactivation decision as a call option and the suspension decision as a put option, and employ the theory of real option valuation and the regime switching model to determine the optimal switching thresholds. Our numerical experiments suggest that given the parameter values in our paper, it is optimal for the firm to suspend the business (or parts of its business) when the fraction of infected employees is higher than 18%, and to reactivate the operation anytime the fraction drops to 3%. When considering the uncertainty in the future, firms are more conservative about the decisions of suspension and reactivation. If the firm incurs switching costs, the suspension threshold increases with costs, while the reactivation threshold decreases with costs. By implementing policies to control the disease, firms can meet their social obligations and in the meantime, increase their values in both regimes.

The Cost Control on a DB underpin hybrid pension plan

Kai Chen & Mary Hardy
University of Waterloo

Abstract: The Defined Benefit (DB) underpin Defined Contribution hybrid pension plan offers an attractive combination of benefit security and upside potential for pension plan members, and offers cost containment for employers, whilst still ensuring the provision of adequate equitable benefits. The DB underpin guarantee is valued and hedged as a financial option, within the traditional funding paradigms of actuarial science. Assuming fixed interest rates, and assuming that salaries can be treated as a tradable asset, contribution rates are developed for Projected Unit Credit and Traditional Unit Credit funding methods. In addition, for the accruals methods, we demonstrate the implied hedging strategy. The traditional unit credit approach shows promise as a funding method in terms of average costs and in the incidence of costs, on average. However, the average monthly hedging costs are time dependent and can be unstable when employees are close to retirement. Some cost control approaches will be proposed to reduce the volatility of hedging cost

Modelling the Cumulative Cases from SARS

Renbao Chen & Ping Wang
National University of Singapore

Abstract: In this paper, we have derived a model of for the cumulative cases of SARS (severe acute respiratory syndrome). To test the model, we applied it to the actual data from the 2003 SARS outbreak. The model proved a good fit for the four areas we examined, China (mainland), Canada, Hong Kong and Singapore, as evident from the high R2 values and the randomness of the residuals.

In addition, we obtained second order derivatives of our curve fits and proposed the use of T^* , the time in days taken to slow the rate of the increase in the number of cumulative SARS cases, as a measure of the effectiveness of control measures in each country.

We then incorporated explanatory variables to link the model parameters to demographic indicators of areas hit heavily by SARS. The work makes it possible to predict the future behavior of SARS or other epidemics should they ever strike again.

Negative Effects of the GIS Clawback and Possible Solutions

Diana K. Chisholm
University of Waterloo

Abstract: In Canada, there are three main sources of government-provided retirement income: the Canada Pension Plan (CPP), which is based on pre-retirement income and contributed to over the course of employment; the Old Age Security (OAS), which is a fixed amount for most but drops off for extremely high-income individuals; and the Guaranteed Income Supplement (GIS), which is designed to supplement those with extremely low income. The annual GIS amount is reduced (or clawed back) by 50 cents for every dollar of annual income in retirement, including CPP and Registered Retirement Savings Plans (RRSP). The result of this is that low-income individuals who aim for a 70% replacement rate actually see a decrease in government-provided funding the more they save for retirement. In fact, savings in an RRSP can effectively be taxed at more than 100% through corresponding reductions in the GIS, social housing, home care, GAINS (Guaranteed Annual Income Supplement), and other benefits based on retirement income. It would be better for these individuals to put their money in a proverbial mattress than to save it in an RRSP! This paper explores a basic GIS exemption, a tax rate of lower than 50%, and various combinations of the two as alternative policies for the GIS. We find that these new methods can reduce the disincentive to save money without dramatically increasing the overall cost of the GIS.

Bounds for Ruin Probabilities and Value at Risk

Samuel Cox, University of Manitoba
Yijia Lin, University of Nebraska
Ruilin Tian, Georgia State University
Luis F. Zuluaga, University of New Brunswick

Abstract: In many situations, complete information about a rare event is not available, meaning the underlying probability distribution is not completely specified. This paper finds the best one can do when the incomplete information consists of estimates of the first two moments of the distribution. These are called semi-parametric lower and upper bounds on the probability of the rare event. We apply it to the a rare event hitting an insurer for which losses are extraordinary high and investment income is low. We refer to this as “ruin” although the company may survive; it is just a convenient way to describe a rare event that would threaten a company’s solvency. We also consider value-at-risk (VaR) in the sense that we find bounds a portfolio return, given only the first two moments of the portfolio components.

