Abstract Booklet for the
2016 Congress on Insurance: Mathematics and Economics
at Georgia State University in Atlanta

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Welcome

On behalf of the Scientific and the Organizing Committee for the 20th International Congress on Insurance: Mathematics and Economics (IME 2016) and the Department of Risk Management and Insurance at Georgia State’s Robinson College of Business, we are very pleased to welcome you to the IME 2016 Conference. The Insurance: Mathematics and Economics congress series is one of the largest and most prominent meeting series in actuarial science. It brings together researchers and practitioners interested in the latest developments in actuarial science to exchange ideas and learn from each other. Since the inaugural IME 1997 in Amsterdam, the meetings have taken place in different locations around the globe. We are very happy about the opportunity to introduce you to Atlanta this time around. We hope that you will enjoy your days here.
Sunday, July 24

Welcome Cocktail Reception: 5:00pm - 7:00pm
Location: J. Mack Robinson College of Business; 55 Park Place NE; Atlanta, GA 30303

Monday, July 25

Registration and Breakfast: 8:00am - 9:00am
Location: Georgia State University; Student Center East (SCE) – Court & House Salons; 55 Gilmer St NE, Atlanta GA 30303

Plenary Session I (Insurance): 9:00am - 10:15am
Location: SCE Auditorium; Chair: Daniel Bauer
Opening Remarks by Richard Phillips, Dean of the Robinson College of Business

Title: Exit time and occupation time problems for insurance risk processes
Presenting Author: David Landriault, University of Waterloo
Abstract: In this talk, I will review some of the recent contributions on first passage times and occupation times for insurance risk processes. A risk management perspective will be given to the quantities under study, which include Parisian ruin, drawdown, and occupation time problems. Special attention will be paid to their analysis in the context of two insurance risk processes, namely the Cramér-Lundberg risk process and the spectrally negative Lévy process. References will also be provided for other notable insurance risk processes, such as the Sparre Andersen risk process and the spectrally negative Markov-additive process.

Coffee Break: 10:15am - 10:45am
Location: Court & House Salons

Slot 1: 10:45am - 12:45pm (A1-F1)
A1 – Pensions: Retirement Issues (Location: SCE Auditorium; Chair: Enrico Biffis)

10:45-11:15
Title: Longevity Risk and Retirement Income Tax Efficiency: A Location Spending Rate Puzzle
Presenting Author: Moshe A. Milevsky, York University (with Huaxiong Huang)
Abstract: We document the pattern by which Canadians de-accumulate financial wealth during retirement and find it puzzling. While the Modigliani lifecycle model can justify a variety of de-accumulation rates, the existence of asymmetric taxes imply that certain financial accounts should be depleted faster than others. Yet our analysis of data from the Survey of Financial Security indicates that Canadian retirees maintain approximately two-thirds of their financial wealth in tax-sheltered accounts and a third in taxable accounts throughout
regardless of age. The ratio of taxable to tax-sheltered wealth increases slightly or remains relatively constant depending on household income which is not what one would expect in theory. Although these are reported averages, we use this aggregate evidence as motivation to (i.) model, (ii.) fully characterize and (iii.) solve a retirement consumption problem under longevity risk aversion with differentially taxed accounts; which is the main contribution of the paper. Indeed, we can’t locate a plausible tax function that justifies a constant "account ratio" with age. For example under flat rates taxable accounts should be depleted well before tax-sheltered accounts are ever touched. The account ratio should go to zero quite rapidly. Under progressive income taxes withdrawals are made from both accounts but at different rates depending on account size, pension income and longevity risk preferences. Again, the "account" ratio should eventually decline. The fact that (Canadian) retirees don’t behave this way is puzzling and is likely due to behavioral considerations linked to mental accounting, etc. It remains to be seen whether retirees in other countries exhibit the same behavior, or perhaps they are less emotional with their taxes.

11:15-11:45

Title: A study on the duration of changes in the generational account options

Presenting Author: Yung-Tsung Lee, National Chiayi University

Abstract: This study plans to investigate the sensitivity of the change in the generational account option to interest rate. Proposed by fiscal economists, generational accounting is a tool to investigate the intergenerational redistribution effects of fiscal policies (Auerbach et al., 1991, 1994; Auerbach et al., 1999; Kotlikoff, 2002). Several researches have extended the concept of generational accounting to pension funds and explore intergenerational value transfers when pension policy switches (Ponds, 2003; Hoevenaars and Ponds, 2008; Cui et al, 2011). However, to the best of our knowledge, the effect of interest rate on the intergenerational transfer has not been studied. This paper attempts to fill this gap by employing the duration approach. Following Hoevenaars and Ponds (2008), we separate the generational account option into two parts: the net benefit option and the residue option. We study the impact on the redistribution of cohorts by valuing the change in the generational account option held by cohort x when policy switches, and this can be separated into the change in the net benefit option and the change in the residue option. The purpose of this study is to investigate the sensitivity of redistribution of cohorts to a change in interest rate. As a measure of interest rate risk, the durations of various asset classes and financial institutions, including insurance companies (e.g., Tsai, 2009) and pension funds (e.g., James and Donald, 2009), has been explored extensively. This paper employs the duration analysis to assess the impact on the change in expectation, i.e., the change in the generational account option, when interest rate changes. Due to the population aging and financial pressure, there is a tendency to reduce costs and increase the contribution for government sponsored DB pension plans. Pension reforms and policy switches are much more common. Generational accounting method provides a useful tool for governments understanding the potential impact on the intergenerational transfers when pension policy switches. Our study explores the impact on the intergenerational transfers when interest rate changes and this helps the application of generational accounting on pension funds go a step further.

11:45-12:15
Title: An Actuarial Analysis of Australian Retirement Village Contracts using Survival Modelling: A Consumer Perspective

Presenting Author: Timothy Kyng, Macquarie university (with Ling Li)

Abstract: Retirement villages (RVs) provide "age friendly" accommodation for the healthy aged. With the aging of the population, demand for retirement village residency is likely to grow. The average consumer’s entry age to RVs is 74 and 67% of them are female. Recent studies of financial literacy indicate that these types of consumers have low levels of financial literacy. RV contracts are complex for consumers to understand and it is difficult for them to compare contracts from different RVs. Applying an actuarial approach, we show that these RV contracts are a combination of insurance and financial products including life tenancies, life annuities, death and disability insurance policies and real estate options exerciseable at the time of exit. This paper proposes several different financial and demographic metrics to quantify the costs and benefits of RV contracts for consumers and to facilitate comparison between different RV contracts. This involves survival modelling of the RV population allowing for both death and disability as exits from the population. Consumers are buying complex insurance and financial products from organisations which are very lightly regulated compared to financial institutions.

12:15-12:45

Title: Saving for Retirement: The Role of Housing

Presenting Author: Mengyi Xu, University of New South Wales (with Michael Sherris and Adam Wenqiang Shao)

Abstract: The family home is typically the single most important asset in household portfolios. Outright home owners can live rent-free, which provides a hedge against rental inflation. Wealth stored in housing can be unlocked through equity release products to improve retirement living standard or to fund health care and aged care. Housing, therefore, plays a pivotal role in retirement planning. Apart from housing wealth, future generations of retirees in Australia are likely to have a significant amount of savings from their superannuation accounts due to longer periods of superannuation coverage and higher contribution rates. The research examines how purchasing home property at different ages would affect an individual’s pre-retirement consumption levels, the amount of savings for retirement, and ultimately the overall utility levels over the working life. The retirement savings consist of liquid assets (cash and stocks), superannuation, and home property net of any mortgages (if home owner). We use a vector autoregressive (VAR) process to model the dynamics of asset returns and labour income growth, and perform Monte Carlo simulations to analyse the role of housing. The parameters of consumption and asset allocation decisions are estimated using the Household, Income and Labour Dynamics in Australia (HILDA) Survey data, reflecting an average Australian’s decisions in his/her age group and home ownership status.

B1 – Actuarial Finance: ALM I (Location: SCE Senate Salon; Chair: Jan Dhaene)

10:45-11:15

Title: Optimal portfolios with downside risk

Presenting Author: Jing Yao, Vrije Universiteit Brussel (with Fima Klebaner, Zinoviy Landsman, and Udi Makov)
Abstract: Markowitz optimal portfolio theory, also known as the Mean-Variance theory, has had a tremendous impact and hundreds of papers are devoted to this topic. This theory addresses the question of minimizing risk for a given expected return and an optimal solution is found under one of the two assumptions: the distribution of the portfolio is normal, or the utility function is quadratic. In this theory, investor’s decision formulates a trade-off between the return and the risk, in which the risk is measured by the variance of the returns. However, it has also been noted numerously in the past, starting with Markowitz himself, that the investors are more concerned with downside risk, i.e. the possibility of returns falling short of a specified target, rather than the variance, which takes into account both the favourable upside deviations as well as the adverse downside parts. Moreover, such classic Mean-Variance framework does not consider investor’s individual preferences. Thus, alternatives are proposed in the literature in the form of downside risk measures, such as target shortfall and semi-variance, or more generally, the so-called lower partial moments; see, for example, Harlow [2] and Sawik [3], Cumova and Nawrocki [1]. This article considers downside risk measures $E((X - K)^a)$, where $a = 1, 2$ and $(X - K)^- = \max(0, K - X)$. When vector of stock returns $X$ has multivariate normal distribution we show that minimization of downside risk for portfolios with pre-specified expected returns leads to the same solution as minimization of the variance. Hence such optimal portfolios are defined by the Markovitz optimal solution. If the expected returns are not pre-specified, we show that the problem of minimization of downside risk has an analytical solution and we present this solution together with several illustrative numerical examples. We also solve the problem on minimization of mixed downside risks considered here, and provide the numerical illustration of results.

Title: Mean-variance asset liability management problem under non-Markovian regime-switching models

Presenting Author: Yang Shen, York University

Abstract: In this paper, we discuss an asset-liability management problem under a mean-variance criterion with regime switching. Unlike previous works, the dynamics of assets and liability are described by non-Markovian regime-switching models. The problem is solved by backward stochastic differential equations and bounded mean oscillation martingales. An efficient strategy and an efficient frontier are obtained and represented by unique solutions to several backward stochastic differential equations. The framework of this paper is general enough to recover some results in existing works and provide some new insights for stochastic control in insurance and finance under regime-switching models.

Title: Markowitz’s mean-variance optimization with investment and constrained reinsurance

Presenting Author: Nan Zhang, University of Melbourne (with Ping Chen, Zhuo Jin and Shuanming Li)

Abstract: This paper deals with the optimal investment-reinsurance strategy for an insurer under the criterion of mean-variance. The risk process is the diffusion approximation of a compound Poisson process and the insurer can invest its wealth into a financial market consisting of one risk-free asset and one risky asset, while short-selling of the risky asset is prohibited. On the side of reinsurance, we require that the proportion of insurer’s retained
According to the dynamic programming in stochastic optimal control, the resulting Hamilton-Jacobi-Bellman (HJB) equation may not admit a classical solution. In this paper, we construct a viscosity solution for the HJB equation, and based on this solution we find closed form expressions of efficient strategy and efficient frontier when the expected terminal wealth is greater than a certain level. For other possible expected returns, we apply numerical methods to analyse the efficient frontier. Several numerical examples and comparisons between models with constrained and unconstrained proportional reinsurance are provided to illustrate our results.

C1 – Insurance Risk Models: Dividends (Location: Sinclair; Chair: Hansjoerg Albrecher)

10:45-11:15

Title: Optimal Dividend and Investment Problems under Sparre Anderson Model

Presenting Author: Lihua Bai, Nankai University

Abstract: In this paper we study an optimal dividend and investment problem assuming that the underlying reserve process follows the Sparre Anderson model, that is, the claim frequency is a "renewal" process. The main feature of the problem is that the underlying reserve dynamics, even in its simplest form, is no longer Markovian. By using the backward Markovization technique we recast the problem in a Markovian framework with expanded dimension, from which we validate the dynamic programming principle. Consequently, we prove that the corresponding value function is a unique constrained viscosity solution to the associated HJB equation.

11:15-11:45

Title: Optimal capital injection and dividend distribution for growth restricted diffusion models with bankruptcy

Presenting Author: Hailiang Yang, Hong Kong University (with Jinxia Zhu)

Abstract: We consider the optimal capital injection and dividend control problem for a class of growth restricted diffusions with the possibility of bankruptcy. The surplus process of a company is modeled by a general diffusion process with return and volatility being functions (with general forms) of the surplus process. The company can control the dividend payment and capital injections with the goal of maximizing the expectation of the total discounted dividends minus the total cost of capital injections up to the time of bankruptcy. We distinguish three cases and provide optimality results for each case.

11:45-12:15

Title: On the Phase-type renewal risk model: a study of dividends and related quantities

Presenting Author: Agnieszka Izabella Bergel, Universidade de Lisboa (with Alfredo D. Egídio dos Reis)

Abstract: For actuarial applications we consider the Sparre-Andersen risk model when the interclaim times follow a Phase-Type distribution, PH(n). The emphasis of our work is on the calculation of the maximum severity of ruin and the expected discounted dividends in order to generalize results obtained in [1] and [2] and extend an ongoing working paper [3]. For this purpose we found expressions for the defective renewal equation and the integro-differential
equation that are satisfied by the survival probability considering the roots of the Lundberg’s equations. Phase-type distributions are quite popular in stochastic modeling because they are algorithmically tractable as well as versatile in their modeling capacity, therefore it is important to consider actuarial models involving this kind of distributions.

12:15-12:45

**Title:** Maximizing Dividends and Consumption under the Vasicek Model  
**Presenting Author:** Julia Eisenberg, TU Vienna  
**Abstract:** At first, we consider an individual or household endowed with an initial capital and an income, modeled as a linear function of time. The discounting function is given by a stochastic process, where the short rate follows the Vasicek model, i.e. the short rate evolves due an Ornstein-Uhlenbeck process. The target is to find an unrestricted consumption strategy such that the value of the expected discounted consumption is maximized. Due to a complex structure of the first hitting times of an Ornstein-Uhlenbeck process with drift, we cannot find an explicit expression for the value function. However, it is possible to describe the value function via several ODEs corresponding to different initial value regions. Also, we prove the optimal strategy to be of a barrier type. In the second part, we consider an insurance entity endowed with an initial capital and an income, modeled as a Brownian motion with drift. It is assumed that the insurance company seeks to maximise the cumulated value of expected discounted dividends up to the ruin time. Whereas, the dividend rates are bounded by some positive real constant. Intuitively, it is clear that the optimal strategy is of a non-linear barrier type. That is why, we cannot apply the classical verification methods and have to rely on the viscosity ansatz.

D1 – Mortality Risk: Mortality-Contingent Securities (Location: Lanier; Chair: Séverine Arnold)

10:45-11:15

**Title:** The Economic Value of Life Expectancy Providers in the Secondary Life Market  
**Presenting Author:** Nan Zhu, Illinois State University (with Daniel Bauer)  
**Abstract:** We study the existence of informational advantage from the life expectancy providers in the secondary life insurance market. Using the unique data set from a large U.S. life expectancy provider, we compare the accuracy of life expectancies furnished from the provider with ones based on statistic models. We further quantify the economic value of such informational advantage from the perspective of a risk-neutral, profit-maximizing life settlement company. Our results justify the role of life expectancies providers as valuable information intermediary, and has economic consequences for the secondary life market and beyond.

11:15-11:45

**Title:** A Novel Numerical Pricing Method for Life Insurance under Stochastic Mortality  
**Presenting Author:** Athanasios Pantelous, University of Liverpool (with Nisha Rambeerich)  
**Abstract:** This paper considers the design of efficient numerical algorithms for pricing life insurance under the assumption that the dynamics of the mortality and the short rate of interest follow a stochastic process. Under the incomplete life insurance market scenario,
the governing pricing equation for the life insurance policy is a non-linear partial differential equation (PDE). In addition, Young (2007, 2008) also proved that for an infinite number of contracts, the limiting price per risk is a solution of a linear partial differential equation and can also be formulated as an expected value with respect to some equivalent martingale measure. No closed form solutions exist for both the linear and nonlinear PDEs, and thus, numerical methods of approximation become imperative. Our present work improves on the algorithm presented in Young (2008) as our numerical scheme combines cubic spline interpolating function with an implicit-explicit scheme for solving the non-linear PDE arising under a single life insurance policy. The cubic spline function provides good approximations on small spatial grids compared to first and second order finite difference discretisations and treating the non-linear term explicitly using the implicit-explicit scheme further avoids the need for an iterative procedure. The numerical scheme discussed in this paper is compared with the solution presented in Young (2008) in order to demonstrate its performance in terms of accuracy achieved on small number of nodal points and CPU timings.

11:45-12:15

Title: Evaluation of Credit Value Adjustment in Mortality-linked Securities
Presenting Author: Xuemiao (Samuel) Hao, University of Manitoba (with Chunli Liang and Linghua Wei)
Abstract: In this paper we model and quantify counterparty credit risk in mortality-linked securities. The modeling involves two folds. First, the original CBD model (Carins et al., 2006) is used to model and predict mortality rates for a selected population. Here, we use a vector autoregressive integrated moving-average (VARIMA) process to fit the time series of mortality indexes vector. Then, default probability and loss given default of security investors, with different credit rating, are modeled by using both reduced-form model and Lévy structural model. Note that these default-related quantities are obtained under a risk-neutral measure by calibrating the models on the investors’ bonds information available in financial market. Finally, we perform the exact evaluation of credit value adjustment (CVA) for two mortality-linked derivatives, k-forward and q-forward, as examples. In conclusion, we (1) propose a framework to quantity CVA for mortality-linked securities; (2) compare model effect on CVA by applying two different default models; (3) compare counterparty credit risk of investors with different credit rating.

12:15-12:45

Title: Crunching mortality and life insurance portfolios with extended CreditRisk+
Presenting Author: Jonas Hirz, TU Wien
Abstract: Using an extended version of the credit risk model CreditRisk+, we develop a flexible framework which is able to forecast developments in mortality as well as which can be used as a building block for mortality and lapse risk in (partial) internal models, in line with Solvency II. Developments in mortality include trends, trend dynamics, as well as shifts in underlying death causes. In our model, deaths and lapse are driven by common, potentially dependent, stochastic risk factors. Furthermore, we provide an efficient, numerically stable algorithm for an exact calculation of one-period loss distributions and capital requirements. Using publicly available data, we give estimation procedures for model parameters including Markov chain Monte Carlo (MCMC) methods based on a Bayesian setting. In addition to
statistical fluctuations, MCMC allows quantification of parameter risk. We conclude with a real world example using Austrian and Australian data.

