Risk: Modelling, Optimization and Inference

with Applications in Finance, Insurance and Superannuation

UNSW-Macquarie University workshop

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Speaker abstracts and bios

UNSW SYDNEY

MACQUARIE University CITY CAMPUS

Robert Elliott

University of Calgary
http://contacts.ucalgary.ca/info/ha/profiles/101-152511

Talk title: The semimartingale representation of a semi Markov chain

Abstract: The sojourn times of a Markov chain have a geometrical distribution in the discrete time case or an exponential distribution in the continuous time case. Processes with more general sojourn times have been found to model empirical data better. We discuss the semimartingale form of the dynamics of semi Markov chains in both discrete and continuous time.

Bio: *Professor Elliott was the RBC Financial Group Professor of Finance. He joined the Haskayne School of Business in 2001, having previously held the AF Collins Chair of Finance at the University of Alberta together with a Professorship in Mathematics. His BA and MA degrees are from Oxford and his PhD and DSc from Cambridge. He has taught at Universities around the world, including Yale, Oxford, Northwestern and Warwick. Professor Elliott is the author of over 460 publications, including 7 books. Russian and Hungarian editions of two of his books have been published. In particular his books 'Mathematics of Financial Markets' with PE Kopp and 'Binomial Methods in Finance' with J van der Hoek have been adopted worldwide. Professor Elliott is an Adjunct Professor in the Department of Mathematics at the University of Calgary. He is also an Adjunct Professor at the University of Adelaide and the University of South Australia.*

Runhuan Feng

University of Illinois
https://faculty.math.illinois.edu/~rfeng/

Talk title: Peer-to-peer multi-risk mutual aid plans

Abstract: Peer-to-peer (P2P) insurance is a decentralized network where a group of participants pool their resources together to compensate those who suffer losses. It is a revival of the centuries-old practice in many societies where members care for each other's financial needs in the event of misfortune. Original models of P2P insurance allow participants to form a common fund to pay for each other's losses and any remaining balance is refunded. Mutual aid is a recent innovation of P2P insurance that requires no common fund and under which the cost of insurance is split among participants after claims are reported. The advantage of the "payment in arrears" system is that, no reserve or risk capital is necessary, as the actual cost of each benefit claim is perfectly absorbed by the mutual aid group. Therefore, it has been argued that mutual aid is a low-cost alternative to traditional insurance. Most of existing business models in practice, whether traditional or P2P, are developed to insure against a particular risk, such as critical illness, accidental deaths, property damage, etc. However, even with the same type of risk, not all participants can be of the same loss distribution due to different age cohort, health status, or property conditions, etc. While differential pricing has well developed for traditional insurance, the fair allocation of cost for P2P insurance is not yet well understood in the literature. This paper presents a variety of mutual aid models that facilitate the exchange of multiple risks and enable participants with different needs of insurance to provide financial support of each other in a transparent and actuarially fair way.

Bio: *Runhuan Feng is an Associate Professor in the Department of Mathematics at the University of Illinois at Urbana-Champaign. He is also director of Actuarial Science, HP Petit Professorial Scholar and State Farm Companies Foundation Scholar in Actuarial Science. His research interests include actuarial Science, risk analytics, quantitative finance, pension and retirement planning, FinTech and InsurTech innovations. A/Prof Feng compled his PhD in Actuarial Science at University of Waterloo, Ontario in 2008 and before that completed a MSc in Actuarial Mathematics, Concordia University, Montreal and a B.Sc. in Statistics, B.Econ in Insurance at Nankai University, Tianjin.*

Jean-Pierre Fouque

University of California Santa Barbara
http://fouque.faculty.pstat.ucsb.edu/

Talk title: Optimal portfolio under fractional stochastic environment

Abstract: Rough stochastic volatility models have attracted a lot of attention recently, in particular for the linear option pricing problem. In this talk, starting with power utilities, we propose to use a martingale distortion representation of the optimal value function for the nonlinear asset allocation problem in a (non-Markovian) fractional stochastic environment (for all Hurst index $H \in (0, 1)$). We rigorously establish a first order approximation of the optimal value, when the return and volatility of the underlying asset are functions of a stationary slowly varying fractional Ornstein-Uhlenbeck process. We prove that this approximation can be also generated by the zeroth order trading strategy providing an explicit strategy which is asymptotically optimal in all admissible controls. Furthermore, we extend the discussion to general utility functions, and obtain the asymptotic optimality of this strategy in a specific family of admissible strategies. If time permits, we will also discuss the problem under fast mean-reverting fractional stochastic environment.