In order to numerically solve the semiparametric bounds considered here, we reformulate the corresponding semiparametric bound problem as a sum of squares (SOS) program. However, a SOS program is an optimization problem where the variables are coefficients of polynomials, the objective is a linear combination of the variable coefficients, and the constraints are given by the polynomials being SOS. This form of the problem allows us to use one of several readily available SOS programming solvers to solve numerically the SOS programming formulation of the moment problem.

Mortality Modelling using Projection Pursuit Regression

Steven Craighead, TP – Tillinghast
Tom Edwalds, Munich American Reassurance Company

Abstract: In this paper, we develop sixteen separate mortality models based on the current SOA mortality data being used for the preferred life study. Our models are constructed using projection pursuit regression. The sixteen models arise from all combinations of sex, smoker status, select and ultimate status, and per life vs. per dollar mortality rates. In general our models confirm the following facts:

1. Mortality rates increase as attained age increases
 2. Mortality rates increase as duration increases.
 3. Mortality rates decrease as Face Amount Bands increase.
 4. Mortality rates decrease if preferred underwriting is present.
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Stochastic Life Annuities

Daniel Dufresne
University of Melbourne, Australia

Abstract: This paper gives analytic approximations for the distribution of a stochastic life annuity. It is assumed that returns follow a geometric Brownian motion. The distribution of the stochastic annuity may be used to answer questions such as "What is the probability that an amount F is sufficient to fund a pension with annual amount y to a pensioner aged x ?" The main idea is to approximate the future lifetime distribution with a combination of exponentials, and then apply a known formula (due to Yor) related to the integral of geometric Brownian motion. The approximations are very accurate in the cases studied

Fourier inversion formulas in option pricing and insurance

Daniel Dufresne, University of Melbourne, Australia
Jose Garrido, Concordia Unvi., Montreal Canada
Manuel Morales, University of Montreal, Canada

Abstract: Several authors have used Fourier inversion to compute prices of puts and calls, some using Parseval's theorem. The expected value of $\max(S - K, 0)$ also arises in excess-of-loss of stop-loss insurance and we show that Fourier methods may be used to compute them. In this paper, we take the idea of using Parseval's theorem further: (1) formulas requiring weaker assumptions; (2) relationship with classical inversion theorems for probability distributions; (3) formulas for pay-offs which occur in insurance. Numerical examples are provided.

Quantitative Risk Measures of Individual Life Settlement Purchases

Shamita Dutta Gupta
Pace University

Abstract: Life Settlement market provides life insurance policyholders an opportunity to realize the values embedded in their policies. It offers liquidity to policyholder and at the same time it creates a new asset class for investors seeking uncorrelated risks. The market has been growing rapidly in recent years. In this paper (talk), we will provide a few summary quantitative risk measures in investing in life settlement policies. It is obvious that the risk of investor reduces as the portfolio size increases. But in this work, we will focus on measures that relate only to individual policy purchases. As examples, some of the measures are, the cost and benefit ratio, the breakeven mortality multiple, the breakeven mortality year, and the breakeven probability. The conclusion is that picking a policy with less cost of carry is as important as picking a policy with high mortality multiple. Lower the cost of carry, Smaller the risk.

Modeling treatment costs associated with a multi-stage pandemic

Michael Ekhaus
Gibraltar Analytics

Abstract: Introduced is an Interacting Particle System (IPS) approach to modeling multiple stage pandemics. The model population receives differing treatments with possibly differing costs depending on the stage of exposure/infection. The total cost of treatment is a time varying utility function of the ensemble population for which this approach uses particle system methods to simulate the cost of maintaining survival of the population. Interacting Particle Systems are a class of spatial-temporal stochastic processes suitable for studying the spread of infectious diseases and other interaction phenomena.

The paper gives a brief background on particle systems with specific focus on "the contact process", followed by expanding the contact process to represent more realistic state transitions.