**E1 – Issues in P&C: Multi-year Problems (Location: Capital; Chair: Marc Goovaerts)**

**10:45-11:15**

**Title:** A statistical modeling approach for car insurance pricing with telematics data  
**Presenting Author:** Katrien Antonio, KU Leuven and University of Amsterdam (with Roel Verbelen and Gerda Claeskens)  
**Abstract:** Telematics technology – the integrated use of telecommunication and informatics – may fundamentally change the car insurance industry by allowing insurers to base their prices on the real driving behavior instead of on traditional policyholder characteristics and historical claims information. Telematics insurance or usage-based insurance (UBI) can drive down the cost for low-mileage clients and good drivers. Car insurance is traditionally priced based on self-reported information from the policyholder, most importantly: age, license age, postal code, engine power, use of the vehicle, and claims history. Over time, insurers try to refine this a priori risk classification and restore fairness using no-claim discounts and claim penalties in the form of the bonus-malus system. It is expected that these traditional methods of risk assessment will become obsolete. Your car usage and your driver abilities can be better assessed based on telematics data collected, such as: the distance driven, the time of day, how long you have been driving, the location, the speed, harsh or smooth breaking, aggressive acceleration or deceleration, your cornering and parking skills... This high dimensional data, collected on the fly, will force pricing actuaries to change their current practice. New statistical models will have to be developed to adequately set premiums based on individual policyholder’s motoring habits instead of the risk associated to their peer group. In this work, we take a first step in this direction. We analyze a telematics data set from a European insurer, collected in between 2010 and 2014, in which information is collected on the amount of meters insureds drive. Besides the number of meters driven, we also registered how this distance is divided over the different kind of road types and time slots. This data allows car insurers the use of real driving exposure to price the contract. We build claims frequency models combining traditional and telematics information and discover the relevance and impact of adding the new telematics insights.

**11:15-11:45**

**Title:** On the Dependence between Frequency-Severities and Bonus-Malus System  
**Presenting Author:** Jae Youn Ahn, Ewha Womans University (with Woojoo Lee and Sojung Park)  
**Abstract:** Recently, a series of literature in automobile insurance found that there is (weak) dependence between frequency and severity. However, statistical methods in the literature may not be easily accessible to practitioners mainly due to technical difficulty. In this presentation, we provide a simple regression model which can accommodate the dependence. With the proposed method, we find the negative dependence between frequency and severity using real data retrieved from one of the major Korean insurance company. Through the concept of bonus hunger and a simulation study, we show that negative dependence can naturally arise.
in bonus-malus system. Finally, using the same data, we provide the empirical evidence which shows that negative dependence and bonus hunger phenomenon are related.

11:45-12:15

**Title**: Micro-level insurance claim count modelling: a multivariate Cox process approach  
**Presenting Author**: Xinda Yang, University of New South Wales (with Benjamin Avanzi, Bernard Wong and Greg Taylor)  
**Abstract**: Micro-level stochastic reserving has drawn increasing interest in the past few years. In this paper, we present a multivariate Cox process model in the context of multivariate insurance products and implement the model in the evaluating the total amount of losses from Incurred-But-Not-Reported claims. Furthermore, we develop estimation and prediction algorithms for our model. A multivariate Cox process model allows for a dependency structure of the claim arrival processes of multiple insurance products. Moreover, we incorporate risk exposure information and allow for reporting delays distributions. The performance and application of our model and estimation algorithms are illustrated using both simulated and real datasets.

### F1 – Risk Management (Location: Lucerne; Chair: Eric Ulm)

10:45-11:15

**Title**: Stochastic Profit Testing of Life Insurance Companies  
**Presenting Author**: Li Shen, Emylon Business School (with Olivier Le Courtois)  
**Abstract**: Every life insurance company needs to know if its products are profitable. However, due to the long term of the life and pension business, it is not an easy task to determine their profitability. For more than thirty years, profit testing has been utilized as a major tool for actuaries involved in product development. A profit test uses mathematical projections to establish the prospective profit profile of a policy over its lifetime in advance of it being written. In this paper, we first define four profit testing indexes: Net Present Value (NPV), Profit Margin (PM), Discounted Payback Period (DPP) and Internal Rate of Return (IRR). Then, we use the Gaussian and Variance Gamma (VG) processes to model the statistical data of Merrill Lynch US Investment grade Corporate Bond Index. As the choice of the assets backing the participating contracts for US insurers are usually corporate bonds. Using the maximum likelihood estimation, we get the parameters and corresponding standard errors for both processes. Nearly all the statistical tests show that the Variance Gamma process is preferable to the Gaussian process, including maximum values of the log-likelihood, Akaike Information Criterion (AIC), Schwarz Based Criterion (SBC) and Vuong statistic. In a life insurance company, the profits are usually distributed to shareholders and/or policyholders according to different structures of the pension schemes. Three types of contracts are studied in this paper: participating contracts, Universal Life contracts – Type B, and Variable Annuities (VAs) with Guaranteed Minimum Death Benefits (GMDBs). For each contract, we use the Monte Carlo method to calculate its profit testing indexes mentioned above and further display the changes of these indexes with respect to the Gaussian and VG model parameters. During the calculation, we assume the StPFL mortality table for all the contracts and use the double correlated Variance Gamma processes to model the insurer’s and policyholder’s assets in the
contract VAs with GMDBs. Our first results show that profit appears much smaller when a more accurate model (taking jumps into account for instance) is used.

**Title**: Risk- and Value-Based Management for Non-Life Insurers under Solvency Constraints  
**Presenting Author**: Johanna Eckert, Friedrich-Alexander University Erlangen-Nürnberg (with Nadine Gatzert)  
**Abstract**: The aim of this paper is to propose an internal model for a non-life insurer and to apply this model for deriving optimal risk- and value-based management decisions regarding the insurer’s investment strategy, which contribute to increasing shareholder value. We thereby considerably extend previous work by explicitly accounting for the policyholders’ willingness to pay depending on their risk sensitivity based on the insurer’s reported solvency status, which will be of great relevance under Solvency II. We further study the impact of the risk-free interest rate on attainable and admissible risk-return asset combinations, dependencies between assets and liabilities as well as the influence of reinsurance contracts, and we derive analytical solutions for maximizing shareholder value. One main finding is that the consideration of the policyholders’ willingness to pay depending on their risk sensitivity towards the insurer’s reported solvency status is vital for optimal management decisions and that in the present setting, reinsurance increases shareholder value only for non-risk sensitive policyholders. Our results further emphasize that low interest rates strongly restrict the insurer’s investment opportunities.

**Title**: Effect of Sarbanes-Oxley Act on Financial Reporting Quality: Evidence from the U.S. Property and Liability Industry  
**Presenting Author**: Isariya Suttakulpiboon, Georgia State University  
**Abstract**: This paper exploits a natural quasi-experiment using unique institutional feature of property and liability (“P&L”) insurance industry in the United States, in order to establish a causal link between the Sarbanes-Oxley Act (SOX) and financial reporting quality. The conservative estimates suggest that SOX improved P&L insurers’ loss reserves estimates. Under-reserved insurers improve their loss reserves estimates post-SOX more than the over-reserved insurers. Further, it is evident that adopting majority independent directors strongly associates with such improvement. However, the overall effect of improved board components and characteristics on SOX compliers (insurers that comply with SOX after 2002) is not different from the effect on the SOX early adopters in most identifications. This might suggest that other factors, apart from board components and characteristics, could play a significant role in improving financial reporting quality e.g. the existence of PCAOB or the enhanced criminal penalty.

**Title**: The Impact of Spillover Effects from Operational Risk Events: A Portfolio Perspective  
**Presenting Author**: Christian Eckert, Friedrich-Alexander University Erlangen-Nürnberg  
**Abstract**: As empirically observed by Cummins et al. (2012) in an event study of the U.S. banking and insurance industry, large operational loss events of more than $50 million in
an announcing firm lead on average to significant negative spillover effects in other non-announcing banks or insurance companies, even though the firm itself did not suffer an operational loss. The consideration of these spillover effects is of high relevance not only for individual firms, which may suffer financial losses, but also for investors with portfolios consisting of stocks of financial firms as well as insurance companies providing protection against operational losses and such spillover effects (as is the case for the reputation insurance policy by Munich Re, see Gatzert et al., 2014), for instance. Even though this is a very topical issue, no quantitative modeling of such spillover effects has been conducted before for single firms or a portfolio of firms. The aim of our article is to fill this gap and to propose an approach how to model and quantitatively assess intra- and inter-sector spillover effects (gains and losses) based on a network analysis and by means of external databases for large operational losses.

Lunch: 12:45pm - 1:45pm  
Location: Court & House Salons

Slot 2: 1:45pm - 3:15pm (A2-F2)  
A2 – Insurance Portfolio Decisions (Location: SCE Auditorium; Chair: Emiliano Valdez)

1:45-2:15  
**Title:** Insurance Portfolio Risk Retention  
**Presenting Author:** Edward Frees, University of Wisconsin  
**Abstract:** In this paper, I introduce a statistic for managing a portfolio of insurance risks. This tool is based on changes in the risk profile when changes in a risk parameter, such as a deductible, coinsurance, or upper policy limit, are made. I refer to the new statistic as a risk measure relative marginal, or RM$^2$, for short, change. By examining data from the Wisconsin Local Government Property Fund, I show how RM$^2$ changes can be used by a policyholder to select an effective risk mitigation strategy. I also show how it can be used by an insurer to identify the “best” and “worst” risks in terms of opportunities for risk management. The RM$^2$ changes reflect the underlying dependence structure of risks; I use an elliptical copula framework to demonstrate the sensitivity of risk mitigation strategy to the dependence structure.

2:15-2:45  
**Title:** New tail-based risk measure and economic capital allocation for heavy-tailed risks  
**Presenting Author:** Edward Furman, York University (with Ricardas Zitikis)  
**Abstract:** I will introduce a general tail-based risk measure and develop an economic capital allocation rule derived from it. The new “tail-Gini” risk measure follows the format of Solvency 2 and takes into account both the tail-heaviness and the tail-variability of risks, requiring the finiteness of the means, only. Applications to a portfolio of elliptical risks, where the new risk measure is coherent and co-monotonically additive, will be discussed with explicit formulas for the tail-Gini risk measure and the economic capital allocation based on it being derived explicitly.
**Title**: Archimedean Copulas: Aggregation and Capital Allocation Methods for Portfolios of Dependent Risks  
**Presenting Author**: Hélène Cossette, Université Laval  
**Abstract**: In this talk, we will consider a portfolio of dependent risks represented by a vector of dependent random variables. We assume the multivariate cumulative distribution function is defined with an Archimedean copula. Archimedean copulas are very popular and well suited for vector of random variables. We propose a simple approach which allows the computation of the cumulative distribution function of the sum or a variety of functions of those random variables. The exchangeability property of Archimedean copulas restricts their application in certain contexts. We hence extend some results to nested Archimedean copulas and propose a different approach permitting to get around certain constraints of these copulas.

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**Title**: A Paradox in Time Consistency in Mean-Variance Problem?  
**Presenting Author**: Kwok Chuen Wong, The University of Hong Kong and Imperial College London (with Alain Bensousan and Phillip Yam)  
**Abstract**: In this talk, we shall establish that, if investors with mean-variance preference adopt the time-consistent equilibrium solutions, an investor facing short-selling prohibition can acquire a greater objective value than his counterpart without the prohibition in a buoyant market. It can be shown that the pure strategy of solely investing on bond can sometimes simultaneously dominate the equilibrium strategy. With numerical experiments, the constrained investor can dominate the unconstrained one for more than 90% of the time horizon. The source of paradox is rooted from the nature of game-theoretic approach on time consistency, which purposely seeks for an equilibrium solution but not the ultimate maximizer. Our obtained results actually advocate that, to properly implement the concept of time consistency in various financial problems, all economic aspects should be critically taken into account at a time.

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**Title**: Mean-variance portfolio selection with regime switching under shorting prohibition  
**Presenting Author**: Miao Zhang, University of Melbourne (with Ping Chen)  
**Abstract**: This paper investigates a mean-variance portfolio selection problem with regime switching under the constraint of short-selling being prohibited. By applying the dynamic programming approach, a system of Hamilton-Jacobi-Bellman (HJB) equations is constructed. Recognizing the features of the optimal wealth process, the optimal feedback control and verification theorem are obtained. The efficient portfolio and efficient frontier are explicitly derived through the Lagrange multiplier approach, while numerical examples are provided to illustrate the results.
2:45-3:15

**Title:** Alpha-Robust Mean-Variance Reinsurance-Investment Strategy  
**Presenting Author:** Bin Li, University of Waterloo (with Danping Li and Dewen Xiong)  
**Abstract:** Inspired by the \(\alpha\)-maxmin expected utility, we propose a new class of mean-variance criteria, called \(\alpha\)-maxmin mean-variance criteria, and apply it to the reinsurance-investment problem. Our model allows the insurer to have different levels of ambiguity aversion (rather than only consider the extremely ambiguity-averse attitude as in the literature). The insurer can purchase proportional reinsurance and also invest the premium income in a financial market consisting of a risk-free asset and a risky asset, whose dynamics is correlated with the insurance surplus. Closed-form time-consistent equilibrium reinsurance-investment strategy is derived by solving the extended Hamilton-Jacobi-Bellman equation. Our results show that the equilibrium reinsurance strategy is always more conservative if the insurer is more ambiguity-averse. When the dependence between insurance and financial risks are weak, the equilibrium investment strategy is also more conservative if the insurer is more ambiguity-averse. However, a more ambiguity-averse insurer may adopt a more aggressive investment strategy for a more diversified insurance-investment portfolio when the insurance market is more ambiguous than the financial market. For an ambiguity-neutral insurer, the investment strategy is identical to the non-robust investment strategy.

C2 - Insurance Risk Models: Ruin I (Location: Sinclair; Chair: Elias Shiu)  
1:45-2:15

**Title:** Aggregate claim analysis in a two-sided exit setting with dependence  
**Presenting Author:** Di Xu, University of Waterloo (with David Landriault and Bin Li)  
**Abstract:** The two-sided exit problem has been the subject matter of risk management analysis to better understand the dynamic of various insurance risk processes. In the two-sided exit setting, the discounted aggregate claims are investigated under a dependent renewal process (also known as dependent Sparre Andersen risk process). Utilizing Lundberg’s generalized equation and Laplace transform, we identify the fundamental solutions to a given integral equation, which will be shown to play a role similar to the scale matrix for spectrally-negative Markov-additive processes. Explicit expressions and recursions are then identified for the two-sided probabilities and the moments of the aggregate claims respectively. A numerical example for the two-sided exit probabilities involving the Farlie-Gumbel-Morgenstern(FGM) copula is provided in the end.

2:15-2:45

**Title:** Optimal dividends and reinsurance with capital injection under thinning dependence  
**Presenting Author:** Kam Chuen Yuen, The University of Hong Kong  
**Abstract:** In this talk, we adopt the variance premium principle to investigate the problem of optimal dividends and reinsurance in a diffusion approximation risk model with thinning-dependence structure. We first study the optimal problem without capital injection. We then consider the incorporation of forced capital injection into the model whenever the reserve level drops below zero. We finally turn to the general problem in which capital injection is allowed but not compulsory. For the three optimal problems, we apply the technique of
stochastic control theory to obtain closed-form expressions for the optimal strategies and the corresponding value functions for two classes of insurance business with thinning dependence. We also present some numerical examples to show the effect of parameter values on the optimal policies.

2:45-3:15

Title: An Insurance-Risk Model
Presenting Author: Rim Essifi, Eindhoven University of Technology
Abstract: We will examine the bankruptcy probability for a surplus process with jumps. Consider a Cramér-Lundberg setup to describe the insurer’s surplus $C_t$ at time $t$ as $C_t = x + ct - S_t$, where $C_0 = x$ is the initial surplus, $c$ is the premium rate, and $S_t$ is the aggregate claim amount up to time $t$ modeled as a compound Poisson process with intensity $\lambda$ and positive jump sizes $Y_1, Y_2, \cdots$ with cumulative distribution function $F_Y(\cdot)$. It is assumed here that the insurer may be allowed to continue the business despite a temporary negative surplus. Concretely, consider a suitable locally bounded bankruptcy rate function $\omega(\cdot)$ depending on the size of the negative surplus $C_s < 0$. If no bankruptcy event has occurred yet at time $s$, then the probability of bankruptcy in the time interval $[s, s + dt]$ is $\omega(-C_s)dt$. Let $\tau$ be the resulting time of bankruptcy, and define the overall probability of bankruptcy as $u(x) = P[\tau < \infty|C_0 = x]$. For $x > 0$, set $u_+(x) := u(x)$, $\tilde{u}_-(x) := u(-x)$ and $u_-(x) := 1 - \tilde{u}_-(x)$. We will determine the Laplace transforms of the functions $u_+$ and $u_-$ for the cases $\omega(x)$ is constant and $\omega(x) = c x$. The key tool is the Wiener-Hopf factorisation technique. When $\omega(x)$ is constant, no specific assumptions will be made on the claim size distribution $F_Y(\cdot)$. However, in the linear case, we need some algebraic hypotheses concerning the Laplace-Stieltjes transform of $F_Y(\cdot)$.

D2 – Mortality Risk: Parameter Uncertainty (Location: Lanier; Chair: Pietro Millossovich)

1:45-2:15

Title: Asymptotic Expansions to Assess Parameter Uncertainty in Mortality Models
Presenting Author: Michel Vellekoop, University of Amsterdam
Abstract: Assessment of parameter uncertainty in dynamic models for human mortality can be challenging, due to two characteristic features of such models. First, the stochastic mortality improvement process is latent and must be estimated from directly observable death counts [1]. This makes it difficult to distinguish parameter uncertainty and volatility in the improvement process [2]. Secondly, the structure of most modern mortality models contains bilinear terms that involve both a high-dimensional unknown parameter vector and the stochastic improvement process [3]. Additional constraints must therefore be imposed to make sure that parameters can be identified. This can make the application of Bayesian methods to find samples for the posterior distribution of unknown parameters particularly challenging. We propose an alternative approach to determine the uncertainty in parameter estimates, which is based on asymptotic expansions. A result on the geometry of normalization is derived which allows us to apply such expansions under identifiability constraints. We find that our expansions give excellent agreement with Markov Chain Monte Carlo methods, while being orders of magnitude faster.
Title: A Bayesian joint model for population and portfolio-specific mortality  
Presenting Author: Frank van Berkum, University of Amsterdam (with Katrien Antonio and Michel Vellekoop)

Abstract: An increasing number of papers consider portfolio-specific mortality [GSD11, Oli11, Pla09, RKR13]. In these papers, however, population mortality and portfolio-specific mortality are treated as separate processes. A notable exception is [CBD2011], who show how mortality trends in different (sub)populations can be related for sufficiently large datasets. We propose adjustments which may improve the quality of estimates by introducing a Bayesian framework in which population and portfolio-specific mortality are modelled simultaneously. We illustrate this framework using the Lee-Carter model for population mortality using a difference stationary process to project the period effect. This population mortality rate is multiplied with a random portfolio-specific effect with prior expectation equal to one. For this portfolio-specific effect we consider both a Gamma prior and a multivariate lognormal prior. The first implies independence over the ages of the portfolio-specific effects, whereas the second imposes nearby ages to be more strongly correlated than ages further apart. We show how the posterior credible intervals for the portfolio-specific factors change when the portfolio size decreases, and how this depends on the specified prior distribution.

Title: Bayesian method for small population longevity risk modelling  
Presenting Author: Liang Chen, Heriot Watt University

Abstract: This talk considers the impact of sampling variation on the calibration of stochastic mortality models. Random variation in deaths counts results in parameter uncertainty in estimates of age, period and cohort effect in the model. In turn this has an impact on time series parameter estimates. With small populations, sampling variation causes an upwards bias in the estimated volatility of period effects using standard maximum likelihood methods. We seek to counteract this problem of bias using Bayesian inference. We use England and Wales (EW) males as a benchmark and then scale this down to simulate small populations. We will discuss to what extent Bayesian methods reduce bias in the model volatility, using full EW population as a benchmark.