Joint work with Ruimeng Hu (UCSB).

Bio: *Jean-Pierre Fouque holds PhD in Mathematics from University Pierre et Marie Curie, Paris 6, 1979.Jean-Pierre Fouque held positions at the CNRS and at the Ecole Polytechnique in France, before joining North Carolina State University in 1998 where he started the Masters of Financial Mathematics. In 2006, he joined the department of Statistics and Applied Probability at the University of California Santa Barbara where he is a Distinguished Professor and Co-director of the Center for Financial Mathematics and Actuarial Research (CFMAR). His research is in the domain of random media with applications ranging from wave propagation phenomena to financial mathematics. He published over one hundred research articles and co-authored three books, co-edited another, and was a member of the Advisory Committee of the U.S. Office of Financial Research (2012-2015). He is currently Editor-in-Chief of the SIAM Journal on Financial Mathematics and President of the Bachelier Finance Society. Jean-Pierre Fouque is a Fellow of the Institute of Mathematical Statistics since 2009 and a SIAM Fellow since 2011.*

Rüdiger Frey

Vienna University of Economics and Business
http://statmath.wu.ac.at/~frey/

Talk title: Value adjustments and dynamic hedging of reinsurance counterparty risk

Abstract: Reinsurance counterparty credit risk (RCCR) is the risk of a loss arising from the fact that a reinsurance company is unable to fulfil her contractual obligations towards the ceding insurer. RCCR is an important risk category for insurance companies which, so far, has mostly been addresses via qualitative approaches. In this presentation we therefore study value adjustments and dynamic hedging for RCCR. We propose a novel model that accounts for contagion effects between the default of the reinsurer and the price of the reinsurance contract. We characterize the value adjustment in a reinsurance contract via a PIDE and derive the hedging strategies using a quadratic method. The talk closes with a simulation study which shows that dynamic hedging strategies have the potential to significantly reduce RCCR.

Bio: *Rüdiger Frey is Professor of Mathematics and Finance at WU Vienna. Prior to that he held positions as Professor of Optimization and Financial Mathematics at the University of Leipzig and various academic positions at the University of Zurich and at the Federal Institute of Technology (ETH) in Zurich. He holds a diploma in mathematics from the University of Bonn where he received his PhD in financial economics in 1996. His main research fields are quantitative risk management, dynamic credit risk models and the pricing and hedging of derivatives under incompleteness and market frictions. Rüdiger has published research papers in leading international academic journals and has given seminars at a number of important international conferences and institutions. He is co-author of the popular book "Quantitative Risk Management: Concepts Techniques & Tools" (Princeton University Press 2005).*

Gery Geenens

University of NSW
https://research.unsw.edu.au/people/dr-gery-geenens

Talk title: Copula modelling for discrete random variables; or how to pour new wine into old bottles

Abstract: Copulas have now become ubiquitous statistical tools for describing, analysing and modelling dependence between random variables. Sklar's theorem, "the fundamental theorem of copulas", makes a clear distinction between the continuous case and the discrete case, though. In particular, the copula of a discrete random vector is not identifiable, which causes serious inconsistencies. In spite of this, downplaying statements are widespread in the related literature, and copula methods are used for modelling dependence between discrete variables. This work calls to reconsidering the soundness of copula modelling for discrete data. It suggests a more fundamental construction which allows copula ideas to smoothly carry over to the discrete case. Actually it is an attempt at rejuvenating some century-old ideas of Udny Yule, who mentioned a similar construction a long time before copulas got in fashion.