Generalized Gerber-Shiu Function in Piecewise-deterministic Markov Processes

Runhuan Feng
University of Waterloo

Abstract: Introduced by Gerber and Shiu (1998) in NAAJ, the Gerber-Shiu expected discounted penalty function has ever since become the standard technical tool in the actuarial literature to analyze a variety of ruin-related quantities such as the probability of ultimate ruin, the joint distribution of the surplus prior to ruin and the deficit at ruin. As ruin theory progresses, great efforts have been made in the literature to study the dividends paid to shareholders up to ruin, which is not a special case of the Gerber-Shiu function. It has been brought to our attention that most techniques applied to the dividends problem are basically parallel to those employed in the analysis of the Gerber-Shiu function. The similarity between the solution methods led us to propose a more general function that contains both the Gerber-Shiu expected discounted penalty function and dividends paid up to ruin, as well as many others that have not been taken into consideration in the same systematic way, such as the insurer's accumulative utility, expected total discounted claim expenses, etc. Not only does the generalized Gerber-Shiu function accommodate more quantities, it is also applicable with a more general class of underlying risk processes called the piecewise deterministic Markov processes, which includes most well-studied non-diffusion processes such as the compound Poisson, Sparre Andersen with phase-type inter-claim times and Markov-modulated risk processes. Our major result provides an unifying approach to obtain integro-differential equations for all ruin-related quantities that fall in the category of the generalized Gerber-Shiu function. In the end, we shall demonstrate the application of generalized Gerber-Shiu function by recovering many well-known results in the literature as well as producing solutions to other aforementioned new quantities of interests.

Valuation of Equity-Linked Insurance Using Risk Measures

Patrice Gaillardetz
Concordia University

Abstract: In this talk, we consider the pricing of equity-indexed annuities using risk measures and present dynamic hedging strategies underlying these valuations. Since these products involve mortality as well as financial risks, we combine the actuarial and financial approaches to protect insurance companies against the unhedgeable mortality risk. First, risk measures are used to determine loaded premiums for equity-indexed annuities. Capital requirements are defined by applying the risk measure on the discounted future losses of the equity-linked insurance contract. Then, using the arbitrage-free theory we seek martingale mortality probabilities such that the fair value of the contract is equal to the capital requirement at time 0. Hence, given the martingale probabilities we can extract the underlying dynamic hedging strategy for the equity-linked products. However, these replicating portfolios are based on certain assumptions and produce discrete hedging errors since the underlying hedging strategies are not self-financing. Thus, the different risk measures obtained will be compared using their respective hedging errors.

Stochastic Modeling - a Research Experience for Undergraduates

Rick Gorvett
University of Illinois

Abstract: During Summer 2007, a Research Experience for Undergraduates (REU) program entitled "Stochastic Modeling in Actuarial Science and Financial Mathematics" is being offered at the University of Illinois at Urbana-Champaign. This program is being offered to six mathematics undergraduate students from different universities in the U.S., and is funded by the National Science Foundation. This presentation will summarize the research projects undertaken by these students during this REU experience.

Using Actuar in Teaching: Case Studies

Vincent Goulet
Université Laval, Québec

Abstract: The actuar project is a package of Actuarial Science functions for the R statistical system. The package currently contains functions and data sets aimed for loss distributions modeling, risk theory and credibility theory. Following R's general philosophy, the functions are designed to serve as tools to ease modeling. This is in contrast to "black boxes" that would automatically return results without one's proper understanding of the underlying principles. This presentation will demonstrate how the package can prove useful in classroom use to solve typical problems in each of the fields mentioned above.

Subexponential Tail of Discounted Aggregate Claims

Xuemiao Hao and Qihe Tang
University of Iowa

Abstract: We study the tail behavior of discounted aggregate claims in a continuous-time renewal model. For the case of subexponential claims, we establish an asymptotic formula, which holds uniformly for all time horizons within a finite interval. Restricting to the compound Poisson model, we further prove that this formula holds uniformly for all time horizons. The uniformity of the asymptotics established is crucial for our applications.

Metrics For Matches, Mismatches, and Non-Matches

Tom Herzog
FHA/HUD

Abstract: When performing record linkages it is important to know the extent to which one has identified (1) correct matches and (2) erroneous matches, or failed to match records that should be matched. In this talk, we review a number of metrics that have been proposed to measure such situations. We also describe the strengths and weaknesses of such metrics and discuss possible research problems in this area.