E2 – Issues in Catastrophe Risk (Location: Capital; Chair: George Zanjani)  
1:45-2:15

Title: Pricing Multi-peril CAT Bonds using Extreme Value Theory  
Presenting Author: Zhongyi Yuan, Pennsylvania State University (with Qihe Tang)

Abstract: CAT bonds have been used by insurers as a popular alternative risk transfer, and more and more innovations in their design are now emerging. On the one hand, CAT bonds have developed from covering one single peril to multiple. On the other hand, while traditional CAT bonds mainly cover natural catastrophe risk such as hurricanes and earthquakes, recent products start to extend their coverage to financial catastrophe risk such as mortgage default risk. In this paper, we develop a pricing framework for such general multi-peril CAT bonds. We propose to use a pricing measure that combines a risk-neutral measure that prices...
the financial risk and a distorted measure that prices the natural catastrophe risk. We point out that for CAT bonds covering both risks, the usual assumption of independence between the two pricing measures is no longer valid. Finally, noticing that the distributions of bond triggers are crucially important for pricing but are not easily available, we propose to use multivariate extreme value theory to approximate the distributions. A few examples are shown for illustration.

2:15-2:45

Title: Model-Independent Price Bounds for the Swiss Re Mortality Bond 2003
Presenting Author: Raj Kumari Bahl, University of Edinburgh (with Sotirios Sabanis)
Abstract: In this paper, we are concerned with the valuation of the first Catastrophic Mortality Bond that was launched in the market namely the Swiss Re Mortality Bond 2003. This bond encapsulates the behavior of a well-defined mortality index to generate payoffs for the bondholders. Pricing this bond is a challenging task and no closed form solution exists in the literature. We adapt the payoff of the terminal principal of the bond in terms of the payoff of an Asian put option and present a new approach to derive model-independent bounds exploiting comonotonic theory as illustrated in [1] for the pricing of Asian options. We invoke Jensen’s inequality for the computation of lower bounds and employ Lagrange optimization technique to achieve the upper bound. The success of these bounds is based on the availability of compatible European mortality options in the market. We carry out Monte Carlo simulations to estimate the bond price and illustrate the strength of these bounds across a variety of models. There is only one earlier publication by [2] in this direction. However these authors propose gain-loss bonds that suffer from model risk. The fact that our bounds are model-independent is a crucial breakthrough in the pricing of catastrophic mortality bonds.

2:45-3:15

Title: Quantifying the Basis Risk of Industry Loss Warranties
Presenting Author: Qihe Tang, University of Iowa
Abstract: A well-known problem related to the use of an index-linked catastrophic loss instrument in the context of hedging is basis risk. This arises when the company’s loss is not sufficiently dependent on the reference index, and hence the latter is not a good representative of the former. In this talk we discuss quantification of the basis risk of dual-triggered industry loss warranties (ILWs), as well as the sensitivity of the basis risk to the dependence between the company’s loss and the industry loss. We employ the central limit theorem (CLT) approach for the case with average sized attachment points while employ the extreme value theory (EVT) approach for the case with large attachment points. This talk is based on a joint work with Zhongyi Yuan at the Pennsylvania State University.

F2 – Risk Measures (Location: Lucerne; Chair: Mike Ludkovski)

1:45-2:15

Title: Computing the value-at-risk and conditional value-at-risk when parameters are linguistic
Presenting Author: Arnold Shapiro, University of Manitoba

Abstract: The value-at-risk (VaR), at a confidence level $\alpha \in (0, 1)$ and a fixed horizon, is given by the smallest number such that the probability that a loss exceeds that number is no larger than $(1 - \alpha)$, and the conditional value-at-risk (CVaR) is the expected loss, given that losses exceed the VaR. When the distribution of losses is known (or can be assumed) and adequate relevant data is available, estimates of the underlying parameters can be procured, and the VaR and CVaR can be computed. However, often there is distributional ambiguity, in the sense that there is uncertainty regarding the distribution of losses, and frequently this uncertainty is associated with parameters that are described in linguistic form owing to vagueness in the historical data and/or imprecision in the opinions of experts. A number of fuzzy logic methodologies can be employed to help resolve such situations, including probabilistic fuzzy systems, fuzzy histograms, and fuzzy simulation. This presentation provides an overview of these methodologies and how they can be implemented to compute the VaR and CVaR when parameters are linguistic.

2:15-2:45

Title: Asymptotic Equivalence of Risk Measures under Dependence Uncertainty

Presenting Author: Haiyan Liu, University of Waterloo (with Jun Cai and Ruodu Wang)

Abstract: In this paper we study the aggregate risk of inhomogeneous risks with dependence uncertainty, evaluated by a generic risk measure. We say that a pair of risk measures are asymptotically equivalent if the ratio of the worst-case values of the two risk measures is almost one for the sum of a large number of risks with unknown dependence structure. The study of asymptotic equivalence is particularly important for a pair of a non-coherent risk measure and a coherent risk measure, as the worst-case value of a non-coherent risk measure under dependence uncertainty is typically difficult to obtain. The main contribution of this paper is to establish general asymptotic equivalence results for the classes of distortion risk measures and convex risk measures under different mild conditions. The results implicitly suggest that it is only reasonable to implement a coherent risk measure for the aggregation of a large number of risks with uncertainty in the dependence structure, a relevant situation for risk management practice.

2:45-3:15

Title: A note on extreme negative dependence

Presenting Author: Etienne Marceau, Université Laval (with Hélène Cossette)

Abstract: In this talk, we examine the aggregation of pair of countermonotonic random variables. Notably, we derive closed-form expressions for the cumulative distribution function or other risk measures for sum of two continuous positive countermonotonic random variables in specific cases. A general approach is also proposed to derive the VaR of the sum of two continuous positive countermonotonic random variables. Results related to extreme negative dependence for vector of more than two random variables are also presented.

Coffee Break: 3:15pm - 3:45pm

Location: Court & House Salons
Slot 3: 3:45pm - 5:45pm (A3-F3)

A3 – Issues in P&C: Claims and Losses I (Location: SCE Auditorium; Chair: Edward Frees)

3:45-4:15

**Title:** The retrospective loss random variable and its relevance in actuarial science  
**Presenting Author:** Emiliano Valdez, University of Connecticut (with J. Vadiveloo, G. Niu and G. Gan)  
**Abstract:** In this paper, we define a retrospective loss random variable and mathematically demonstrate that its expectation is the retrospective reserve which in turn equals the prospective reserve. By defining an associated random variable for the retrospective reserve, similar to the prospective loss random variable for the prospective reserve, we can explore various properties of the retrospective loss random variable. We demonstrate that the retrospective loss random variable provides us with valuable historical information on how actual experience varies from reserving assumptions and whether it is significant enough to adjust the prospective reserves for the business. The paper concludes with a model of a block of inforce policies with actual experience different from reserving assumptions, and a rigorous and consistent methodology on how prospective reserves could be adjusted based on the realized retrospective loss random variable.

4:15-4:45

**Title:** Ratemaking of dependent risks  
**Presenting Author:** Maria de Lourdes Centeno, CEMAPRE-ISEG-Universidade de Lisboa (with Andrade e Silva, J.M.)  
**Abstract:** We start by describing how, in some cases, we can use variance related premium principles in ratemaking, when the claim numbers and individual claim amounts are independent. We use quasi-likelihood generalized linear models, under the assumption that the variance function is a power function of the mean of the underlying random variable. We extend this approach to the cases where the claim numbers are modeled by a bivariate Poisson, by a generalized bivariate negative binomial and by a bivariate Poisson-Laguerre polynomial, which nests the bivariate negative binomial. We apply these models to a portfolio of the Portuguese insurance company Tranquilidade.

4:45-5:15

**Title:** On claims reserves estimation using individual level claims data  
**Presenting Author:** Liivika Tee, University of Tartu (with Meelis Käärik)  
**Abstract:** Accurate loss reserves are essential for insurance companies to meet and administer their contractual obligations to policyholders. Many claims reserving methods have now been established and in the actuarial literature the focus has mainly been on aggregate reserving techniques. These macro-level models perform analysis with aggregate claims data, while micro-level models handle claims related data on an individual basis, rather than aggregating by underwriting year and development period. Due to the aggregation of the data, useful information regarding the claim development process is lost, but micro-level models work on the individual claim level to deal with the development throughout each claim’s lifetime.
In recent years, there have been many proposals of reserving models that are based on individual level claims data. Martinez-Miranda et al. (2013) extend the traditional chain ladder framework towards the continuous use of individual claims data, where data is aggregated by month in run-off triangle and reserves are estimated with non-parametric estimation of the underlying density. The question arises whether estimations based on monthly data substantially outperform results obtained by, say, quarterly data. We investigate whether and how much the use of different levels of claim data can improve the reserving process. The data is simulated on daily basis and evaluation of the impact of each level of data aggregation (monthly, quarterly and annual) on the predictive distribution of the outstanding reserve will follow. Simulated loss payments are aggregated to obtain the reserve estimate for the portfolio. To estimate the uncertainty the simulation routine is repeated number of times to generate a predictive distribution of the reserve estimate. Comparison and evaluation of the performances of classical chain ladder method and continuous chain ladder method is carried out on each considered data level. To investigate further the impact of each aggregation level, we demonstrate the case study with the application of the models in real-world insurance data.

5:15-5:45

**Title:** Pair Copula Constructions for Semicontinuous Longitudinal Data with Application to Insurance Experience Rating

**Presenting Author:** Peng Shi, University of Wisconsin-Madison (with Lu Yang)

**Abstract:** In non-life insurance, insurers use experience rating to adjust premium to reflect the policyholder’s previous claim experience. Performing prospective experience rating can be challenging when the claim distribution is complex. For instance, insurance claims are often semicontinuous in that a fraction of zeros is associated with an otherwise positive continuous outcome from a right-skewed and long-tailed distribution. Practitioners use credibility premium that is a special form of the shrinkage estimator in the longitudinal data framework. However, the linear predictor is not informative especially when the outcome follows a mixed distribution such as the insurance case. In this article, we introduce a mixed vine pair copula construction framework for modeling semicontinuous longitudinal claims. In the proposed framework, a two-component mixture regression is employed to accommodate the zero inflation and thick tails in claim distribution. The temporal dependence among repeated observations is modeled using a sequence of bivariate conditional copulas based on a mixed D-vine. We emphasize that the resulting predictive distribution allows insurers to incorporate past experience into future premiums in a nonlinear fashion and the classic linear predictor can be viewed as a nested case. In the application, we examine a unique claims data of government property insurance from the state of Wisconsin. Due to the discrepancies between claim and premium distributions, we employ an ordered Lorenz curve to evaluate the predictive performance. We show that the proposed approach offers substantial opportunities for separating risks and identifying profitable business when compared with alternative experience rating methods.

B3 – Actuarial Finance: ALM II (Location: SCE Senate Salon; Chair: Etienne Marceau)

3:45-4:15
Title: Optimal Asset Allocation with both Dependent Potential Returns and Default Risks
Presenting Author: Yiying Zhang, The University of Hong Kong
Abstract: In this talk, we study the optimal allocation of wealth for a risk-seeking investor confronted with a set of risk assets with statistically dependent potential risk returns having dependent default risks. Not only are the orderings derived among the components of the optimal allocation policy, but also the configurations of the analytical optimal allocation strategies are determined. As a result, three similar and explicit optimal allocation policies are proposed respectively stating that all the wealth should be allocated on the risk asset with both the largest potential return and smallest default probability when the dependence structure among risk assets is specified by comonotonicity, UTPD joint density function or PDS copula characterized by the convex combination of independence copula and comonotonicity copula. The results derived here complement and generalize some of those known in Cheung and Yang (2004), Chen and Hu (2008), Li and Li (2016) and You and Li (2016).

4:15-4:45

Title: Optimal Drawdown-Based Premium-Change Policy Design
Presenting Author: Shu Li, University of Illinois at Urbana-Champaign (with David Landriault and Bin Li)
Abstract: In this talk, we will consider an optimal policy design problem for the drawdown-based regime-switching Lévy insurance model, where the underlying drawdown process is used to trigger the change of premium. We define an objective function involving the state-dependent surrender rate and analyze its properties to find the optimal trigger level. Numerical examples will be provided as well.

4:45-5:15

Title: Optimal consumption, investment, and insurance decisions incorporating the housing habits and the implications of background risk
Presenting Author: Shang-Yin Yang, Tunghai University (with Ko-Lun Kung)
Abstract: This study considers the optimal consumption-investment-insurance problem incorporating the housing habits and the implications of premium loading for a household in a stochastic environment. We investigate household’s consumption and portfolio decision with mortality and life insurance involved. To hedge against the mortality risk, the household should reduce its stock holding and increase other portfolios investment. Due to the income and substitution effect introduced by the loading in insurance, we find the consumption being hump-shaped for the household. The loading’s risk has significance reduced the wealth effect to the household. Finally, we quantify the reduction effect.

5:15-5:45

Title: Optimal reinsurance and investment strategies for insurers with mispricing and model ambiguity
Presenting Author: Ailing Gu, Guangdong University of Technology (with Frederi G. Viens and Bo Yi)
Abstract: We discuss optimal proportional reinsurance-investment problems for an insurer with mispricing and model ambiguity under a complex stochastic environment: The surplus
The process is described by a classical Cramér-Lundberg (i.e., C-L) model and the financial market contains a pair of mispriced stocks, a risk-free asset and a market index. We assume that the dynamics of the pair satisfies a “co-integrated system” advanced by Liu and Timmermann in a 2013 manuscript which can be witnessed in a new policy of Financial Market in China as “Shanghai-Hong Kong Stock Connect program”. The insurer hopes to exploit the temporary mispricing by using a portfolio strategy under a utility function framework. Furthermore, she is ambiguity-averse and has specific preferences for the diffusion risk and jump risk respectively. Similar to Maenhout (2004), we incorporate the ambiguity aversion and formulate optimal robust reinsurance-investment problem. By employing the dynamic programming approach, we derive explicit optimal robust reinsurance-investment strategy and optimal value function. Finally, we give numerical illustration to explain our results and analyze impact of some parameters on optimal strategies and optimal value functions.

C3 – Insurance Risk Models: Ruin II (Location: Sinclair; Chair: Gord Willmott)

3:45-4:15

Title: A Revisit to the Ruin Probability with Heavy-tailed and Dependent Insurance and Financial Risks
Presenting Author: Yiqing Chen, Drake University (with Zhongyi Yuan)
Abstract: Recently, Sun and Wei (2014, Insurance: Mathematics and Economics) studied the finite-time ruin probability of a discrete-time model in which the one-period insurance and financial risks are assumed to be independent and identically distributed copies of a random pair \((X, Y)\). For the heavy-tailed case, under a restriction on the dependence structure of \((X, Y)\) they established an asymptotic formula for the finite-time ruin probability. We show that this restriction can be squarely removed. Furthermore, we extend the result to the infinite-time ruin probability. Employing the multivariate regular variation framework, we simplify the formula so that it shows in a transparent way how the ruin probability is affected by the tail dependence of \((X, Y)\).

4:15-4:45

Title: A Discretely-Continuously Observed Insurance Risk Model with Grace Period
Presenting Author: Jeff Wong, University of Waterloo (with Bin Li and Gordon E. Willmott)
Abstract: In this paper, we propose a hybrid mechanisms to monitor insurance surplus processes. Specifically, a discrete observation scheme is adopted as long as the insurance business was under a healthy financial situation at the last observation. But once the sign of insolvency is detected, the insurance surplus will be monitored continuously and a grace period is granted for the insurance surplus to rebound to some safe level. The insurer is ruined if the surplus fails to recover within the grace period. Closed-form expression of the probability of ruin is solved for spectrally negative Lévy risk models. This hybrid observation scheme also provides an interesting approximation to the classical Parisian ruin.

4:45-5:15

Title: Ruin Probability via Quantum Mechanics Approach
Presenting Author: Muhsin Tamturk, University of Leicester (with Sergey Utev)
Abstract: The finite time probability of ruin is computed via the Quantum Mechanics Approach that provides an alternative powerful tool to the traditional probability calculations. In addition, surplus process with an additional capital injection and withdrawal is investigated. Numerical results on the non-ruin probability derived via the Quantum Mechanics Approach are compared with the Appell Polynomials approach as introduced in Picard-Lefevre and traditional Markov chain approach. Moreover, we apply the Quantum Mechanics Approach to solve numerically Capital Allocation type problems in Actuarial Sciences such as how to maximize the proportion of the total claim amount paid with the prescribed ruin level; how to minimize the ruin probability via the Optimization of the time and amounts of Capital Allocation of Investments and Withdrawals and how to minimize the ruin probability via Optimization of Allocation of Initial Capitals.

5:15-5:45

Title: Simulation-based inference for the finite-time ruin probability of a surplus with a long-memory

Presenting Author: Yasutaka Shimizu, Waseda University (with Yeteng Zheng)

Abstract: We are interested in the finite-time ruin probability of an insurance surplus whose claim process has a long-range dependence. Since, under a suitable asymptotics, a normalized claim processes can weakly converge to a fractional Brownian motion with the Hurst parameter $H > 1/2$, we will consider a ruin probability of a drifted fractional Brownian motion starting from a positive initial reserve. Using a change of measure technique, we can find a probability measure under which the surplus ruins almost surely, and we can compute the finite-time ruin probability by a kind of Importance Sampling if some parameters in the model are decided. In practice, those parameters are unknown and to be estimated from discrete observations of the surplus. Estimating those, we can compute an asymptotically normal estimator of the finite-time ruin probability. Moreover, an expression of the asymptotic variance is given via the Malliavin Calculus, and it is actually computed by Importance Sampling, again. As a result, we can construct a confidence interval of the finite-time ruin probability.

D3 – Mortality Risk: New Approaches I (Location: Lanier; Chair: Hong Li)

3:45-4:15

Title: Gaussian Process Models for Mortality Improvement Factors

Presenting Author: Michael Ludkovski, UC Santa Barbara (with Jimmy Risk and Howard Zail)

Abstract: We investigate modeling the mortality rate surface and mortality improvement factors in the Gaussian process (GP) regression framework. We use a nonparametric response surface approach which quantifies the uncertainty regarding the underlying mortality experience and allows to generate full stochastic trajectories for out-of-sample forecasts. GP regression takes a data-driven approach to determining the spatial dependence in mortality rates, coherently handling the smoothing of existing data across both calendar years and ages. Our framework is also well suited for updating projections when newly available data arrives, and for dealing with "edge" issues where credibility is lower. We present a detailed analysis of Gaussian process model performance for US mortality experience based on both CDC and SSA
datasets. Some of the specific questions we investigate are the interaction between trend and residual modeling, Bayesian and non-Bayesian GP methodologies, accuracy of in-sample and out-of-sample forecasting, stability of model parameters, and the effect of chosen covariance structures. We also document the general decline, along with strong age-dependency, in mortality improvement factors in the past few years, contrasting our findings with the RP-2014 and -2015 models that continue to project constant improvement factors into the future.