Bio: *Gery Geenens obtained his PhD from the Louvain Catholic University (UCL, Belgium) in 2008 before taking up a post-doctoral research position at the University of Melbourne and then moving to UNSW in 2009. Research interests focused on developing nonparametric and semiparametric methods in various contexts including nonparametric regression models (mainly kernel smoothing methods), semiparametric regression models (mainly Single-Index Models), nonparametric copula models for dependence modelling and nonparametric methods for functional data analysis.*

Katja Hanewald

University of NSW
https://www.business.unsw.edu.au/our-people/katja-hanewald

Talk title: Long-term care insurance financing using home equity release: evidence from an experimental study

Abstract: Long-term care (LTC) insurance protects against future unexpected LTC costs. However, due to the costly nature of LTC insurance, take-up rates are relatively low internationally. At the same time, home equity release products, including reverse mortgages and home reversion plans, are also unpopular, as individuals use their housing assets to hedge against future unexpected LTC cost. To solve the difficulties of funding LTC insurance and the substitution effect of housing wealth, we develop a new financial product which allows individuals to use their housing wealth to fund LTC insurance premiums. To ascertain the demand for this new product, we conduct and analyse an experimental online survey that focuses on Chinese homeowners aged 45-64. We make two key contributions to the literature: (1) We suggest viable solutions to both the LTC insurance and the reverse mortgage puzzles; and (2) we analyse the potential demand for different product designs linking LTC insurance and home equity release products. We test how accessible housing wealth and socioeconomic covariates impact the demand for LTC insurance. Our results will allow policymakers and businesses to assess the potential demand for the new products and to develop a successful and mature private market for LTC insurance.

Bio: *Katja Hanewald is a Senior Lecturer in the School of Risk and Actuarial Studies. She is also an Associate Investigator in the ARC Centre of Excellence in Population Ageing Research (CEPAR), where she is developing the research program of CEPAR's Australia-China Population Ageing Research Hub. Her research addresses risk management and insurance aspects of population ageing with a focus on China. Her current research investigates optimal retirement financial decisions of older households in China and the design of retirement financial products such as reverse mortgages, long-term care insurance, and annuities. Katja held academic positions at Humboldt-Universität zu Berlin, Germany (2008-2010), and at the University of New South Wales (2011-2013), and worked at the German Federal Ministry of Finance (2013-2015). She obtained her doctoral degree in Economics from Humboldt-Universität zu Berlin in November 2010.*

Michael Hanke

University of Liechtenstein
https://www.uni.li/michael.hanke?set_language=en

Talk title: Numeraire dependence in risk-neutral probabilities of event outcomes

Abstract: For most non-financial events, risk-neutral outcome probabilities are identical across numeraire currencies. Some events, however, such as elections or referendums, may have an impact on exchange rates. This implies numeraire dependence in risk-neutral outcome probabilities, which leads to different state prices for affected currency pairs. If betting odds available to punters do not reflect these differences, this may give rise to (approximate) arbitrage opportunities. Despite the sizable risk this creates, odds quoted by bookmakers seem to ignore this effect.

Bio: *Michael Hanke holds a Chair in Finance at the University of Liechtenstein. He is involved with teaching at all levels, scientific research and transfer projects in the areas of quantitative finance, esp. asset allocation, portfolio management, pension finance, derivatives pricing and financial engineering, empirical research in financial markets, scenario generation and stochastic optimization.*

Katja Ignatieva

University of NSW
https://www.business.unsw.edu.au/our-people/katjaignatieva

Talk title: Quantifying credit contagion through numbers of defaults

Abstract: This paper develops a comprehensive model for assessing the number of defaults $N(p)$ for a credit portfolio of n obligors each with a probability of default p, using an approach that combines the multivariate generalised Pareto distribution introduced in Hendriks and Landsman (2017) with survival Archimedean copulas. We compute the probability function and the moments of the number of defaults, and derive their limiting behaviours for various special cases including Clayton, Gumbel, Joe, Frank and AMH copulas. When dealing with the case of two credit portfolios with the numbers of defaults $N_{\mathbf{X}}$ and $N_{\mathbf{Y}}$, we develop a flexible dependence structure combining multivariate generalised Pareto distributions and survival Archimedean copulas. Special attention is paid to the copula generator functions $h(\cdot)$ possessing regularly varying and rapidly varying property, which allows us to devise important theoretical results for the conditional probability $P(N_{\mathbf{X}}(p) \geq n_{\mathbf{x}} \mid N_{\mathbf{Y}}(p) \geq n_{\mathbf{Y}})$ and its limiting properties, derived for various special cases.