Possibilistic Modeling for Loss Distribution and Premium Calculation

Zhen Huang & Lijia Guo
Otterbein College

Abstract: This paper uses possibility distribution approach to estimate the insurance loss amount. A special class of parametric possibility distributions is used to model insurance loss variables. The parameters of the possibility distribution are estimated by combining statistical analysis of sample data and domain knowledge provided by actuarial experts. Insurance premiums are calculated using possibilistic mean, downside risk, and possibility quintile. Since our risk loading premium calculation method separates overall risk into downside risk and upside risk, it can be applied spatially to those asymmetric loss possibility variables with a heavy right tail. Estimation of aggregate loss claim amount is also discussed.

Implementation of Markov approach to Joint Life Mortality

Min Ji
University of Waterloo

Abstract: Based on the industry-wide joint life annuity data, it is shown that there is an obvious dependence between the mortalities of a couple of husband and wife, due to the effect of common life style, broken heart factor and common shock as mentioned in many papers. At the present, the research on how to model such dependence is mainly focused on parametric models, for example, Youn, Heekyung Arkady Shemyakin, and Edwin Herman (2002). Some very preliminary work has been done using the Markov approach (Li, 2006, in a Masters essay). This empiric study gets mortality rates in each state and captures the extent of dependence between wife and husband based on the available bivariate data, introduces common shock factor into Li's Markov approach, and then moves to semi-Markov model, i.e., the selection (i.e. duration) effect of mortality being modeled. Such a try aims at developing a full model reflecting more realistic joint life mortality in the pricing and risk management of a wide range of joint life products, including life insurance, annuities, pensions, and reverse mortgages.

Mitigating the Impact of Endogeneity in Healthcare Data via Multilevel Models

Paul Johnson
University of Wisconsin-Madison

Abstract: It has been widely recognized that racial disparities exist in healthcare. In particular, analysts have found extensive evidence of racial disparities in mental healthcare, both in health status outcomes associated with mental health treatment and in utilization of mental health services. These racial disparities have been attributed to factors such as differences in socio-economic status health insurance coverage, patient preferences for treatment, physician bias, and discrimination. This paper examines whether racial disparities occur in inpatient mental health treatment, by considering the outcome variable hospital total charges (TOTCHG). We consider whether TOTCHG incurred by discharges admitted for a mental health disorder vary significantly for US adults (ages 18 to 64) by race, using 2003 data from the Healthcare Cost and Utilization Project's Nationwide Inpatient Sample and the Area Resource File, which contain discharge, hospital, and county information. We expand upon the ordinary least squares models used previously in the literature by modeling TOTCHG with multilevel models, and show that more precise estimates of model parameters and different inferences about racial disparities are obtained. Further, these data are endogenous; factors such as patient preferences and physician bias are omitted variables that can bias the regression coefficients of many model covariates. We employ multilevel model-based fixed effects and instrumental variables estimation strategies that mitigate the impact of these endogeneities. These methods are recommended as an alternative approach to modeling potentially endogenous healthcare data.

Claims Prediction Model and the Simulation of Health Savings Account (HSA) Performance

Vincent Kane
Urx/DxCG

Abstract: Using three waves of data from the Health & Retirement Study, a two-part medical claim prediction model is estimated for the cohort of survey respondents approaching Medicare-eligibility age (age 50-65). Based on this claims prediction model, forecasted claims streams are generated for the selected population, the “average respondent”, and a set of “hypothetical respondents” with varying health status. A High Deductible Health Plan (HDHP) with a companion Health Savings Account (HSA) is applied to the simulated claims streams to model the build-up of HSA assets over the near-retirement years. Results show that the HSA is a grossly inadequate savings vehicle to provide for retiree medical care expenses at age 65, even when allowing catch-up provisions and maximum HSA contributions for this age cohort. Moreover, HSA adequacy worsens exponentially with decreasing health status, whether self-reported or measured as the number of chronic medical conditions. Based on these simulation results, it is apparent that Baby Boomers cannot adequately provide for the costs of medical care in retirement using HSAs exclusively. For the chronically ill in this age cohort, HSA performance deteriorates so rapidly that high deductible plan choice based on a savings motivation cannot be justified in simulation. It remains to be seen what will attract the chronically ill to such plans.