4:15-4:45

Title: Mortality Modeling and Forecasting Using Non-Gaussian Innovations
Presenting Author: I-Chien Liu, National Taichung University of Science and Technology (with Chou-Wen Wang and Hong-Chih Huang)
Abstract: This paper aims to extend the mortality model proposed by Mitchell et al. (2013) using five non-Gaussian distributions, including Student’s t-distribution, jump diffusion distribution, variance gamma distribution, normal inverse Gaussian distribution and generalized hyperbolic skew Student’s t-distribution, to model the error terms of the mortality model and mortality indices, because the error terms of our extended model and the mortality indices exhibit skewness, leptokurtosis and fat tails. For five-year age group of Human Mortality Database from eight countries (Denmark, Finland, France, Italy, Netherlands, Norway, Sweden, and England and Wales) over the period 1900-2012, we find the properties of high peak and heavy-tailed for the error terms of the mortality model and mortality indices, such that we have to reject that the error terms of the mortality model follow Gaussian distribution. Using log-likelihood function, Akaike information criterion, Bayesian information criterion and three testing methods (Kolmogorov-Smirnov test, Anderson-Darling test, Cramér-von-Mises test), we examine which distribution is better for the error terms of the mortality model and mortality indices. Finally, we investigate the mortality forecasting ability of our proposed model.

4:45-5:15

Title: Mortality Improvement Rates: Modelling and Parameter Uncertainty
Presenting Author: Andres M. Villegas, University of New South Wales (with Andrew Hunt)
Abstract: Rather than looking at mortality rates directly, a number of recent academic studies have looked at modelling rates of improvement in mortality when making mortality projections. Although relatively new in the academic literature, the use of mortality improvement rates has a long-standing tradition in actuarial practice when allowing for improvements in mortality from standard mortality tables. However, mortality improvement rates are difficult to estimate robustly and models of them are subject to high levels of parameter uncertainty, since they are derived by dividing one uncertain quantity by another. Despite this, the studies of mortality improvement rates to date have not investigated parameter uncertainty due to the ad hoc methods used to fit the models to historical data. In this study, we adapt the Poisson model for the numbers of deaths at each age and year, proposed in Brouhns et al. [Insurance: Mathematics and Economics 3 (2002) 31] to model mortality improvement rates. This enables models of improvement rates to be fitted using standard maximum likelihood techniques and allows parameter uncertainty to be investigated using a standard bootstrapping approach. We illustrate the proposed modelling approach using data for England and Wales population.
E3 – Novel Approaches to Insurance Risks I (Location: Capital; Chair: Georgios Pitselis)

3:45-4:15

Title: Optimal Employee Behavior and Optimal Sickness Insurance Design when Employers Penalize Sickness Presenteeism

Presenting Author: Annika Krutto, University of Tartu (with Colin M. Ramsay and Victor I. Oguledo)

Abstract: In a recent paper, Ramsay and Oguledo (2015) considered the optimal design of an employer sponsored sickness-disability insurance plan that maximizes the employer’s expected discounted profits over each employee’s working lifetime. They used a simple multi-state model of the evolution of an employee’s health over time to capture the impact of sickness induced absenteeism, presenteeism, and shirking on the employer’s profits. They also assumed sick employees were asymptomatic, i.e., they showed no signs of illness at work, and thus were able to work regardless of their level of illness. In this paper, we extend the Ramsay-Oguledo model by introducing a new "severely ill" sickness state where employees are symptomatic, i.e., they show signs of illness while at work, and presenteeism exists. To combat presenteeism, we also introduce the new concept of a presenteeism penalty whereby employers penalize employees who are found to be very sick while at work. Specifically, penalized employees are sent home and receive a penalized sick-pay that is lower than the normal sick pay. Thus sick employees must decide whether to stay at home and receive a sick pay (that is less than their working pay) or go to work sick and run the risk of being sent home and penalized. Assuming employees get a positive utility from income and a disutility (negative utility) from work, we determine each employee’s optimal behavior/strategy in each sickness state (i.e., whether to stay home or to work) that maximizes her discounted expected utility over her working lifetime. As in Ramsay and Oguledo (2015), permissible employee strategies are captured in a set of Volterra integral equations that are solved numerically to determine each employee’s optimal strategy/behavior. Assuming employees are expected utility maximizers, we determine the employer’s optimal sick pay, presenteeism penalty, and health check probabilities that maximize the employer’s discounted expected profits over an employee’s working lifetime.

4:15-4:45

Title: The joint mortality of couples in continuous time

Presenting Author: Petar Jevtic, McMaster University (with Hurd R. Thomas)

Abstract: This paper introduces a probabilistic framework for the joint survivorship of couples in the context of dynamic stochastic mortality models. In contrast to previous literature, where the dependence between male and female times of death was achieved using a copula approach, this new framework gives an intuitive and flexible pairwise cohort-based probabilistic mechanism that can accommodate both deterministic and stochastic effects which the death of one member of couple causes on the other. It is sufficiently flexible to allow modeling of effects that are short term (broken heart) or long term in their durations. In addition, it can account for the state of health of the both the surviving and dying spouse and thus can allow for dynamic and asymmetric reactions of varying complexity. Finally, it can accommodate the dependence of lives before the first death. Analytical expressions for bivariate survivorship in representative models are given, and their estimation, done in two stages, is seen to be
straightforward. First, marginal survivorship functions are calibrated based on UK mortality data for males and females of chosen cohorts. Second, the maximum likelihood approach is used to estimate the remaining parameters from simulated joint survival data. We show that the calibration methodology is simple, robust and fast, and can be readily used in practice.

4:45-5:15

Title: How might temperature and interest rate changes effect the pricing process of Life Insurance products?
Presenting Author: Malgorzata Seklecka, University of Liverpool (with Athanasios A. Pantelous and Colin O'Hare)
Abstract: Changes in mortality rates have had a significant impact on financial and pension planning. The pricing of financial, pension and insurance products that are contingent upon survival or death is based on the accurate forecasting of mortality rates. Thus identification of the circumstances affecting and knowledge of future mortality changes is very important from a financial point of view as a significant proportion of the financial markets are driven by pension funds. Recently, in Seklecka et al. (2016), a new temperature related mortality model is introduced, and compared with several other extensions of the Lee-Carter model using data from the United Kingdom. In the present paper, we demonstrate the impact of uncertainty on various parameters involved which are related to the mortality (e.g. temperature related factor) and the annuity modeling (e.g. interest rates), and how their fluctuations influence the insurance pricing and forecasting ability.

5:15-5:45

Title: Mortality Effects of Temperature and Economic Changes in the United Kingdom
Presenting Author: Lydia Dutton, University of Liverpool (with Malgorzata Seklecka and Athanasios A. Pantelous)
Abstract: It is well known that the health of a population is affected by social, environmental, and economic factors. Therefore, changes in death rates may occur due to climate and economic changes. In this article we extend on a previous study into excess deaths as a result of climate change to also investigate the impact of economic changes using annual data for the United Kingdom. A new stochastic mortality model is proposed which extends the Lee-Carter model and recent extensions by including an additional economic factor alongside a temperature-related term. This model is shown to provide better fitting and forecasting results.

F3 – Novel Approaches to Insurance Risks II (Location: Lucerne; Chair: Arnold Shapiro)

3:45-4:15

Title: Compound Distributions of Exchangeable Random Variables – Moments and Central Moments
Presenting Author: Georgios Pitselis, University of Piraeus
Abstract: In the present paper we apply de Finetti’s theorem and derive probability density functions of compound distributions for exchangeable random variables, when the counting distribution for the aggregate claims is Poisson, negative binomial, logarithmic and binomial
distribution. Moment generating functions, moments and central moments are also derived when the exchangeable random variables $X_i$ are conditional on a random quantity $\theta$ that follows a $Q$ distribution that may be interpreted as "beliefs about the limiting relative frequency of 1's".

4:15-4:45

**Title:** Robust Optimal Stopping  
**Presenting Author:** Roger J.A. Laeven, University of Amsterdam (with Volker Krätschmer, Marcel Ladkau, John G.M. Schoenmakers, and Mitja Stadje)  
**Abstract:** This paper studies the optimal stopping problem in the presence of model uncertainty (ambiguity). We develop a numerically implementable method to solve this problem in a general setting, allowing for general time-consistent ambiguity averse preferences and general payoff processes driven by jump-diffusions. Our method consists of three steps. First, we construct a suitable Doob martingale associated with the solution to the optimal stopping problem using backward stochastic calculus. Second, we employ this martingale to construct an approximated upper bound to the solution using duality. Third, we introduce backward-forward simulation to obtain a genuine upper bound to the solution, which converges to the true solution asymptotically. We analyze the asymptotic behavior and convergence properties of our method. We illustrate the generality and applicability of our method and the potentially significant impact of ambiguity to optimal stopping in a few examples.

4:45-5:15

**Title:** Asymptotic Ruin Probabilities for a Multidimensional Renewal Risk Model with Multivariate Regularly Varying Claims  
**Presenting Author:** Dimitrios G. Konstantinides, University of the Aegean (with Jinzhu Li)  
**Abstract:** This paper studies a continuous-time multidimensional risk model with constant force of interest and dependence structures among random factors involved. The model allows a general dependence among the claim-number processes from different insurance businesses. Moreover, we utilize the framework of multivariate regular variation to describe the dependence and heavy-tailed nature of the claim sizes. Some precise asymptotic expansions are derived for both finite-time and infinite-time ruin probabilities.

Tuesday, July 26

**Breakfast:** 8:00am - 9:00am  
Location: Georgia State University; Student Center East (SCE) – Court & House Salons; 55 Gilmer St NE, Atlanta GA 30303

**Plenary Session II (Mathematics):** 9:00am - 10:15am  
Location: SCE Auditorium; Chair: Enrico Biffis

**Title:** A Unified Approach to Systemic Risk Measures via Acceptance Sets  
**Presenting Author:** Jean-Pierre Fouque, University of California Santa Barbara (with Francesca
Biagini, Marco Frittelli, and Thilo Meyer-Brandis)

Abstract: We propose a general methodological framework that is flexible enough to cover a wide range of possibilities to design systemic risk measures via multi-dimensional acceptance sets and aggregation functions, and to study corresponding examples. Existing systemic risk measures can usually be interpreted as the minimal amount of cash needed to secure the system after aggregating individual risks. In contrast, our approach also includes systemic risk measures that can be interpreted as the minimal amount of cash that secures the aggregated system by allocating capital to the single institutions before aggregating the individual risks. This allows for a possible ranking of the institutions in terms of systemic riskiness measured by the optimal allocations. Another important feature of our approach is the possibility of allocating cash according to the future state of the system (scenario-dependent allocation). We illustrate with several examples the advantages of this feature.

IME Journal Report by Rob Kaas, University of Amsterdam

Coffee Break: 10:15am - 10:45am
Location: Court & House Salons

Slot 4: 10:45am - 12:15pm (A4-F4)
A4 – Issues in P&C: Claims and Losses II (Location: SCE Auditorium; Chair: Rob Kaas)

10:45-11:15
Title: Generalized linear models for dependent frequency and severity of insurance claims
Presenting Author: Jose Garrido, Concordia University (with C. Genest and J. Schulz)
Abstract: Traditionally, claim counts and amounts are assumed to be independent in non-life insurance. This paper explores how this oft unwarranted assumption can be relaxed in a simple way while incorporating rating factors into the model. The approach consists of fitting generalized linear models to the marginal frequency and the conditional severity components of the total claim cost; dependence between them is induced by treating the number of claims as a covariate in the model for the average claim size. This model is both easy to implement and has the advantage that when Poisson counts are assumed together with a log-link for the conditional severity model, the resulting pure premium can be expressed as the product of a marginal mean frequency, a modified marginal mean severity, and an easily interpretable correction term that reflects the dependence. The approach is illustrated through simulations and applied to a Canadian automobile insurance dataset.

11:15-11:45
Title: Stochastic Loss Reserving with Dependence: A Flexible Multivariate Tweedie Approach
Presenting Author: Phuong Anh Vu, University of New South Wales (with Benjamin Avanzi, Greg Taylor, and Bernard Wong)
Abstract: Stochastic loss reserving with dependence has received increased attention in the last decade. A number of parametric multivariate approaches have been developed to capture dependence between lines of business within an insurer’s portfolio. Motivated by the richness
of the Tweedie family of distributions, we propose a multivariate Tweedie approach to capture cell-wise dependence in loss reserving. This approach provides a transparent introduction of dependence through a common shock structure. In addition, it also has a number of ideal properties, including marginal flexibility, transparency, and tractability including moments that can be obtained in closed form. Theoretical results are illustrated using a simulated dataset and a real dataset from a property-casualty insurer in the US.

11:45-12:15

Title: Adjusting the premium relativities in a bonus-malus system: An integrated approach using the first claim time and the number of claims
Presenting Author: Chong It Tan, Australian National University (with Rahim Mahmoudvand and Narges Abbasi)
Abstract: In this paper, we propose an integrated approach to adjust the premium relativities in a bonus-malus system by using the information of the first claim time (expressed in terms of sub-period in a year) and the number of claims reported by individual policyholder. We provide a formal representation for the newly proposed structure and derive the analytical expressions for the adjusted premium relativities. Other things being equal, a lower adjusted premium relativity is imposed for an earlier sub-period of the first claim made, whereas policyholders with more claims are subject to a higher adjusted premium relativity.

B4 – Actuarial Finance: VAs I (Location: SCE Senate Salon; Chair: Maciej Augustoniak)

10:45-11:15

Title: Variable Annuities with VIX-linked Fee Structure under a Heston-type Stochastic Volatility Model
Presenting Author: Zhenyu Cui, Stevens Institute of Technology (with Runhuan Feng and Anne MacKay)
Abstract: The Chicago Board of Options Exchange (CBOE) advocates linking variable annuity (VA) fees to its trademark VIX index in a white paper (CBOE, 2013a,b). It claims that the VIX-linked fee structure has several advantages over the traditional fixed percentage fee structure. However, the evidence presented in the white paper was largely based on non-parametric extrapolation of historical data. Our work lays out a theoretical basis with a parametric model to analyze the impact of the VIX-linked fee and test some claims from the CBOE white paper. In a Heston-type stochastic volatility setting, we jointly model the asset underlying a VA policyholder’s account and the VIX index. In this framework, we price a guaranteed minimum maturity benefit (GMMB) with VIX-linked fees. Through numerical examples, we show that the VIX-linked fee reduces the sensitivity of the insurer’s liability to market volatility, when compared to a VA with the usual fixed percentage fee.

11:15-11:45

Title: Valuation of Variable Annuities with Guarantees via Stochastic Control Optimization
Presenting Author: Pavel V. Shevchenko, CSIRO
Abstract: In this talk we present a numerical valuation of variable annuities with Guaranteed Minimum Withdrawal Benefit (GMWB) and Guaranteed Minimum Death Benefit (GMDB)
under optimal policyholder behavior solved as an optimal stochastic control problem. A variable annuity with GMWB promises to return the entire initial investment through cash withdrawals during the policy life plus the remaining account balance at maturity, regardless of the portfolio performance. This product simultaneously deals with financial risk, mortality risk and human behavior. We assume that market is complete in financial risk and mortality risk is completely diversified by selling enough policies and thus the annuity price can be expressed as appropriate expectation. Developed numerical methodology to solve the optimal stochastic control problem is based on a robust and efficient Gauss-Hermite quadrature method and cubic spline interpolation. As expected, we found that the fair fee in the case of optimal policyholder withdrawals is significantly higher than in the case of static (predetermined) withdrawals commonly assumed in the industry practice for valuation of these products. At low interest rate and a moderate penalty threshold level, the extra fee due to optimal withdrawal can be as high as 40% and more on top of the base case of no withdrawal or the case of fixed withdrawals at the penalty threshold. We also present results for three different types of death benefit and show that, under the optimal policyholder behavior, adding the premium for the death benefit on top of the GMWB can be problematic for contracts with long maturities if the continuous fee structure is kept, which is ordinarily assumed for a GMWB contract. In fact for some long maturities it can be shown that the fee cannot be charged as any proportion of the account value – there is no solution to match the initial premium with the fair annuity price. On the other hand, the extra fee due to adding the death benefit can be charged upfront or in periodic installment of fixed amount, and it is cheaper than buying a separate life insurance. Using change of numeraire technique we also developed efficient numerical algorithm to price these contracts in the case of stochastic interest rate. Here we found that when the correlation between the underlying asset and interest rate is positive, the GMWB price under stochastic interest rate is significantly higher compared to the case of deterministic interest rate, while for negative correlation the difference is less but still significant.
mean-reversion of the stochastic interest rate process. Generally, the GMWB pricing function behaves non-linearly with changing volatility of the stochastic interest rates. We find that, when volatilities of stochastic interest rate process and stochastic volatility process approach zero, the GMWB price converges to the price observed in the static case. Both, static and dynamic (optimal) withdrawal strategies related to the policyholder’s behavior are investigated. The valuation framework is also extended by incorporating stochastic mortality. We find that hedging costs for GMWBs are lower when mortality risk is added to the modeling framework, compared to fees under no mortality assumption. Our results demonstrate the importance of correct quantification of risks embedded in GMWBs, and provide guidance to product providers on how to optimally hedge various risks that impact GMWBs.

C4 – Insurance Risk Models: Reinsurance (Location: Sinclair; Chair: Maria de Lourdes Cen-teno)

10:45-11:15

Title: Optimal Stop-loss Reinsurance Strategy under Distortion Risk Measures
Presenting Author: Yunzhou Chen, University of Liverpool (with Hirbod Assa)

Abstract: In this paper, we consider the optimal problem in both static and dynamic settings. The objective is to find the optimal retention level of the stop-loss reinsurance to maximize the barrier dividend policy. The next period dividends is used for static case while the conditional expectations of the total discounted dividends until infinity is maximized in the dynamic case. The optimal problem is subject to the budget constraint which is the balance of the surplus just before paying the dividends for the same period. The reinsurance premium and the solvency condition are both measured by the distortion risk measures in the integral form of Value at Risk (VaR) with corresponding distortion functions. The dynamic setting is calculated following the similar framework in the book of Ljungqvist and Sargent (2004). Since the results in dynamic model consists to the discrete one, the optimal reinsurance strategy is myopic. The results under VaR, Conditional VaR and Wang’s Premium in Wang (1996) are also presented as examples.

11:15-11:45

Title: A Joint Optimal Reinsurance-Investment Strategy to Reach a Given Benchmark
Presenting Author: Danping Li, Tianjin University (with David Landriault, Bin Li and Dongchen Li)

Abstract: In this paper, we examine optimal reinsurance-investment strategies for an insurer which aim to (1) maximize the probability to reach a wealth level $b$ before level $0$, (2) minimize the probability to reach level $0$ before the wealth level $b$. We consider an insurer’s surplus process modelled by a diffusion process, which is killed at rate $\lambda > 0$. In addition, the insurer can purchase proportional reinsurance and invest its wealth in a financial market consisting of a risk-free asset and a risky asset, whose dynamics is correlated with the insurance surplus. By applying the dual approach and solving an associated Hamilton-Jacobi-Bellman (HJB) equation, we obtain explicit expressions for the optimal reinsurance-investment strategies and the corresponding optimal value functions of the two optimization problems. Numerical examples are considered to compare the two optimal reinsurance-investment strategies.
Title: Optimal reinsurance strategy for the compound Poisson risk model with thinning dependence  
**Presenting Author:** Wei Wei, University of Hong Kong  
**Abstract:** This paper is concerned with the optimal reinsurance problem for the compound Poisson risk model, in which different classes of business in an insurance company are correlated due to the thinning-dependence structure. Under the criterion of maximizing the adjustment coefficient, explicit expressions for the optimal reinsurance strategy are derived for both the expected value premium principle and the variance premium principle. Numerical examples are also provided to illustrate the impact of different parameters on the optimal strategies.