Fuzzy clustering study on the structure of insurance policies

Yefu Kou
University of Waterloo

Abstract: In this study, we propose using a fuzzy clustering method for analyzing and classifying insurance policies. By identifying and comparing the similarities and dissimilarities among the vast number of insurance policies, this method can provide additional insights on the characteristics of these policies. This in turns can have important implications on improving the pricing of the existence policies and also on the underwriting of future insurance policies. The advantages of our proposed approach are demonstrated by using a simulated example.

Fixing Social Security and Medical Care

Andrew Lang

Retired health care and pension consulting actuary

Abstract: Together Social Security and medical care are near the top of the world's most serious problems. Yet Social Security is very easy to fix; and while medical care is tougher, it needs the very same type of plan and two components before it can succeed.

On Pricing and Hedging the No-Negative-Equity-Guarantee in Equity Release Mechanisms

Siu Hang Li, Mary Hardy, and Ken Seng Tan

The University of Waterloo

Abstract: For many people, a shortfall in retirement income can be met by participating in home equity release mechanisms (ERMs) which enable homeowners to draw down part of the equity in their houses. Among various types of ERMs, roll-up mortgages are the most popular in the UK equity release market today. In a roll-up mortgage, the homeowner receives a loan in the form of a lump sum. The loan is rolled up with interest until the homeowner dies, or moves into long-term care. The house is sold at that time, and the proceeds are used to repay the loan and interest. For most policies, the loan repayment cannot exceed the proceeds of the house sale. This is called the No-Negative-Equity-Guarantee (NNEG), which may be viewed as a put option on the sale of the property. The valuation of the NNEG requires a model for stochastic future mortality and a time-series process that can reasonably model the auto-correlation and varying volatility effects in the dynamics of house price returns. However, under the identified time-series process, there exists more than one equivalent risk-neutral probability measure, leading to many possible prices for the guarantee. This phenomenon is known as market incompleteness. The core of this study is the investigation into the pricing formula, and the hedging and capital reserving strategies for the NNEG in such an incomplete market.

Diffusion Processes and their Applications in Financial Market

George Liu
University of Waterloo

Abstract: Commercial commodities are found to have strong mean reversion property in their spot prices. For instance, electricity prices (or their logarithms) tend to revert to some fundamental level in the long run. Mean reverting processes are frequently used in real options to well describe this stochastic behaviour, and are thus very useful for pricing futures contracts, and valuating other financial and real assets. In this paper, we use a nonlinear Vasicek model for the electricity spot price, to derive the future price. And we develop the closed-form Maximum Likelihood Estimators for the parameters of our model, and do some calibrations and data analysis with the historical spot data and forward data in electricity market of Norway. The nonlinear Vasicek model we propose does not give rise to the price spikes that are such a prominent feature of the actual spot prices in the Norway markets. One possible approach to incorporating these is by including jump terms in this model.

An approach to valuing guaranteed minimum income benefit riders

Claymore Marshall and David Saunder
University of Waterloo

Abstract: This research considers an approach to pricing and hedging a typical Guaranteed Minimum Income Benefit (GMIB) rider available in the U.S. market. A GMIB is a rider offered on a variable annuity that guarantees the policyholder a minimum level of income for the rest of their life when the policy matures, protecting against poor market performance on the policyholder's annuity investment. Most GMIB riders offered in practice have complex payoff structures which are difficult, if not impossible, to value analytically. Simulation is used to value the payoff on a particular rider offered in practice, based on benchmark financial models.

Analysis of a Threshold Strategy in the Discrete-time Sparre Andersen Model

Ana Maria Mera
University of Waterloo

Abstract: In this paper, it is shown that the application of a threshold on the surplus level in a particular discrete-time delayed Sparre Andersen insurance risk model results in a process that can be analyzed as a doubly infinite Markov chain with finite blocks. Two major cases, encompassing all possible values of this threshold, are explored. Matrix analytic methods are employed to establish a computational algorithm for each case. The resulting procedure is then used to calculate the probability distributions associated with fundamental ruin-related quantities of interest, such as the time of ruin, the surplus immediately prior to ruin, and the deficit at ruin. The ordinary Sparre Andersen model, an important special case of the general model, with varying threshold levels is considered in a numerical application.

Comparison of a simple Bayesian Reserving Model with traditional Methods

Yessica Perez-Camarillo
A.C. Nielsen & ITAM, Mexico

Abstract: There is a large literature on claims reserving. The available methods range from the simple deterministic ones to the very sophisticated stochastic. Stochastic or statistical models allow the actuary to estimate future claims along with some measure of their uncertainty, such as the variance. The more advanced methods will provide, in addition, the complete distribution or some quantiles. However most of the stochastic models are too complex and end up being a black box for practitioners. They also tend to be overparameterized, which has the effect that they tend to model historical observations very accurately, but they do not necessarily perform well when predicting future claims. In this paper we apply a Bayesian method that was developed for forecasting very short series with stable (seasonal) patterns. It is constructed on basic Bayesian concepts and leads to very simple prediction formulas. Then we compare it with several other methods as to their predictive effectiveness. In so doing, we depart from the traditional ‘triangle-shaped’ framework for development data.

Death of an Annuity Market Foretold

Ana Veronica Perez Villasana and Tapen Sinha
ITAM, Mexico

Abstract: In the past decade, most research on the structure, performance, and regulation of publicly mandated but privately pension funds. Most research has been focused on the accumulation phase of private pension. There has been less effort to examine the problems of the payout phase. Many countries that have enhanced the role of the private sector in pension provision will start facing the problem of converting the individual balances accumulated in defined contribution schemes into streams of retirement income, such as contingent annuities.

How does a country design and develop an efficient market for such products from a low initial base? Can the insurance sector can effectively deliver relatively complex products such as annuities, and honor contracts that span decades? Given the lack of reliable mortality data in countries where there is no history such data in developing countries, there is very little institutional and regulatory framework.

Mexico substituted its defined benefit system (IMSS) of the formal sector by a defined contribution system in 1997. The initial plan called for buying single premium annuities for the widows and disabled workers under the new system. In the first three years, this market came to occupy a significant part of the insurance sector. Then, the number of workers getting benefits started to fall dramatically.

We show that such a fall has been a direct result of how the IMSS authorizes the issuance of single premium annuities. We analyze the rationale behind such a dramatic change in policy. It stems from a cash-flow problem that IMSS is trying to stem. We analyze various possible scenarios of IMSS strategies. We examine the problem to see if it brings in any long-term benefits to IMSS.

Is a Final Salary DB Plan that Much Better than a DC Plan?

Semira Puskar and Claire Bilodeau
Laval University

Abstract: The Cadillac pension plan seems to be the final salary defined benefit pension plan. It is known that the defined contribution plan may at times offer a much better deal, but it comes with all the financial risk... Notwithstanding, is the final salary defined benefit plan really the one plan every employee should wish for?

On the Application of Wilkie's Models to TSX Price Index

Chao Qiu
University of Calgary

Abstract: My presentation evaluates the ability of Wilkie's stochastic investment models to predict TSX price index yield. Wilkie's model suggested constructing the correlation of different econometric indices through a cascade structure.

The empirical study of TSX price index yield in this thesis shows the following results with regard to Wilkie's model:

1. The suggested multivariate models by Wilkie's cascade structure do not make significantly better prediction than univariate models do.
2. The dividend yield model is not suitable for prediction based on latest data analysis.
3. The new model structure suggested in this thesis is similar to the Wilkie's structure, but not a cascade one. There are some significant feedback relationships between different components.

Therefore this presentation suggests a multidirectional model structure without dividend yield as a tool to predict the movement of any components within the structure.

A Bayesian Two-Part Predictive Model for Health Care Costs Using Individual-level Data

Margie Rosenberg
University of Wisconsin-Madison

Abstract: The incidence rates and costs of inpatient health care are each known to have long-tailed distributions. A Bayesian two-part model that considers the probability of hospitalization in the first part and the costs of the inpatient stay in the second part is developed using individual-level data collected over time. Predictive distributions for each individual resulting from the modeling process are used to estimate the number of hospitalizations and costs by individual, and by calendar year. One advantage of this approach is that differences by individuals, such as disease severity, are automatically reflected. In addition, these predictive distributions can be used to illustrate the extreme variability in hospital utilization. Knowledge of this potential uneven and unpredictable occurrence of utilization, and potential cost, would be beneficial in the design of insurance programs or for disease management programs.