D4 – Pensions: Management (Location: Lanier ; Chair: Katrien Antonio)

10:45-11:15

**Title:** Considering Part-time Work After Retirement: Should I Stay Or Should I Go?  
**Presenting Author:** Hong Mao, Shanghai Second Polytechnic University & Krzysztof Ostażewski, Illinois State University (with James M. Carson and Zhongkai Wen)  
**Abstract:** In this article, we study the optimal retirement decision with consideration for part time work after the “official” retirement age. We apply dynamic leisure preference in our optimization model. We assume that the leisure preference increases with the individual’s age, meaning that he/she will enjoy leisure more at older age in life, including the ages after the “official” retirement age when the worker is still working part-time. The results of our analyses indicate that optimal retirement age is very sensitive to the following parameters: coefficient of risk version, coefficient of leisure preference before retirement, coefficient of survival function (describing the individual’s mortality), interest rate and discount rate, and is especially sensitive to the growth rate of wage. Our results also indicate that the optimal initial consumption is very sensitive to the initial wage and the growth rate of wage, although the optimal retirement age is very insensitive to the initial wage. Finally, we discuss the effect of reduction of wage rate after retirement on the optimal retirement age. Our results show that the optimal retirement age increases with the decrease of initial wage after retirement.

11:15-11:45

**Title:** Optimal investment strategy of DC pension plan with imperfect information: The case of Hidden Markov Model  
**Presenting Author:** Ling Zhang, Guangdong University of Finance (with Yongzeng Lai)  
**Abstract:** We investigate the optimal asset management strategy for multi-period defined contribution pension plan with stochastic salary when the investor can only observe partial information from the financial market. The financial market consists of one risk-free asset and multiple risky assets whose returns are modulated both by the observable market state and the unobservable market. And the dynamics of the unobservable market state is described by a discrete-time finite-state hidden Markov chain. The distribution of the unobservable market state can be estimated by using sufficient statistics based on the whole observable information, and the optimization problem under a multi-period mean-variance criterion with partially
observable information can be converted into the optimization problem with fully observable information. We obtain the analytical expressions of efficient investment strategy and the efficient frontier by the dynamic programming method and the Lagrange dual method. Also, we discuss the properties of the efficient investment strategy and the efficient frontier under our model. Finally, numerical results are given to present the results obtained in our paper.

11:45-12:15

Title: Cohort Changes in the Retirement Resources from Reverse Mortgages in Taiwan

Presenting Author: Linus Fang-Shu Chan, Soochow University (Taiwan)

Abstract: This study examines the enhancement effect of reverse mortgages on the retirement income of different generations of homeowners in Taiwan. We employ Taiwan’s population mortality rate and housing returns data to calculate the principal limit factor referred to by Szymanoski (1994). We then use the estimated housing prices to calculate the income levels that the elderly homeowners can obtain by taking advantage of these reverse mortgages, and thereby measure the extent of their impact on the retired homeowners’ income replacement rate. Our results show that the average enhancement effect of the reverse mortgages on the retirement income replacement ratio of the elderly homeowners living alone is between 70% and 100%. As for the impacts among different age cohorts within the population, due to the fluctuations in housing prices in Taiwan, the enhancement effect of reverse mortgages on the retirement income of the younger generation of retired homeowners is greater than that in the case of the older generation of retired homeowners.

E4 – Insurance Portfolios: Aggregation (Location: Capital; Chair: David Landriault)

10:45-11:15

Title: Economic capital analysis within a portfolio of dependent and heavy-tailed risks

Presenting Author: Yisub Kye, York University (with Edward Furman)

Abstract: The problem of evaluating the economic capital (EC) for the aggregate risk of a portfolio as well as of consequently allocating the aforementioned EC to risk sources is fundamental in many areas of actuarial science, be it risk management or pricing. In this talk, I will discuss a complete solution to this problem within a portfolio of Paretian risks. As the EC allocation rule, I will use some popular members of the class of weighted EC allocation functionals.

11:15-11:45

Title: On a Class of Premium Calculation Principles Based on the Multivariate Weighted Distribution

Presenting Author: Wenjun Zhu, Nankai University (with Ken Seng Tan and Lysa Porth)

Abstract: This paper proposes a new class of premium calculation principles based on the multivariate weighted distribution, where risk loadings are imposed by transforming the density of the original underlying risk with some auxiliary variables. This premium principle has a number of desirable characteristics, including scale and translation invariance, additivity, stochastic dominance preserving, and additivity for layers. It is also shown that by appropriately selecting auxiliary variables, this premium principle has increasing relative risk loading,
which is desirable for insurance layer pricing. This premium principle is important for actuarial pricing practice because it is able to integrate additional important information, such as market conditions, economic conditions, catastrophic events, etc., into the pricing framework. We highlight the usefulness of this new premium principle by using a unique data set comprised of agricultural reinsurance experience in Manitoba from 2001 to 2011. Developing a scientific methodology for agricultural insurance products is challenging due to a number of unique features compared to other commercial lines of Property & Casualty insurance, including moral hazard, adverse selection, shortness of data, and other structural factors of the loss experience. The advantage of this new proposed premium principle based on the multivariate weighted distribution is the ability to scientifically reweight historical loss experience using auxiliary variables to refine the pricing framework. The auxiliary variables could include material information for pricing, such as economic and market conditions, liability, weather, soil, and other important information. The results show that integrating auxiliary variables into the pricing framework improves the accuracy of the rating by redistributing premium rates and assigning higher loadings to riskier reinsurance contract layers, helping reinsurers achieve better sustainability in the long term.

11:45-12:15

Title: Quasi-Monte Carlo methods for copula based risk aggregation models
Presenting Author: William Guevara-Alarcón, University of Lausanne (with Hansjörg Albrechera)
Abstract: Copula based risk aggregation models are popular in insurance practice through their flexible dependence structures for insurance risk by means of a hierarchical tree construction (see Arbenz et al. (2012) and Côté and Genest (2015)). In this paper we study the use of Quasi-Monte Carlo (QMC) techniques for such hierarchical structures for the simulation of statistics of the aggregate risk. In particular, we investigate the effective dimension and use a refined version of the Koksma-Hlawka inequality to design efficient QMC techniques that can significantly outperform the classical Monte Carlo approach.

F4 – International and Emerging Issues in Insurance (Location: Lucerne; Chair: Hirbod Assa)

10:45-11:15

Title: Optimal Demand for Life Insurance in China under Culture Barriers and Investment Uncertainties
Presenting Author: Ruilin Tian, North Dakota State University
Abstract: We propose a dynamic optimization model to explore the optimal demand for life insurance of a Chinese household with two breadwinners. The lifecycle welfare is measured as the total utility of consumption over the lifetime of the household. We solve a household’s portfolio problem by explicitly recognizing the existence of culture barriers, social security after retirement, loadings on insurance premiums, and uncertainty of mortality. Our results show that life insurance purchase decision is not independent but correlated with a consumer’s wealth, social security, investment risk, bequest incentives, and human capital. Moreover, the presence of incompatible shared values and ideas that place cultural barriers may impede life insurance purchase, which causes a serious uninsurance/underinsurance problem in China.
11:15-11:45

**Title:** An Empirical Investigation of Drivers and Value of Enterprise Risk Management in European Insurance Companies  
**Presenting Author:** Alexander Bohnert, Friedrich-Alexander University Erlangen-Nürnberg (with Nadine Gatzert and Philipp Lechner)  
**Abstract:** In the course of the recent regulatory development in the aftermath of the financial crisis, e.g. the introduction of Solvency II in 2016, holistic enterprise-wide risk management (ERM) frameworks have become increasingly relevant for insurance companies (see, e.g., Beasley et al., 2005; McShane et al., 2011). Solvency II requires an integrated, enterprise-wide perspective on a firm’s entire risk portfolio in contrast to traditional silo-based risk management approaches, and the risk management system has to be consistent with the company’s overall business strategy (see, e.g., Gatzert and Wesker, 2012). Moreover, rating agencies such as Standard & Poor’s or A.M. Best emphasize the importance of a holistic risk management and have started to consider specific ERM rating categories to evaluate the financial strength as well as the creditworthiness of insurance companies (see, e.g., Standard & Poor’s, 2013; Berry-Stoelzle and Xu, 2014). While ERM activities are highly relevant for insurers to comply with Solvency II requirements (especially Pillar 2), the implementation of an ERM system should also contribute to enhancing shareholder value according to the theoretical and empirical literature, e.g. by supporting the board and senior management with necessary risk management information, by increasing capital efficiency, and by better exploiting natural hedges within the company (see, e.g., Meulbroek, 2002; Beasley et al., 2008; Gatzert and Martin, 2015).

11:45-12:15

**Title:** Cybersecurity Insurance: Modeling and Pricing  
**Presenting Author:** Maochao Xu, Illinois State University (with Lei Hua)  
**Abstract:** Cybersecurity has become a problem that is threatening the economy, human privacy, and even national security. The cybersecurity insurance, which is designed to mitigate losses from a variety of cyber incidents, including data breaches, business interruption, and network damage, has received much attention recently. However, the contributions to modeling the cybersecurity risk in the literature are largely descriptive, which is mainly because the cyber risk is very different from the traditional financial risks. The significant property that distinguishes cyber risk from the conventional risk is that information and communication technology resources are interconnected in a network, and therefore the analysis of risk and its related potential losses needs to take into the network topology. In this paper, we will discuss the challenges in modeling the cybersecurity risks including the high-dimensional dependence, and cyber epidemic spreading. The pricing strategy for the insurance companies based on the proposed epidemic spreading model and related simulation will be presented as well.

**Lunch:** 12:15pm - 1:15pm  
**Location:** Court & House Salons
Slot 5: 1:15pm - 2:45pm (A5-F5)

A5 – Optimality and Capital Allocations (Location: SCE Auditorium; Chair: Qihe Tang)

1:15-1:45

**Title:** Robust and Pareto Optimality of Insurance Contracts  
**Presenting Author:** Vali Asimit, Cass Business School (with Alexandru M. Badescu, Valeria Bignozzi, Ka Chun Cheung and Eun-Seok Kim)  
**Abstract:** The optimal insurance problem represents a fast growing topic that explains the most efficient contract that an insurance player may get. The classical problem investigates the ideal contract under the assumption that the underlying risk distribution is known, i.e. by ignoring the parameter and model risks. Taking these sources of risk into account, the decision-maker aims to identify a robust optimal contract that is not sensitive to the chosen risk distribution. We focus on Value-at-Risk (VaR) and Conditional Value-at-Risk (CVaR)-based decisions, since these are the two most known risk measures in practice, but decisions based on any distorted risk measure may be investigated in the same manner if the moral hazard is removed. Worst-case scenario and Worst-case regret robust models are discussed in this talk, which have been already used in the investment portfolio literature. Recent developments of robustness of risk measures are discussed and compared to the main targets of robust optimisation, but adapted to our problem. Closed-form solutions are obtained for the VaR Worst-case scenario case, while Linear Programming (LP) formulations are provided for all other cases. The Pareto optimality of the robust insurance contracts is also investigated and simple numerical methods are found for constructing insurance contracts that are Pareto and robust optimal. Our numerical results show that the decision-maker makes more robust decisions via our proposals when model risk is present.

1:45-2:15

**Title:** Risk capital allocations for insurance portfolios  
**Presenting Author:** Tim Boonen, University of Amsterdam (with Andreas Tsanakasy Mario and V. Wüthrich)  
**Abstract:** The existing literature studies risk capital allocation problems, under the explicit assumption that portfolios are formed as linear combinations of random loss/profit variables, with the firm able to choose the portfolio weights. This assumption is highly debatable in insurance, where arbitrary scaling of risks is generally not possible. We model risks that are partially generated by Lévy processes, which leads to non-homogeneous fuzzy games. For such games, we seek capital allocations that are in the core, that is, do not provide incentives for splitting portfolios. We show that the Euler rule of an artificial linearised fuzzy game (non-uniqely) satisfies the core property and thus provides a plausible and easily implemented capital allocation. This allocation for the non-homogenous fuzzy game is generally not suitable for performance measurement under the standard criteria of Tasche (1999). However, under a weaker definition of suitability, the allocations gives appropriate signals for improving the portfolio underwriting profit.

2:15-2:45
Title: The Marginal Cost of Risk and Capital Allocation in a Property and Casualty Insurance Company  
Presenting Author: Qiheng Guo, Georgia State University (with D. Bauer and G. Zanjani)  
Abstract: In this paper, we introduce a multi-period profit maximization model for a property and casualty (P&C) insurance company, and use it for determining the marginal cost of risk and resulting economic capital allocations. In contrast to previous literature and as an important innovation, our model features a loss structure that matches the characteristics of a P&C company, comprising short-tailed and long-tailed business lines. In particular, we take into account the loss history and loss development years. As an example application, we implement the model using two P&C insurance business lines and two development years, and using NAIC loss data for calibration. Our numerical results demonstrate how loss history affects the marginal cost and capital allocations.

B5 – Actuarial Finance: VAs II (Location: SCE Senate Salon; Chair: Lukasz Delong)

1:15-1:45

Title: Regression Modeling for the Valuation of Large Variable Annuity Portfolios  
Presenting Author: Guojun Gan, University of Connecticut (with Emiliano Valdez)  
Abstract: Variable annuities are life insurance policies that contain complex guarantees. Due to the complexity of the guarantees, there is no closed-form formula to calculate the value of the guarantees except for some special cases. Insurance companies rely heavily on the Monte Carlo simulation method to price the guarantees. However, it is very time-consuming to use the Monte Carlo simulation method to price a large portfolio that contains hundreds of thousands of variable annuity policies. For example, if we use a Monte Carlo simulation model with 1,000 risk-neutral scenarios and 360 monthly time steps to value a portfolio of 100,000 variable annuity policies, then the number of cash flow projections is $3.6 \times 10^{10}$. It will take a computer that can process 200,000 cash flow projections per second about 50 hours to finish the computation. As a result, valuation and risk management of such large portfolios are a big challenge to insurance companies.

Metamodeling has been proposed to address the computational challenge mentioned above. The metamodeling approach consists of two components: an experimental design method and a metamodel. The experimental design method is used to select a small set of variable annuity policies from a large portfolio. The metamodel is used to approximate the fair market value (or other quantities of interesting) of the portfolio based on the selected policies and their fair market values calculated by the Monte Carlo simulation model. Existing metamodels (e.g., kriging) assume that the fair market value of the guarantees follows a normal distribution. However, this assumption is not appropriate for the fair market value of the guarantees, which is positively skewed. The skewness is caused by the fact that the payoffs of guarantees has a larger range than the fees of guarantees. To address this problem, we propose to use GB2 (generalized beta of the second kind) distributions with four parameters to model the fair market values of VA guarantees. Compared to the existing techniques, the proposed method is able to capture the skewness of the distribution of the fair market values.

1:45-2:15
Title: Mitigating interest rate risk in variable annuities: An analysis of hedging effectiveness under model risk
Presenting Author: Maciej Augustyniak, Université de Montréal (with Mathieu Boudreault)
Abstract: Variable annuities are investment vehicles offered by insurance companies that combine a life insurance policy with long-term financial guarantees. These guarantees expose the insurer to market risks, such as volatility and interest rate risks, which can only be managed with a hedging strategy. The objective of this article is to study the effectiveness of dynamic Greeks-based hedging strategies for mitigating interest rate risk in variable annuities with either a guaranteed minimum death benefit (GMDB) or guaranteed minimum withdrawal benefit (GMWB) rider. Our analysis centers on three important practical issues: (i) the robustness of interest rate hedges to model uncertainty, (ii) the impact of guarantee features (maturity versus withdrawal benefits) on the performance of the hedging strategy, and (iii) the importance of hedging interest rate risk in either a low and stable or rising interest rate environment. Overall, we find that the impact of interest rate risk is equally felt for the two types of products considered, and that interest rate hedges do lead to a significant risk reduction for the insurer, even when the ongoing low interest rate environment is factored in.

2:15-2:45

Title: The Effect of Labor Income and Health Uncertainty on the Valuation of Guaranteed Minimum Death Benefits
Presenting Author: Eric Ulm, Georgia State University (with Jin Gao)
Abstract: We examine the effect of labor income and health uncertainty on the optimal choices of policyholders with Guaranteed Minimum Death Benefits embedded in Variable Annuities. These choices are determined in the context of a utility-based life cycle model including bequest motives and optimal term life purchases. We then determine risk-neutral prices from the perspective of the issuing financial institutions. In contrast to previous studies which do not include income and health uncertainty, we find that very risk-averse policyholders in weak job markets would be willing to pay the risk-neutral price in order to receive these benefits. This occurs because an unemployed individual with a low account balance would be unwilling to pay for term insurance, but has precommitted to pay the now small GMDB fees in exchange for the death benefits.

C5 – Insurance Risk Models: Ruin III (Location: Sinclair ; Chair: Julia Eisenberg)

1:15-1:45

Title: On the joint-insolvency risk model with proportional reinsurance and ruin-based capital allocation
Presenting Author: Tianxiang Shi, University of Nebraska-Lincoln (with Jun Cai, David Landriault, and Wei Wei)
Abstract: The multi-dimensional risk model has received increasing attention recently in risk theory. The interdependence of claim arrival dynamics among different insurance-business lines makes it very challenging to analyze the joint ruin probabilities of multiple surplus processes. In this paper, following Avram et al. (2008)’s approach, we study the joint ruin problems in the two-dimensional Markovian arrival (MAP) processes with proportional reinsurance setting. By introducing a generalized time-dependent penalty function, the Laplace
transforms of various joint-ruin quantities are obtained. Moreover, we also propose to use the finite-time and infinite-time joint-ruin probabilities as risk measures to allocate risk capital among different business lines. The joint-ruin allocation approach not only enables us to capture the risk dynamics over a given time horizon, but also overcomes the "cross-subsidizing" assumption made in many existing allocation principles.

1:45-2:15

**Title**: Periodic capital injection strategy embedded at claim instants  
**Presenting Author**: Ran Xu, The University of Hong Kong (with Jae-Kyung Woo)  
**Abstract**: The literature on the various risk models related to capital injection problem has grown considerably in recent years. Most proposed models implicitly assume that the decision on capital injections are made according to the continuous monitoring of the insurer’s surplus. However, it is costly and unrealistic in practice. Therefore, in this talk we propose the periodic capital injection strategy in which surplus level is recovered to a predetermined minimum solvency level “z” whenever it is below level “z” after every Nth claim. We also assume that an immediate capital injection with the penalty involving the deficit is required when ruin occurs. Furthermore, with the aid of the discounted density of surplus at claim instants, higher order ordinary differential equation with an integral-type boundary condition is derived for the expected discounted capital injection when the claim size distribution is a combination of exponentials. Lastly, some numerical examples are presented to illustrate how the strategy based on N has impact on the expected discounted capital injection amount.