Fuzzy Random Variables

Arnold Shapiro
Smeal College of Business, Penn State University

Abstract: There are two important sources of uncertainty: randomness and fuzziness. Randomness models the stochastic variability of all possible outcomes of a situation and fuzziness relates to the unsharp boundaries of the parameters of the model. In this sense, randomness is largely an instrument of a normative analysis that focuses on the future, while fuzziness is more an instrument of a descriptive analysis reflecting the past and its implications. Clearly, randomness and fuzziness are complementary, and so a natural question is how fuzzy variables could interact with random variables. This presentation focuses on one important dimension of this issue, fuzzy random variables (FRVs). The goal is to model these FRVs and, in doing so, to illustrate how naturally compatible and complementary randomness and fuzziness are.

Knowledge or skills ... or both?

John Shepherd
Macquarie University

Abstract: Actuarial curricula everywhere tend to focus on “what actuaries need to know” at the expense of “what actuaries need to do”. This paper aims to identify a set of generic capabilities that underpin “what actuaries need to do”, and to suggest how future actuaries might be enabled and encouraged to develop these capabilities through their educational experiences.

Research evidence from higher education suggests that stand-alone skills development courses are less effective than programs that integrate skills development with the learning of core knowledge. This raises a challenge for course design of achieving a balance between substantive knowledge content and skills development.

The paper discusses the integration of generic actuarial skills into the education curriculum. A developmental approach is advocated, giving students regular opportunities to gradually build and appreciate such skills as they move through the curriculum. Opportunities to learn, practise, receive feedback, evaluate and reflect on the skills need to be embedded in the learning of the core knowledge and techniques.

Assessment of students’ skills is identified as a critical curriculum design issue. Traditional assessments like exams are suited neither to assessing levels of skills (eg teamwork, research) nor to assessing whether students can transfer skills from one context to another. The paper suggests ways in which actuarial education curricula may be enhanced to foster the development by future actuaries of capabilities and attributes that will ensure they not only know “what actuaries need to know” but can also do “what actuaries need to do”.

Salary Profiles of Affiliates of Pension Funds

Tapen Sinha
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Abstract: Calculating the retirement benefits under a defined contribution pension plan requires information about lifetime salary profiles along with the density of contribution. Most often, in developing countries, a simple income profile is assumed with no regard to actual income profiles. One commonly used rule is to assume a x percent growth in income throughout the working lives of affiliates. Does the reality correspond to such assumptions? Using Mexico as an example, we set out to examine this question. We start with a dataset of 100,000 men and 100,000 women who are in the Mexican defined contribution scheme during the period 1998-2005. The dataset is a stratified random sample with equal number of people from each quintile of income distribution such that the age of each affiliate is 20, 25, 30, 35, 40, 45, 50, 55 and 60 in 1998. Thus, we follow the actual income path of each person in each group during 1998-2005. We show that for each group, the real income is almost always increasing during this period. However, the rate of increase vary substantially between age groups, between income levels and between men and women. We also show that macroeconomic factors play a significant role in the behavior of income dynamics. We draw policy conclusions from these observations.

Portfolio Risk Management with CVaR-like constraints

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Abstract: Our paper proposes a new optimization approach applying CVaR-like constraints for portfolio risk management. CVaR is defined as the expected loss (or return) exceeding the Value-at Risk (VaR). The CVaR optimization technique aims at reshaping the left tail of the distribution and has no impact on the right one significantly, or vice versa. Instead of optimizing CVaR directly, we show how to manage portfolio risk by adding CVaR-like constraints to the traditional Markowitz mean-variance (MV) optimization problem. Actually, we can add more than one CVaR-like constraint and reshape the return distribution according to the customers' preferences. We illustrate how to apply the CVaR-like constraint method with an example on optimizing an insurer's asset-liability portfolio.

We also compare the proposed CVaR-like constraint approach with some other alternatives such as CVaR approach (directly optimize CVaR), VaR approach (optimize VaR instead of variance conditional on the mean constraint), Boyle-Ding approach (an approach that linearizes skewness within a small interval of the original portfolio) as well as mean-absolute deviation (MAD) approach (use the absolute value of deviation instead of variance to measure the variation). Our numerical analyses clearly demonstrate the effectiveness of the CVaR-like constraint approach on improving MV skewness compared with our discussed other methods.