2:15-2:45

**Title**: Parisian Ruin for a Refracted Lévy Process  
**Presenting Author**: Mohamed Amine Lkabous, Université du Quebec a Montreal (with Irmina Czarna and Jean-François Renaud)  
**Abstract**: Parisian ruin occurs if the time spent below zero by the risk process is longer than a fixed delay. In this talk, we investigate Parisian ruin for a refracted Lévy process. We generalize the result of Loeffen, Czarna & Palmowski (2013) for the probability of Parisian ruin of a standard Lévy insurance risk process. Other fluctuation identities with Parisian delay will be presented. Finally, we will give examples to illustrate the results.

D5 – Mortality Risk: New Approaches II (Location: Lanier; Chair: Michel Vellekoop)

1:15-1:45

**Title**: Semi-parametric extensions of the Cairns-Blake-Dowd model: a one-dimensional kernel smoothing approach  
**Presenting Author**: Colin O’Hare, Monash University (with Han Li)  
**Abstract**: Over the last few decades, there has been an enormous growth in mortality modeling as the field of mortality risk and longevity risk has attracted great attention from academic, government and private sectors. In this paper, we propose a time-varying coefficient mortality model aiming to combine good characteristics of existing models with efficient model calibration methods. Nonparametric kernel smoothing techniques have been applied in the literature of mortality modeling and based on the findings from Li et al.’s (2015) study,
such techniques can significantly improve the forecasting performance of mortality models. In this study we take the same path and adopt a kernel smoothing approach along the time dimension. Since we follow the model structure of the Cairns-Blake-Dowd (CBD) model, the TVC model we propose can be seen as semi-parametric extensions of the CBD model and it gives specific model design according to different countries’ mortality experience. The fitting and forecasting results from empirical studies have shown superior performances of the model over a selection of well-known mortality models in the current literature.

1:45-2:15

Title: Analysis of the Stochasticity of Mortality
Presenting Author: Erland Ekeden, Stockholm University (with Ola Hössjer)
Abstract: We analyse the stochasticity in mortality data from the USA, the UK and Sweden, and in particular to which extent mortality rates are explained by systematic variation, due to various risk factors, and random noise. We formalise this in terms of a mixed regression model with a logistic link function, and decompose the variance of the observations into three parts: binomial risk, the variance due to random mortality variation in a finite population, systematic risk explained by the covariates and unexplained systematic risk, variance that comes from real changes in mortality rates, not captured by the covariates. The fraction of unexplained variance caused by binomial risk provides a limit in terms of the resolution that can be achieved by a model. This can be used as a model selection tool for selecting the number of covariates and regression parameters of the deterministic part of the regression function, and for testing whether unexplained systematic variation should be explicitly modelled or not. We use a two-factor model with age and calendar year as covariates, and perform the variance decomposition for a simple model with a linear time trend on the logit scale. The population size turns out to be crucial, and for Swedish data, the simple model works surprisingly well, leaving only a small fraction of unexplained systematic risk, whereas for the UK and the USA, the amount of unexplained systematic risk is larger, so that more elaborate models might work better.

2:15-2:45

Title: A Mortality Improvement Rate Model With Normal Inverse Gaussian Mortality Index
Presenting Author: Funda Kul, Hacettepe University (with Meral Sucu)
Abstract: Pension scheme providers have to price mortality risk by accurate mortality forecasting method. There are many mortality forecasting methods constructed and used in literature which use mortality rate. The main problem of these models is non-stationarity of mortality rates. To eliminate this problem, mortality improvement rates defined and try to modeling. In this paper, we propose and use normal inverse gaussian distribution to modeling mortality index in mortality improvement rate model. Using population mortality data for Italy, France, and Turkey, the model’s forecasting capability is investigated, and a comparative analysis with other models is ensured by some well-known criterions.
Title: Market-Consistent Actuarial Valuation of the Participating Life Insurance Contract
Presenting Author: Ahmad Salahnejhad Ghalehjooghi, Maastricht University
Abstract: Pension policies impose very long-dated liabilities that are not fully traded and hedgeable in the market and due to existence of the actuarial risk in their payoff, they are normally priced by the non-linear premium principles. Such long-term positions makes the issuer’s valuation and risk management vulnerable against the dynamics of the middle-term fluctuations. To reflect the effect of the middle-time evolution on the price, we require time-consistency argument while the premium principles are not time-consistent. On the other hand, the regulator calls for the market-consistent valuation for such liabilities, while they are not fully tradable. This paper provides a time-consistent and market-consistent pricing method for a participating life/pension scheme with guaranteed interest rate. We consider a hybrid combination of the actuarial risk and hedgeable financial risks in the final payoff and the profit-sharing mechanism over the life of the contract. We achieve the market-consistency by “two-step actuarial valuation” proposed by Pelsser and Stadje (2014) and time-consistency by repeating the one-period valuation procedure by a “backward iteration” in the sub-intervals over the valuation period. We use Least-Square Monte-Carlo (LSMC) method to implement the backward iteration. We report the results by comparing the above price to the expected value of the discounted payoff and measure the relative risk loading and time-consistency risk premium. We also study the effect of the stochastic interest rate comparing to the deterministic one, on the price of the contract.

1:45-2:15
Title: Market-consistent valuation of combined financial-actuarial claims
Presenting Author: Karim Barigou, Katholieke Universiteit Leuven (with Pierre Devolder and Jan Dhaene)
Abstract: An insurance liability is often partially replicable by traded assets. This may be due to the fact that the payoff of the underlying insurance contract is defined in terms of a combination of hedgeable and unhedgeable claims (e.g. unit-linked insurance) or due to the existence of traded insurance-linked securities of which the payoff is correlated with the payoff of the insurance liability (e.g. catbonds). Recent insurance regulations (Swiss Solvency Test, Solvency II) require insurers to calculate a best-estimate and a risk margin for non-hedgeable risks, via a so-called market consistent valuation. In this paper, we investigate a framework for the market-consistent valuation of the liabilities related to an insurance policy or portfolio in discrete time. In a first step of the valuation process, a "best hedge" for the liability is set up, based on the traded assets in the market via mean-variance hedging. In a second step, the remaining part of the claim is evaluated via a standard actuarial valuation principle. The final value defined as the sum of the price of the hedge and the actuarial value of the non-hedged part of the claim leads to a unique market-consistent value.

2:15-2:45
Title: Market consistent valuations in imperfect markets
Presenting Author: Hirbod Assa, University of Liverpool
Abstract: As from January 2016, all insurance companies within the group of countries that their companies are regulated according to Solvency II have to evaluate their insurance positions using a market consistent valuation method. The reason is that nowadays the insurance
industry (mostly in the developed countries) is strongly connected to the financial system. In this paper, we introduce and study market consistent valuations in imperfect financial markets. We will see in imperfect markets one needs to have two type of market consistency, namely type I and II. While market consistency of type I holds without very strong assumptions, the type II consistency (which in the literature is known as the usual definition of market consistency) does not hold unless the market prices are linear for fully hedged assets. We also characterize the market consistent evaluators by introducing a best estimate framework for risk assessment. We discuss how market consistent valuations can be regarded as robust approach to hedging and pricing in the presence of market imperfections such as market incompleteness and frictions.

F5 – Mathematical Finance: Pricing and Hedging (Location: Lucerne; Chair: Bin Li)

1:15-1:45

**Title:** Quantile hedging interest rate linked payoffs using equity  
**Presenting Author:** Anne MacKay, Université du Québec à Montréal  
**Abstract:** In a complete bond market, payoffs that depend on the term structure of interest rates can be perfectly replicated by a hedging strategy whose initial cost is the risk-neutral price of the payoff. Quantile hedging may reduce the cost of the strategy if the investor is willing to accept the risk that, with low probability, the payoff will not be perfectly replicated. In this paper, we use the results from Föllmer and Leukert (1999) to assess whether the cost of a quantile hedging strategy can be reduced by the introduction of a risky asset in the complete bond market. In a simplified market model, we derive explicit expressions for the initial cost of the hedge and the expectation of the unhedged loss. We show that while investing in the risky asset reduces the cost of the hedge, its effect on the unhedged loss depends on the structure of the market. These results are presented with applications to pension plan funding in mind.

1:45-2:15

**Title:** An Efficient Quasi-Monte Carlo Algorithm for Pricing of Discrete-time Barrier Options  
**Presenting Author:** Chengguo Weng, University of Waterloo  
**Abstract:** Real contracts with barrier provisions often specify discrete monitoring instants, and there are essentially no formula for their price. It is indeed difficult to accurately compute their price even numerically. In this talk, we present an innovative Quasi-Monte Carlo (QMC) algorithm for the pricing of discrete-time barrier options. Our algorithm is designed to handle the discontinuity issue of the integrand for QMC method. We mainly focus on the integrand as a product of a smooth function and an indicator function over a polyhedron. We manage to circumvent the negative impact of the discontinuity by incorporating the virtues of both the orthogonal transform method and the smoothing method which are two prevalent methods in the QMC literature for mitigating the discontinuity issue. Specifically, we attach a function to smooth the integrand for each facet of the polyhedron and decompose the integrand into a sequence of QMC-friendly payoff functions. Then, the expected values of the functions attached are computed by the QMC method through orthogonal transformation. In addition, to extend the applicability of our algorithm, we also introduce a new control variate scheme,
which combines both the Monte Carlo (MC) method and QMC method, to mitigate the effect of the “curse of high dimensionality”. The efficiency of our algorithm is confirmed by a vast number of numerical experiments on the pricing of discrete-time barrier options.

2:15-2:45

**Title**: Variance Swap under a Threshold Mean-reverting Model  
**Presenting Author**: Fangyuan Dong, The Chinese University of Hong Kong (with Hoi Ying Wong)  
**Abstract**: Variance swap has become a typical financial tool for managing volatility risk since the recent financial crisis. In this paper, we evaluate different types of variance swaps under a threshold Ornstein-Uhlenbeck process for the log-asset value with both mean reversion and regime switching features, which have drawn a greater attention in empirical and theoretical research. Analytical solution for the joint moment generating function of log-asset prices at two distinct time points is derived with a two-step method involving the Laplace transform and partial differential equation. This enables us to price variance swaps analytically.

Coffee Break: 2:45pm - 3:15pm
Location: Court & House Salons

Slot 6: 3:15pm - 4:45pm (A6-F6)

A6 – Application of Statistical Concepts in Insurance and Finance (Location: SCE Auditorium; Chair: Vali Asimit)

3:15-3:45

**Title**: A Neyman-Pearson perspective on optimal reinsurance with constraints  
**Presenting Author**: Ambrose Lo, University of Iowa  
**Abstract**: The formulation of optimal reinsurance policies that take various practical constraints into account is a problem commonly encountered by practitioners. We introduce how a variation of the Neyman-Pearson lemma in the realm of testing statistical hypotheses can be employed to solve a wide class of constrained optimal reinsurance problems analytically and readily. As an illustration of the versatility and superiority of the proposed method, we provide complete and more transparent solutions of some specific constrained optimal reinsurance problems, many of which were partially solved in the literature by substantially more difficult means and under extraneous technical assumptions.

3:45-4:15

**Title**: The demand for insurance with upper limits on the first two moments of coverage  
**Presenting Author**: Shengchao Zhuang, University of Waterloo (with Yichun Chi and Ken Seng Tan)  
**Abstract**: In this paper, the design of an optimal insurance policy is studied from the perspective of a risk-averse insured who would like to maximize the expected utility of the final wealth. In contrast to the previous studies, we assume that the upper limits on the first two moments of coverage are imposed by an insurer to restrict its risk exposure and completely
determine the quantity of the insurance premium. We derive the optimal insurance policy explicitly, and find that it heavily depends upon the values of the upper limits. Moreover, the effects of the insured’s initial wealth on the demand for insurance are studied in detail.

4:15-4:45

**Title:** Importance Sampling using Regularized Regression Methods  
**Presenting Author:** Hyekyung Son, Ewha Womans University (with Jae Youn Ahn, Jeongrim Byeon, and Woojoo Lee)  
**Abstract:** Using a quadratic approximation of a change in portfolio, [Glasserman et al., 2000] developed an efficient importance sampling method to estimate value-at-risk of the change. However, their approximation method is not always preferred. For example, in the case of Asian options, calculation of Greeks (delta and gamma), which are necessary quantities in the approximation in [Glasserman et al., 2000], can be difficult. In this presentation, we consider regularized regression methods to obtain a quadratic approximation of the change in portfolio when calculation of Greeks is difficult. Considering a very large number of financial assets and heavy computing time to obtain a value of the portfolio, we show that the proposed method is computationally efficient.

B6 – Actuarial Finance: Issues in Quantitative Insurance and Finance I (Location: SCE Senate Salon; Chair: Athanasios Pantelous)

3:15-3:45

**Title:** Asset allocation, sustainable withdrawal, longevity aversion and non-exponential discounting  
**Presenting Author:** Lukasz Delong, Warsaw School of Economics (with An Chen)  
**Abstract:** The present research studies an optimal withdrawal and investment problem for a retiree who is interested in sustaining her retirement consumption over a pre-specified consumption level. Apparently, the withdrawal and investment policy depends substantially on the retiree’s health condition and her time preferences (subjective discount factor). We assume that the health of the retiree can worsen or improve in an unpredictable way over her lifetime and model the retiree’s mortality intensity with a stochastic process. In order to make the decision about the consumption and investment policy more realistic from the economic point of view, we assume that the retiree applies a non-exponential discount factor (by adding a small amount of hyperbolic discounting to an exponential discounting) to value her future income. In other words, we consider an optimization problem by combining four important aspects: asset allocation, sustainable withdrawal, longevity risk and non-exponential discounting. Due to the non-exponential discount factor, we have to solve a time-inconsistent optimization problem. We derive the HJB equation which characterizes the equilibrium optimal investment and consumption strategy and solve the HJB equation by applying expansion techniques. We find the first order approximations to the equilibrium optimal consumption and investment strategy.

3:45-4:15
Title: A generic approach for buffering Lévy shocks in unit-linked insurance contracts
Presenting Author: Daniël Linders, KU Leuven (with Servaas Van Bilsen)
Abstract: In this paper we propose new class of unit-linked annuity contracts where market shocks are gradually transformed to consumption. Hence, the policyholder takes investment risk, but it takes some time to adjust the annuity payments after a financial shock. This framework allows to tailor insurance contracts adapted to the risk-profile of the policyholder. Two special cases which are captured by our design are the traditional annuities with guaranteed interest rate and the typical unit-linked products where financial shocks are directly reflected in the annuity payments. In order to build a more realistic risk management framework, we consider a financial market with Lévy distributed shocks. We show how to price and hedge the liabilities associated with this contract. Moreover, we show the impact of a misspecification of the model.

4:15-4:45

Title: Analytic Valuation of Reload Executive Stock Options Allowing for Early Exercise
Presenting Author: Otto Konstandatos, University of Technology Sydney
Abstract: Employee stock options (ESOs) are common in performance-based employee remuneration. ESOs typically have a vesting period where exercise is not allowed, followed by an exercise window where exercise is allowed. Following a substantial stock price decline before vesting, an ESO may be deeply out-of-the-money. ‘Reload’ (or ‘reset’) ESOs allow the ESO to be cancelled and re-issued with a lower exercise price and/or later maturity in this case. The IFRS2 and AASB2 financial reporting standards require public corporations to include the cost of ESOs in their financial statements. The standards also require early exercise to be taken into account and mandate that for reload ESOs the down and out component of the ESO be priced separately from the down and in component. We extend the analysis of Kyng et al (2016) which treated simple ESO structures, and use the Hull and White (2004) exercise-multiple characterisation of voluntary early exercise, to show that the reload ESO is a combination of standard and sequential barrier options with different barriers during the vesting and exercise periods. We apply the non-standard Method of Images (Buchen (2001)) to obtain novel closed form valuation formulae in terms of standardised European binary power option instruments, requiring the use of multiple image function techniques. Although we focus on voluntary early exercise, our approach is readily adapted to incorporate early exercise driven by employee attrition using empirically determined survival functions. Our valuation formulae are relatively simple and readily implementable by practitioners. We briefly discuss the theoretical underpinnings of the Method of Images in relation to the group theoretical properties of the Black-Scholes equation.

C6 – Credit Risk Management (Location: Sinclair; Chair: Xuemiao Hao)

3:15-3:45

Title: Credit and Systemic Risks in the Financial Services Sector: Evidence from the 2008 Global Crisis
Presenting Author: Jean-François Bégin, HEC Montréal (with Mathieu Boudreault, Delia Alexandra Doljanu, and Geneviève Gauthier)
Abstract: The Great Recession has shaken the foundations of the financial industry and led to tighter solvency monitoring of both the banking and insurance industries. To this end, we develop a portfolio credit risk model that includes firm-specific Markov-switching regimes as well as individual stochastic and endogenous recovery rates. Using weekly credit default swap premiums for 35 financial firms, we analyze the credit risk of each of these companies and their statistical linkages, placing special emphasis on the 2005-2012 period. Moreover, we study the systemic risk affecting both the banking and insurance subsectors.

Title: Credit Benchmarking, Risk Premium Adjustment Factors, and Credit Solvency Capital Requirements: A Recovery-Based Approach
Presenting Author: Olivier Le Courtois, EMLyon Business School (with Jeremy Allali and Mohamed Majri)
Abstract: This article constructs a recovery-based framework for computing the credit Solvency Capital Requirements of insurers under the constant position paradigm. Although this framework is most suited under the Solvency 2 regulation, it also provides concepts that can be useful under the Basel regulation. After a brief survey of the extant technology on rating transitions and default probabilities, the paper provides new results on risk premium adjustment factors. Then, three different procedures for reconstructing constant-position market-consistent histories of credit portfolios from quoted Merryll Lynch indices are given. The reconstructed historical credit values are then calibrated to mixed empirical-Generalized Pareto Distribution (GPD) dynamics. Several validations of the calibration are also provided. Finally, credit Solvency Capital Requirements are computed and an analysis of the results per rating class is given.

Title: Credit risk estimation under survivorship bias and its impact on risk management
Presenting Author: Mathieu Boudreault, Université du Québec à Montréal (with Diego Amaya and Don McLeish)
Abstract: Survivorship (or survival) bias in finance is the error committed in an analysis built on companies that have not defaulted. When survival bias is not accounted for, it may overestimate the true return on the firm and this can have important impacts in various aspects of risk management. It is a well-known phenomenon when analyzing mutual fund performance and persistence but it has often been overlooked in the credit risk estimation literature. Credit risk of corporations is mostly calculated using default counts (or ratings transitions) or security prices such as stocks, credit default swaps, corporate bonds, etc. However, whenever security prices are used, estimation is affected by the survivorship bias because the assessment of the solvency of an individual firm is conditional upon its survival. In this paper, we examine maximum likelihood estimation of first-passage structural credit risk models conditional upon survivorship. We first analyze the size of the bias with a large Monte Carlo study. For structural models based upon the geometric Brownian motion, we then derive maximum likelihood estimates that correct for this bias and determine their properties. Finally, we conduct an empirical analysis of the size of the survivorship bias with stock price data of over 5000 firms and investigate its impact on credit risk management.
D6 – Mortality Risk: Heterogeneity (Location: Lanier; Chair: Corina Costantinescu)

3:15-3:45

**Title:** On the heterogeneity of human population as reflected by the mortality dynamics  
**Presenting Author:** Séverine Arnold, University of Lausanne (with Demetris Avraam, Olga Vasieva, and Bakhtier Vasiev)  
**Abstract:** The heterogeneity of human population is a common consideration in describing and validating its various age-related features. Particularly the heterogeneity, amongst other factors, is used to explain the variability of mortality rates across the lifespan and their deviations from an exponential growth at young and very old ages. A mathematical model that combines the population heterogeneity with the assumption that the mortality of each constituent subpopulation increases exponentially with age, has recently been shown to successfully reproduce the entire mortality pattern across the lifespan as well as its evolution over time. Furthermore, the analysis of time-evolution of the mortality patterns, performed by fitting the model to actual data of consecutive periods, confirms the applicability of the compensation law of mortality to each subpopulation and concludes on the evolution of the population towards its homogenization. In this work we aim to show that the heterogeneity of human population is not only a convenient consideration for fitting mortality data but is indeed the actual structure of the population as reflected by the dynamics of its mortality over age and time. Particularly we demonstrate that the model of heterogeneous population fits mortality data better than most of the other models if the data are taken for the entire lifespan and better than all other models if we consider only old ages. Also, we show that the model can reproduce seemingly contradicting observations in late-life mortality dynamics namely the deceleration, the leveling-off and the mortality decline. Furthermore, assuming that the heterogeneity is reflected by genetic variations in the population and using Swedish mortality data for 20th century we confirm that the evolution of mortality dynamics and homogenization of the population can be explained by natural selection and a spread of favored gene variant. This has important implications for potential future mortality improvements.

3:45-4:15

**Title:** Cause-of-Death Mortality and Heterogeneity  
**Presenting Author:** Labit Héloïse, University of Lausanne (with Séverine Arnold, Nicole El Karoui, and Sarah Kaakai)  
**Abstract:** A number of studies have demonstrated how the socio-economic status of a person significantly affect his mortality patterns. Consequently, it is crucially important to understand and model the age composition in a heterogenous population, heterogeneity being in this study related to the socio-economic status. This project combines population dynamics and cause-of-death mortality theories to study heterogeneity in mortality, fertility and age pyramids. We show how population dynamics for a heterogenous population act on aggregated mortality quantities, by taking into account interactions between mortality and fertility. In particular, we are interested in quantifying the impacts of cause-specific mortality changes in a heterogeneous population within a simplistic framework. We illustrate our study using a unique database obtained from the UK Office for National Statistics that contains informations on cause-specific death rates by age, gender and deprivation level. We demonstrate how
a reduction of mortality could lead to a counterintuitive deterioration of the life expectancy over the long run.

**E6 – Dynamic Issues in Insurance Markets (Location: Capital; Chair: Tim Boonen)**

3:15-3:45

**Title:** A Model of Non-Cooperative Dynamic Game for General Insurance Markets  
**Presenting Author:** Renchao Wu, University of Liverpool (with Tim J. Boonen and Athanasios A. Pantelous)  
**Abstract:** In the insurance markets, the number of product-specific policies from different companies has increased significantly lately. The strong market competition has boosted the demand for a competitive premium. In actuarial science, scant literature still exists on how competition actually affects the calculation and the pricing cycles of company’s premia. In this paper, we model premium dynamics via a differential game, and study the insurers’ equilibrium premium pricing in a competitive market. We apply an optimal control theory approach to determine the premiums in the pure Nash Equilibrium. Each insurer is assumed to maximize its utility of terminal wealth. The price sensitivity parameter is embedded in the model, which represents different insurer’s premium pricing sensitivity regarding the competition with others. We initially characterize the competition between any selected pair of insurers, then the technique of aggregate games is applied to consider N players’ competition. A numerical example illustrates the main findings of the paper.

3:45-4:15

**Title:** Nondiversification Traps in a Market with Catastrophic Risks  
**Presenting Author:** Hengxin Cui, University of Waterloo (with Ken Seng Tan and Fan Yang)  
**Abstract:** Catastrophic risks are usually characterised to be heavy-tailed and dependent. In practice, catastrophe insurance provides compensation for losses created by such risks. However, it has often been observed that insurance providers may not be willing to issue insurance for catastrophic risks and to participate in reinsurance markets, even though full risk sharing through diversification can be reached in a reinsurance market. In Ibragimov et al. (2009), they showed that there is a nondiversification trap when independent risks have heavy tails and insurance providers have limited liability. In our work, we incorporate two types of dependence structures among catastrophic risks. The first one is a symmetric dependence model with common shock. The second one is a nonsymmetric and spatially correlated model. We show that the occurrence of nondiversification traps depends on the heavy-tailedness of risks and dependence structure. That is, the value of diversification may be negative on the scale of the individual insurance company, but positive on a market scale. Therefore, there may be a need for some type of coordination mechanism to ensure risk sharing.

4:15-4:45

**Title:** Asymptotic Analysis of Portfolio Diversification  
**Presenting Author:** Chen Zhou, Bank of The Netherlands (with Hengxin Cui, Ken Seng Tan and Fan Yang)
**Abstract:** Interconnectedness and heavy-tailedness of risks may result in high systematic risk. When the number of risks are fixed, maximizing diversification benefits can lower the portfolio risk. In this work, the diversification ratio, also known as the risk concentration, is used to measure the diversification benefit. We aim to construct the most diversified portfolio when risks are heavy-tailed and dependent, modeled by the multivariate regularly variation structure. Since explicit solutions to such optimization problems are generally not available and the computation burden of such solution is very heavy and not stable, asymptotic analysis is conducted as an alternative way to study them. The asymptotic solution is showed to be a good approximation to the true solution and the approximation error is given as well. Our theoretical results are supported by extensive numerical simulations. The estimation of the asymptotic solution is provided and then our strategy is also applied to real market data.

**F6 – Health Insurance Risk (Location: Lucerne; Chair: Colin Ramsay)**

3:15-3:45

**Title:** Indexing Lifelong Medical Insurance Premiums With An Application To The Belgian System  
**Presenting Author:** Hamza Hanbali, Katholieke Universiteit Leuven (with Michel Denuit, Jan Dhaene, Nathalie Lucas and Julien Trufin.)  
**Abstract:** This paper proposes a practical way to index premium amounts ex-post in medical insurance. The difficult point is to account for the accumulated reserves when premiums have been leveled. We show that indexing can be achieved by considering only premiums, without explicit reference to reserves. This appears to be relevant in practice as reserving mechanisms may not be transparent to policyholders and as some insurers do not compute contract-specific reserves, managing the whole portfolio in a collective way. The present study originates in a proposal for indexing medical insurance premiums in Belgium. As an application, we study the impact of various indexing mechanisms on a typical medical insurance portfolio on the Belgian market.

3:45-4:15

**Title:** Fuzzy Logic Application of Health Risk Assessment: Revisited  
**Presenting Author:** Marie-Claire Koissi, University of Wisconsin – Eau Claire (with Arnold F. Shapiro)  
**Abstract:** Health risk is assessed on several characteristics such as age, height, and weight, but also life style and habits such as smoking, drinking, level of weekly exercise, and diet (or eating habits). Information related to life style is often expressed in linguistic form (for example: underweight, normal weight, overweight, obese). Since fuzzy logic is superior to traditional methods in situations where the linguistic variables are used to express the logic rules, the information is subjective, incomplete or unreliable, and the problem spaces are often nonlinear, it seems an appropriate methodology for evaluating health risk. In this talk, we discuss how fuzzy logic can be used to model health risk parameters such as body mass index (BMI), blood pressure, and drinking habit. We will present particular health risk assessment cases studies with a fuzzy risk evaluation model and the fuzzy matrix tool.
**Title:** Towards Fairer Compensation: Personal Injury Claims Computation for Future Loss of Earnings  
**Presenting Author:** Priscillah Mogaka, Strathmore University  
**Abstract:** In this paper, we establish the inadequacies in the current approaches to personal injury compensation computation in the African markets. We establish the limitations and inconsistencies in the personal injury litigation system and the lack thereof of a statistically sound approach to computing personal injury benefits. We utilize a penta-factor modelling approach that considers employment status, previous disabilities for the claimant, education attainment, economic trends and existing life tables to exemplify the role of dynamic modelling in facilitating fairer personal injury compensation. A log-linear model is implemented to estimate the maximal offer with spherical disturbances being allowed for. We recommend the adoption of the penta-factor dynamic modeling approach to create Africa-focused personal injury compensation tables and apply generalized inference theory to estimate confidence intervals for variance.

**CEAR Conference Dinner (with Presentation) at the Georgia Aquarium: 6:00pm - 10:00pm**  
Location: Georgia Aquarium; 225 Baker St. NW; Atlanta, GA 30313. Welcome by John Thielman, Seated Dinner, and Dinner Presentation:  
**Title:** Integration of Insurance Mathematics and Economics Through Application Driven Theory  
**Presenting Author:** Patrick L. Brockett, University of Texas at Austin  
**Abstract:** This talk will discuss the evolution of insurance mathematics and insurance economics and show how, in its modern form, it developed from an application driven approach to theory. Also discussed is how application driven theory holds a future for further important developments in our field. From a historical perspective, insurance existed before the theoretical underpinnings we now consider commonplace were developed and we show how all this changed in the 1650s due to two application driven investigations that founded the modern basis of both insurance mathematics and economics. Finally we discuss further developments needed.

**Wednesday, July 27**

**Breakfast: 8:00am - 9:00am**  
Location: Georgia State University; Student Center East (SCE) – Court & House Salons; 55 Gilmer St NE, Atlanta GA 30303

**Plenary Session III (Economics): 9:00am - 10:15am**  
Location: SCE Auditorium; Chair: George Zanjani  
**Title:** Government vs. Market Solutions to the Problem of Reclassification Risk  
**Presenting Author:** Michael Hoy, University of Guelph
Abstract: Governments worldwide have adopted a number of measures to provide more equitable insurance market opportunities. In terms of the insurance literature, the main goal is typically to avoid classification or reclassification risk. In the context of health insurance, government interventions include (i) provision of national health insurance schemes, (ii) regulation of private insurance premiums, (iii) risk transfer mechanisms, and (iv) more complex sets of regulations (e.g., the Patient Protection and Affordable Care Act). In the context of life (and other) insurance markets, many countries ban certain types of information from being used to classify risks (e.g., race, religion, gender, genetic background). A brief review of these policies will constitute part I of the talk.

Part II of the talk will address whether guaranteed renewable (GR) insurance contracts (or provision of long term contracts) can provide an effective solution to the problem of reclassification risk in the context of a life insurance market. I will discuss how the presence of unpredictable fluctuations in demand for life insurance over an individual’s lifetime may compromise the effectiveness of GR contracts.

Whether a market or government approach is better would seem to depend on many idiosyncrasies of the insurance market being addressed.

IME 2017 Invitation SCE Auditorium by Julia Eisenberg, TU Vienna

Coffee Break: 10:15am - 10:45am

Location: Court & House Salons

Slot 7: 10:45am - 12:45pm (A7-F7)

A7 – Consumption & Investment (Location: SCE Auditorium; Chair: Daniel Bauer)

10:45-11:15

Title: Nonrecursive Separation of Risk and Time Preferences

Presenting Author: Mogens Steffensen, University of Copenhagen (with M.A. Fahrenwaldt and N.R. Jensen)

Abstract: Recursive utility disentangles preferences with respect to time and risk by recursively building up a value function of local increments. This involves certainty equivalents of indirect utility. Instead we disentangle preferences with respect to time and risk by building up a value function as a non-linear aggregation of certainty equivalents of direct utility of consumption. This leads to time-consistency issues which are dealt with by looking for an equilibrium control and an equilibrium value function rather than an classically optimal control and a classical optimal value function. We characterize the solution in a general diffusive incomplete market model and find that, in certain special cases of utmost interest, the characterization coincides with what would arise from a recursive utility approach. But also importantly, in other cases, it does not: The two approaches are fundamentally different but actually match, exclusively but importantly, in the mathematically special case of homogeneity of the value function. Among the cases of coincidence, we find solutions to incomplete market problems with both power and exponential utility, that have not been addressed in the literature before.
11:15-11:45

**Title:** Equilibrium consumption and portfolio decisions with stochastic discount rate and time-varying utility functions  
**Presenting Author:** Huiling Wu, China Institute for Actuarial Science, Central University of Finance and Economics (with Chengguo Weng and Yan Zeng)  
**Abstract:** This paper studies a multi-period investment-consumption optimization problem with a stochastic discount rate and varying utility functions, which are governed by a Markov-modulated regime switching model. The investment is dynamically reallocated between one risk-free asset and one risky asset. The problem is time-inconsistent due to the non-constancy of the discount rate, and an analytical equilibrium solution is established by resorting to a game theoretical framework. Numerous sensitivity analysis and numerical examples are provided to demonstrate the effects of stochastic discount rate and varying utility functions on the decision-maker’s investment-consumption behavior. Our results show that many properties which are satisfied in classical models do not hold any more when the discount rate is not constant.

11:45-12:15

**Title:** Consumption and Portfolio Choice under Loss Aversion and Endogenous Updating of the Reference Level  
**Presenting Author:** Servaas van Bilsen, University of Amsterdam (with Roger J.A. Laeven and Theo E. Nijman)  
**Abstract:** This paper explicitly derives the optimal dynamic consumption and portfolio choice of a loss averse agent who endogenously updates his reference level. His optimal choice seeks protection against consumption losses due to downside financial shocks. This induces a (soft) guarantee on consumption and is due to loss aversion. Furthermore, his optimal consumption choice gradually adjusts to financial shocks. This resembles the payout streams of financial plans that respond sluggishly, smoothing investment returns to reduce payout volatility, and is due to endogenous updating. The welfare losses associated with various suboptimal consumption and portfolio strategies are also evaluated. They can be substantial.

12:15-12:45

**Title:** How to invest optimally with a Wishart state variable?  
**Presenting Author:** Jitze Hooijsma, Universiteit van Amsterdam  
**Abstract:** In this talk we investigate under which conditions optimal portfolio weights are given by an analytic expression. In particular, we consider several optimal portfolio choice problems, where either the covariance matrix of the traded assets or the precision matrix of the traded assets is affine in a Wishart state variable. We optimize over expected utility of terminal real wealth and solve the portfolio choice problems using the dynamic programming approach. Our main finding is that optimal portfolio weights are only analytic if the dimension of the covariance/precision matrix of the assets is larger than or equal to the dimension of the Wishart state variable.
B7 – Actuarial Finance: Issues in Quantitative Insurance and Finance II (Location: SCE Senate Salon; Chair: Anne MacKay)

10:45-11:15

Title: A conditional equity risk model for regulatory assessment
Presenting Author: Anthony Floryszczak, SMABTP (with J. Lévy Véhel and M. Majri)
Abstract: We define and study in this work a simple model allowing for a prudential valuation of solvency capital requirement while avoiding over-assessment specifically after market disruption. The main idea is to include a dampener component in charge of refining risk assessment after a market failure. Rather than aiming at a realistic, and thus complex, description of equity prices movements, our model concentrates on minimal features enabling accurate computation of regulatory capital requirements. The model is defined both in a discrete and continuous fashion. In the latter case, we prove the existence, uniqueness and stability of the solution of the stochastic functional differential equation that specifies the model.

One difficulty is that the proposed underlying stochastic process has neither stationary nor independent increments. We are however able to perform statistical analyses in view of its validation. Numerical experiments show that our model outperforms more elaborate ones of common use as far as medium term (between 6 months and 5 years) risk assessment is concerned. We believe that our approach offers an attractive alternative for insurance and reinsurance companies to assess their 1 year equity-risk solvency capital requirement with an internal model and their ORSA capital.

11:15-11:45

Title: Optimal investment strategy for an equity-linked life insurance contract with minimum return guarantee
Presenting Author: Peter Hieber, University of Ulm (with An Chen and Thai Nguyen)
Abstract: In a complete market setting, we determine the investment strategy that maximizes expected utility of the terminal payoff of an equity-linked life insurance contract with guarantee. The option-like payoff of a guarantee contract does not allow to apply standard utility maximization theory as the utility of the terminal contract payoff is neither concave nor strictly increasing. We first solve for optimal terminal wealth from the policyholder’s perspective using concavification and a martingale duality approach. Then, we include a minimum reservation utility constraint by the insurance company and determine the Pareto-efficient frontier, i.e. the set of contracts where a change in contract parameters or investment strategy cannot lead to utility improvements for the policyholder without deteriorating the utility of the insurance company. Those results have interesting implications for optimal contracting and asset allocation of life insurance contracts with guarantee. In numerical experiments, we identify situations where a gambling strategy is optimal. Further, we show that a guarantee contract can Pareto-dominate an asset investment if the risk aversion of policyholder and insurance company have different degrees of risk aversion.

11:45-12:15

Title: On Maximizing a Fund Manager’s Payroll under Drawdown-based Risk Measures
Presenting Author: Dongchen Li, University of Waterloo (with David Landriault and Bin Li)
Abstract: In this paper, we introduce the extended deviation measure (EDM) and propose a new class of drawdown-based EDM. Subsequently, we study the problem of maximizing a fund manager’s long term expected payroll, the scheme of which is determined by a ceiling rate and a penalization structure depending on an investor’s specific choice of drawdown-based EDM. Under the Black-Scholes framework, we study a piecewise constant penalization structure and a linear penalization structure. In each case, explicit expressions for the maximized payroll (MP) and the optimal trading strategy are obtained by applying a dual approach. We find that in the nonpenalization region, as fund level increases, the manager is more conservative, while in the penalization region, the manager can be either more or less conservative depending on his payroll scheme.

C7 – Insurance Risk Models: Bailout, Dividends, and Capital Injections (Location: Sinclair; Chair: Jose Garrido)

10:45-11:15

Title: On a class of dependent Sparre Andersen risk models and a bailout application
Presenting Author: Andrei Badescu, University of Toronto
Abstract: In this paper a one-dimensional surplus process is considered with a certain Sparre Andersen type dependence structure under general interclaim times distribution and correlated phase-type claim sizes. The Laplace transform of the time to ruin under such a model is obtained as the solution of a fixed-point problem, under both the zero-delayed and the delayed cases. An efficient algorithm for solving the fixed-point problem is derived together with bounds that illustrate the quality of the approximation. A two-dimensional risk model is analyzed under a bailout type strategy with both fixed and variable costs and a dependence structure of the proposed type. Numerical examples and ideas for future research are presented at the end of the paper.

11:15-11:45

Title: On Renewal Risk Processes and Lévy Processes under a Dividend Barrier Strategy
Presenting Author: Ruixi Zhang, University of Western Ontario (with Kristina P. Sendova and Chen Yang)
Abstract: We consider renewal risk processes and Lévy processes in the presence of a constant dividend barrier. For the former, the probability of ruin is shown to be 1 if either the claim sizes exceed the barrier with positive probability or 0 is a point of increase of the inter-claim time. For Lévy processes the probability of ruin is 1 under Parisian ruin. For Kn-distributed inter-claim times, we offer a revised proof regarding the number of roots to the generalized Lundberg’s equation. The density and moments of the time to ruin are approximated numerically for generalized Erlang(n) inter-claim times and rational-distributed claim sizes. The probability of ruin may be reduced to 0 if neither condition is satisfied, and a dividend-reinsurance strategy is discussed. Finally, generalizations to certain dependent risk processes are included.