Enhancing Insurer value using Reinsurance and Value-at-Risk Criterion

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Abstract: The quest for optimal reinsurance design has remained an interesting problem among insurers, reinsurers, and academicians. An appropriate use of reinsurance can reduce the underwriting risk of an insurer and thereby enhances its value. This paper complements the existing research on optimal reinsurance by proposing another model for the determination of the optimal reinsurance design. The problem is formulated as a constrained optimization problem with the objective of minimizing the value-at-risk of the total risk of the insurer while subjecting to a profitability constraint. The proposed optimal reinsurance model, therefore, has the advantage of exploiting the classic tradeoff between risk and reward. Under the additional assumptions that the reinsurance premium is determined by the expectation premium principle and the ceded loss function is confined to a class of increasing convex functions, explicit solutions are derived. Depending on the risk measure's level of confidence, the safety loading for the reinsurance premium, and the expected profit guaranteed for the insurer, we establish conditions for the existence of reinsurance. When it is optimal to cede the insurer's risk, the optimal reinsurance design can be in the form of pure stop-loss reinsurance, quota-share reinsurance, or some combination of them.

Disability Causes and their Effect in the Mortality of Disabled Annuitants in Mexico

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Abstract: Development of annuities markets is a critical element of any private system. In Mexico, when the new pension regimen came into existence in 1997, the Mexican Institute of Social Security (IMSS) was supposed to buy a single premium annuity for all the people who become eligible under the new regime. According to the rules, the eligible person would receive offers from different insurance companies authorized to sell annuities. Depending on the preference of the eligible person, he or she would select one offer. IMSS would be informed of this choice and in turn, it would authorize a single premium for the annuity.

The number of people who has become eligible from 1997 to 2003 is 134,754. Disability pensions represent 37% of total pensions sold up to date. Mortality of disables show substantial differences against the mortality table use to compute the annuity. Most of the differences can be explained by looking at the disability causes.

IMSS issues a Disability Medical Certificate, which includes the cause of disability, but Insurance Companies have no access to this document.

Using information for social security for 2001 and 2002, regarding mortality and disability, this paper presents the main causes of disability among disables and the main causes of mortality of those disables who died in their first and second year of disability. The analysis of those cases apart from explaining the important differences between the expected mortality and the observed mortality during the first two years of disability, also explains some of the latter changes in the operational rules of IMSS.

Economic Capital and Regulation of Banks and Insurers

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Abstract: In many countries, insurers and banks are separately regulated. In some countries, banks and insurers are not allowed to be part of the same conglomerate and share capital. This raises questions about the efficient use of capital and return on equity to shareholders. In this empirical study, we view economic capital from a solvency perspective with the focus on downside risk. The key question addressed is "What efficiencies, if any, are gained by allowing banks and insurers of different types to merge and thus share capital." We examine to what degree bank and insurer performances have been correlated historically, especially in the downside tail. This case study is based on Canadian banks, life insurers and property-casualty insurers.

Generalized Linear Models in Loss Reserving

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Abstract: Loss reserving is one of the most challenging tasks facing actuaries. Numerous approaches have been developed to give reasonable estimates. Recently, some aggregate loss reserving models have been extended or developed by academicians with the framework of generalized linear models (GLMs). In this paper we established a more complex structural reserving method with more detailed information as premium exposure emergence pattern, loss emergence pattern and loss development pattern within the framework of GLMs under certain assumptions.

A risk model when premium rate depends on claim size

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Abstract: This paper considers a dependent classical risk model with diffusion, in which the premium rate is determined by the amount of the previous claim. It is assumed that different claim size will lead to different premium rate, such as a large claim size will lead to higher premium rate and small claim size will allow to be lower premium rate. At the same time, we can also assume that each premium rate has a different diffusion coefficient. Using the tool of Laplace transform, we give the closed Laplace transform form of the survival probability. Moreover, we also show that the survival probability can be obtained step by step by employing renewal equations. At last, some examples are presented to show the influence of parameters on the probability of ruin

New Iterative Calculation of American-style Derivatives -- a lower approximation of the Snell envelope

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Abstract: I present an iterative procedure for computing the lower approximation of the Snell envelope - a value process of the American option. The method produces an increasing sequence of approximations of the Snell envelope from below, which coincide with the Snell envelope in discrete time after finite steps. Advantages of this method compared with other well-known traditional approaches will be discussed first. Then, I will elaborate the algorithm details associated with theoretical proofs. An example of constructing the lower approximation is available with numerical results, which are demonstrated in figures. Some characteristics of the implementation in the computational environment and an improvement are mentioned at the end.