11:45-12:15
Title: Effects of negative interest rate on capital injections
Presenting Author: Paul Krühner, TU Vienna (with J. Eisenberg)
Abstract: For a long time it seemed to be a fact that interest rates are and ever will be positive. Recently, some government banks – like the swiss central bank – have decided to introduce a negative key interest rate. This, of course, has an effect for company policies. We inspect the question of optimal capital injection for an insurance company whose surplus is modelled by a Brownian motion with drift. The interest rate is modelled by an independent Markov switching model which takes positive and negative values. This leaves the company with phases of negative interest during which capital injections are cheaper if done early and phases of positive interest where capital injections will only be done if necessary. We identify the conditions under which the optimal capital injection problem is well posed and conditions under which the optimal strategy is or is not the classical strategy, i.e. capital injections are only done if necessary. This talk is based on joint work with J. Eisenberg.

12:15-12:45
Title: The optimal reinsurance and dividend with model uncertainty
Presenting Author: Jingzhe (Jane ) Liu, Central University of Finance and Economics
Abstract: In this paper we analyze the optimal reinsurance and dividend problem with model uncertainty for an insurer. Here the model uncertainty is incorporated into the traditional diffusion surplus assumption, which denotes the possible deviation between the real market and the assumed model. By choosing the reinsurance and the dividend strategy, the objective is to maximize expected discounted dividend before ruin in the worst case of all possible scenarios, namely, the worst market. We solve this problem by combining robust control theory and singular control theory, which is more difficult than the traditional robust control or the singular control only. By dynamic programming approach, the closed form solution can be derived.

D7 – Mortality Risk: Multiple Populations (Location: Lanier; Chair: Colin O’Hare)

10:45-11:15
Title: Modeling and forecasting mortality with economic growth: a multi-population approach
Presenting Author: Hong Li, Nankai University (with Tim J. Boonen)
Abstract: Existing literature on mortality modeling of multiple populations focuses mainly on extrapolating the past mortality trends and summarizing these trends by one or more common latent factors. This paper proposes a multi-population stochastic mortality model which utilizes the explanatory power of economic growth. In particular, we extend the Li and Lee model (Li and Lee, 2005, Coherent mortality forecasts for a group of populations: An extension of the Lee-Carter method. Demography 42 (3), 575-594) by including economic growth, represented by the real gross domestic product (GDP) per capita, to capture the common mortality trend for a group of populations with similar socioeconomic conditions. We find that our proposed model provides a better in-sample fit and an out-of-sample forecast performance. Moreover, it generates lower (higher) forecasted period life expectancy for countries with high (low) GDP than the Li and Lee (2005) model.
11:15-11:45

Title: Multi-population mortality modelling with Lévy processes  
Presenting Author: Chengwei Qin, McMaster University (with Petar Jevtić)  
Abstract: This paper constructs a theoretical framework for multi-population mortality modelling by introducing generalized linear models and Lévy stochastic perturbations driven by a common and an idiosyncratic factor. To accommodate the evolution of factor loadings across age and calendar time, we specify the loadings on common factors to be deterministic nonlinear functions of age and calendar time. Different model formulations are explored by using Lévy processes such as Gamma process and Variance Gamma process, and their in-sample fitting and out-of-sample forecasting performances are evaluated. In addition, we systematically investigate the dependence structure of both the inter-population and cross-population kind. In our empirical investigations, the mortality experiences of male and female lives in UK over the period 1964-2013 are used.

11:45-12:15

Title: Coherent mortality forecasts for dependent populations: a Bayesian approach  
Presenting Author: Anastasios Bardoutsos, KU Leuven (with Katrien Antonio and Wilbert Ouburg)  
Abstract: Underestimating the future improvement of mortality rates translates into higher than expected pay-out-ratios for pensions funds and insurance companies and therefore implies a risk, the so-called longevity risk. The solvency of pension systems and annuity providers in the presence of longevity risk is a major point of concern. Quantification of the longevity risk with appropriate stochastic mortality models is key. Recent studies propose multi-population stochastic mortality models as a strategy for achieving robust and coherent projections of mortality rates. This paper presents a Bayesian analysis of two coherent multi-population models of log-bilinear type, designed for two or more populations, while allowing for dependence between these populations. The first model is inspired by Cairns et al. (2011) and Enchev et al. (2016), and the second is the well known Li & Lee model, proposed by Li and Lee (2005). For both models we identify the parameters through appropriate constraints and we avoid the multi-step calibration strategy that is currently used in the literature. We assume a Poisson distribution for the number of deaths at a certain age and in a certain period and include full dependency between the period effects. As such, we extend earlier work where period effects are considered independent. Moreover, we utilize the Kannisto parametric mortality law to close the generated mortality scenarios for higher ages and provide projections of important demographic markers, such as period and cohort life expectancy. We develop the technicalities necessary for Markov Chain Monte Carlo ([MCMC]) simulations and provide software implementation (in R) for the models discussed in the paper. We finally present a case study using five European countries which are geographically close and share similar socio-economic characteristics.

12:15-12:45

Title: Structural Constraints on Multi-population Mortality Models  
Presenting Author: Pietro Millossovich, Cass Business School (with Valeria D’Amato and Andres M. Villegas)
Abstract: Multi-population mortality models have been proposed in the literature to compare and project the mortality of a group of two or more related populations. The benefit of these multivariate models are multiple, ranging from the measurement of mortality differentials (see Villegas and Haberman (2014)), the production of more consistent forecasts of small populations mortality through the experience of larger populations, the assessment of basis risk in standardized hedges (as for instance in Li and Hardy (2011)). In this paper, we seek to identify structural constraints to be imposed on multi-population models which jointly specify the entire population and its exhaustive parts. Such approach is appealing because the mortality dynamics of each individual subpopulation benefits from the reliable estimate of parameters obtained at the entire population level. However, it raises the issue of the internal consistency of such approach. We review different models proposed in the literature under different assumptions and establish under what conditions this consistency can be achieved. Finally, we investigate if the constraints are compatible with the coherence of a forecasting model, as defined in Li and Lee (2005), and show implications on mortality projections.

E7 –Issues in P&C: Claims and Losses III (Location: Capital; Chair: Liang Peng)

10:45-11:15

Title: Multi-year non-life insurance risk of dependent lines of business in the multivariate additive loss reserving model

Presenting Author: Lukas Hahn, University of Ulm and Institute for Finance and Actuarial Sciences (IFA)

Abstract: We derive and unveil analytical estimators of non-life insurance risk in multi-year view for the multivariate additive loss reserving model. Thereby we jointly assess reserve and premium risk of multiple years for portfolios of possibly dependent lines of business in one integrated approach. By extending existing formulae for the univariate additive model to the multivariate case, risk estimators for the aggregated portfolio now include the inherent dependencies among all lines of business. The resulting risk evaluation over one-year and general multi-year horizons is fundamental to regulatory reporting and risk-oriented business planning of multi-line non-life insurances. A case study illustrates the fruitful application of our formulae and reproduces previous findings for the special case of ultimo view.

11:15-11:45

Title: Multi-year non-life insurance risk for correlated loss portfolios under chain ladder model assumptions

Presenting Author: Marc Linde, BELTIOS P&C GmbH and University of Ulm

Abstract: In this paper we extend the definition of multi-year claims development results and quantification of multi-year non-life insurance risk to the bivariate chain ladder model as introduced by Braun in 2004. In this model, we assume two correlated loss portfolios each of which is underlying the classical chain ladder model. In accordance with standard literature, multi-year risk is defined through the variation of the multi-year claims development result and quantified in terms of the corresponding mean squared error of prediction. Following previous research on the univariate chain ladder model, for the first time we derive closed analytical expressions for the prediction error of the aggregate multi-year claims development
result via first-order Taylor approximation. We reproduce well-known results for the ultimo view from literature. The goodness of our approximation is confirmed by a simulation study. Furthermore, a case study demonstrates the applicability of our analytical formulae.

11:45-12:15

**Title:** Combining local regression and distribution fitting methods to estimate claim frequency  
**Presenting Author:** Meelis Käärik, University of Tartu (with Raul Kangro and Liina Muru)  
**Abstract:** The problem of premium estimation is an essential part of the insurance mathematics. Often the problem is divided into two parts: estimation of claim number (or frequency) and the estimation of individual claim amounts (severities). In this paper, we will focus on the former. More precisely, we are looking for certain dynamic regression type model to avoid the "price shock" issue of static classification. We also take into account that it is hard to specify the form of suitable regression functions, and simple choices of such functions usually have undesirable effects by implicitly implying that risk behaviour of clients corresponding to one region of values of regression variables contain information about the risk behaviour of clients corresponding to a very different region of the same variables. Thus we are proposing certain local regression model, where for each new client we first fix a neighborhood of similar clients (depending on the values of certain argument variables) and then apply the local regression model on this neighborhood. Local maximum likelihood estimation is used to determine the parameters of the model and cross-validation techniques are used to determine the optimal size of the neighborhood. As a result, we propose certain semiparametric model for estimating the claim frequency for each new client. A case study with real vehicle casco insurance dataset is included, the results obtained by proposed method are compared by the ones obtained by global regression and the classification and regression trees (C&RT) approach.

F7 – Issues in Probability with Applications to Insurance and Finance (Location: Lucerne; Chair: Daniël Linders)

10:45-11:15

**Title:** Convex Ordering for Insurance Preferences  
**Presenting Author:** Wing Fung Chong, University of Hong Kong; King’s College London (with K.C. Cheung and S.C.P. Yam)  
**Abstract:** In this talk, we study two broad classes of convex order related optimal insurance decision problems, in which the objective function or the premium valuation is a general functional of the expectation, Value-at-Risk and Average Value-at-Risk of the loss variables. These two classes of problems include many existing and contemporary optimal insurance problems as interesting examples being prevalent in the literature. To solve these problems, we apply the Karlin-Novikoff-Stoyan-Taylor multiple-crossing conditions, which is a useful sufficient criterion in the theory of convex ordering, to replace an arbitrary insurance indemnity by a more favorable one in convex order sense. The convex ordering established provide a unifying approach to solve the special cases of the problem classes. We show that the optimal indemnities for these problems in general take the double layer form.
11:15-11:45

**Title:** A Class of Weak Stochastic Orders with Dependence and Their Applications in Optimization Problems  
**Presenting Author:** Wei Wei, University of Wisconsin-Milwaukee  
**Abstract:** In the field of insurance and finance, many optimization problems employ the tool of stochastic orders to compare risks or portfolios. Meanwhile, due to the widely existence of the phenomenon of dependence, modeling dependence structure has been showing its increasing importance. Therefore, those optimization problems calls for a tool which combines stochastic order and dependence structure. Classic stochastic orders, such as likelihood ratio order, usual stochastic order, and convex order, do not concern dependence between random variables in comparison, because these orders are solely defined through marginal distribution functions. Shanthikumar and Yao (1991) were among the first to introduce dependence structure to stochastic orders. They proposed several bivariate stochastic orders, which concern both marginal distributions and dependence structures. They also gave theoretical characterizations of these orders. Later, the concept of bivariate stochastic order has been applied to study optimization problems in finance and insurance, see for example, Kajima and Ohnishi(1998), Hennessy and Lapan (2002), Cheung and Yang (2004, 2008). Recently, Cai and Wei (2014, 2015), You and Li (2014), Li and You (2015), and Li and Li (2016) have generalized the concept of bivariate stochastic order to multivariate case and explored applications in optimization problems. However, the bivariate stochastic orders and their extensions proposed in the above literature have a major limitation. That is, most of them require all risks or assets under consideration to be ordered according to the usual stochastic order. This is very restrictive and is not generally supported by insurance or financial practice. In order to overcome this limitation, the presented research proposes several new types of stochastic orders by introducing dependence to a class of weak stochastic orders. In doing so, the new developed orders require all components to be ordered only according to some order weaker than the usual stochastic order, which is more flexible. This research shall develop theoretical properties of the new proposed orders and illustrate their applications in insurance and finance.

11:45-12:15

**Title:** SVM-Jacobi for Fitting Exponential Sums to Probability Distributions with Applications to Quantitative Finance and Actuarial Science  
**Presenting Author:** Xixuan Han, The University of Hong Kong  
**Abstract:** We propose a method called SVM-Jacobi to approximate probability distributions by linear combinations of exponential distributions, associated with a comprehensive asymptotic analysis. In multivariate cases, the method also effectively works to provide approximations by linear combinations of products of independent exponential distributions. The proposed method is particularly applicable and useful in quantitative finance and actuarial science. Many pricing and hedging formulas have closed forms under exponential distributions. By approximating the real distributions, we are capable to use the closed-form formulas and fitted coefficients of SVM-Jacobi to approximate the prices and Greeks. In addition to the methodology, we give examples of approximating the credit value adjustment of defaultable bonds, financial derivatives with single payments and credit default
swaps, and the value of equity-linked death benefits. Some numerical results also are presented for illustration.

12:15-12:45

**Title:** Asymptotic Expansions of Heavy-tailed Dependent Sums  
**Presenting Author:** Fan Yang, University of Waterloo  
**Abstract:** The study for tail probabilities of sums of random variables is the foundation of many important risk management problems, for example, VaR based risk measures and capital allocation questions. The independent sums have been well studied. When a dependence structure is assumed among random variables, only the first-order asymptotic properties of the sums are investigated in the literature. In this paper, we pursue the second-order expansions of heavy-tailed dependent sums when the dependence structure is imposed with asymptotic smooth condition. Various special cases are presented to illustrate our results.

_Closing and Lunch: 12:45pm - 1:45pm_  
Location: Court & House Salons
Presenter and Chair Names and Sessions

Presenter Names and Sessions

Agnieszka Izabella Bergel – C1
Ahmad Salahnejhad Ghalehjooghi – E5
Ailing Gu – B3
Alexander Bohnert – F4
Ambrose Lo – A6
Anastasios Bardoutsos – D7
Andrei Badescu – C7
Andres M Villegas – D3
Anne MacKay – F5
Annika Krutto – E3
Arnold Shapiro – F2
Athanasios Pantelous – D1
Bin Li – B2
Chen Zhou – E6
Chengguo Weng – F5
Chengwei Qin – D7
Chong It Tan – A4
Christian Eckert – F1
Colin O’Hare – D5
Daniel Linders – B6
Danping Li – C4
Di Xu – C2
Dimitrios G. Konstantinides – F3
Dongchen Li – B7
Edward Frees – A2
Edward Furman – A2
Emiliano Valdez – A3
Eric Ulm – B5
Erland Ekudden – D5
Etienne Marceau – F2
Fan Yang – F7
Fangyuan Dong – F5
Frank van Berkum – D2
Funda Kul – D5
Georgios Pitselis – F3
Guojun Gan – B5
Hailiang Yang – C1
Haiyan Liu – F2
Hamza Hanbali – B6
Helen Colette – A2
Hengxin Cui – E6
Hirbod Assa – E5
Hong Li – D7
Huiling Wu – A7
Hyekyung Son – A6
I-Chien Liu – D3
Isariya Suttakulpiboon – F1
Jacques Lévy Véhel – B7
Jae Youn Ahn – E1
Jean-François Bégin – C6
Jeff Wong – C3
Jing Yao – B1
Jingzhe (Jane) Liu – C7
Jitze Hooijsma – A7
Johanna Eckert – F1
Jonas Hirz – D1
Jose Garrido – A4
Julia Eisenberg – C1
Kam Chuen Yuen – C2
Karim Barigou – E5
Katrien Antonio – E1
Krzysztof Ostaszewski – D4
Kwok Chuen Wong – B2
Labit Héloïse – D6
Li Shen – F1
Liang Chen – D2
Lihua Bai – C1
Liivika Tee – A3
Ling Zhang – D4
Linus Fang-Shu Chan – D4
Lukas Hahn – E7
Lukasz Delong – B6
Lydia Dutton – E3
Maciej Augustyniak – B5
Malgorzata Seklecka – E3
Maochao Xu – F4
Marc Linde – E7
Maria de Lourdes Centeno – A3
Marie-Claire Koissi – F6
Mathieu Boudreault – C6
Meelis Käärik – E7
Mengyi Xu – A1
Miao Zhang – B2
Michael Ludkovski – D3
Michel Vellekoop – D2
Mogens Steffensen – A7
Mohamed Amine Lkabous – C5
Moshe A. Milevsky – A1
Muhsin Tamturk – C3
Nan Zhang – B1
Nan Zhu – D1
Nikolay Gudkov – B4
Olivier Le Courtois – C6
Otto Konstandatos – B6
Paul Krühner – C7
Pavel V. Shevchenko – B4
Feng Shi – A3
Petar Jevtic – E3
Peter Hieber – B7
Phuong Anh Vu – A4
Pietro Millossovich – D7
Priscillah Mogaka – F6
Qihe Tang – E2
Qiheng Guo – A5
Raj Kumari Bahl – E2
Ran Xu – C5
Renchao Wu – E6
Rim Essifi – C2
Roger J.A. Laeven – F3
Ruilin Tian – F4
Ruixi Zhang – C7
Servaas van Bilsen – A7
Séverine Arnold – D6
Shang-Yin Yang – B3
Shengchao Zhuang – A6
Shu Li – B3
Tianxiang Shi – C5
Tim Boonen – A5
Timothy Kyng – A1
Vali Asimit – A5
Wei Wei – C4
Wei Wei – F7
Wenjun Zhu – E4
William Guevara-Alarcón – E4
Wing Fung Chong – F7
Xinda Yang – E1
Xixuan Han – F7
Xuemiao (Samuel) Hao – D1
Yang Shen – B1
Yasutaka Shimizu – C3
Yiqing Chen – C3
Yisub Kye – E4
Yiying Zhang – B3
Yung-Tsung Lee – A1
Yunzhou Chen – C4
Zhenyu Cui – B4
Zhongyi Yuan – E2
Session Chairs Names and Sessions

Anne MacKay – B7
Arnold Shapiro – F3
Athanasios Pantelous – B6
Bin Li – F5
Colin O’Hare – D7
Colin Ramsay – F6
Corina Costantinescu – D6
Daniel Bauer – A7
Doniel Linders – F7
David Landriault – E4
Edward Frees – A3
Elias Shiu – C2
Emiliano Valdez – A2
Enrico Biffis – A1
Eric Ulm – F1
Etienne Marceau – B3
George Zanjani – E2
Georgios Pitselis – E3
Gord Willmott – C3
Hailiang Yang – B2
Hansjoerg Albrecher – C1
Hirbod Assa – F4
Hong Li – D3
Jan Dhaene – B1
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Julia Eisenberg – C5
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Liang Peng – E7
Lukasz Delong – B5
Maciej Augustoniak – B4
Marc Goovaerts – E1
Maria de Lourdes Centeno – C4
Michel Vellekoop – D5
Mike Ludkovski – F2
Olivier Le Courtois – E5
Pietro Millossovich – D2
Qihe Tang – A5
Rob Kaas – A4
Severine Arnold – D1
Tim Boonen – E6
Vali Asimit – A6
Xuemiao Hao – C6