Bio: *Katja is a senior lecturer in the School of Risk and Actuarial Studies at UNSW Business School. She joined UNSW in November 2011 after completing her Co-tutelle PhD in Finance at Goethe University Frankfurt, Germany and Macquarie University Sydney. Prior to her PhD studies, Katja has completed MSc in Mathematics and Statistics from Humboldt University Berlin, Germany as well as Glasgow University, UK. Katja's research interests lie in the area of quantitative finance, in particular, financial econometrics, derivative pricing and risk management. Katja performs empirical research in financial markets, commodity and energy markets, and insurance. Katja has published her research in the top tier international journals such as Journal of Business & Economic Statistics, Journal of Banking and Finance, Energy Economics and Insurance: Mathematics and Economics among others.*

Han Li

Macquarie University
https://researchers.mq.edu.au/en/persons/han-li

Talk title: Analyzing mortality bond indexes via hierarchical forecast reconciliation

Abstract: In recent decades, there has been significant growth in the capital market for mortality- and longevity-linked bonds. Therefore, modeling and forecasting the mortality indexes underlying these bonds have crucial implications for risk management in life insurance companies. In this paper, we propose a hierarchical reconciliation approach to constructing probabilistic forecasts for mortality bond indexes. We apply this approach to analyzing the Swiss Re Kortis bond, which is the first "longevity trend bond" introduced in the market. We express the longevity divergence index associated with the bond's principal reduction factor (PRF) in a hierarchical setting. We first adopt time-series models to obtain forecasts on each hierarchical level, and then apply a minimum trace reconciliation approach to ensure coherence of forecasts across all levels. Based on the reconciled probabilistic forecasts of the longevity divergence index, we estimate the probability distribution of the PRF of the Kortis bond, and compare our results with those stated in Standard and Poor's report on pre-sale information. We also illustrate the strong performance of the approach by comparing the reconciled forecasts with unreconciled forecasts as well as those from the bottom-up approach and the optimal combination approach. Finally, we provide first insights on the interest spread of the Kortis bond throughout its risk period 2010–2016.

Bio: *Dr Han Li is a Lecturer in the Department of Actuarial Studies and Business Analytics at Macquarie University. Before that, she worked at the University of New South Wales as a Senior Research Associate. She received a Bachelor of Commerce (Honours) degree in Actuarial Studies at the University of Melbourne and completed her PhD degree in Econometrics and Business Statistics at Monash University. She is an Associate of the Institute of Actuaries of Australia, and has a broad range of research interests around longevity and mortality risks, ageing and retirement, and climate change. Specifically, much of her research expertise centers on mortality modelling and forecasting using advanced econometric and statistical techniques. She has attracted research funds from the Society of Actuaries and her research has been published in top tier journals including Insurance: Mathematics and Economics, ASTIN Bulletin, Journal of Forecasting and Annals of Actuarial Science.*

Stéphane Loisel

ISFA, Université Lyon
http://pages.isfa.fr/~stephane/

Talk title: Longevity risk and quickest detection in practice

Abstract: In this talk, we first briefly recall key features of longevity risk. Then, we explain how to detect as quickly as possible the date where that the actuarial assumptions related to longevity risk are no longer valid. The problem is stated as a quickest detection problem. We introduce the so-called cusum process and show its optimality for a generalized Lorden criterion. We explain how to design Key Risk Indicators thanks to the cusum process. We analyze its advantages and drawbacks for longevity risk monitoring, as well as for some other insurance risks. The method is illustrated on simulated and real-world case studies. This is a joint work with N. El Karoui and Y. Salhi.

Bio: *Prof Stéphane Loisel's interest include actuarial mathematics, theory of ruin, transit times, multi-dimensional processes, stochastic dependence, Malliavin calculation applied to insurance, securitization of insurance risks, stochastic mortality, longevity risk, Solvency II project (in part, calibration of stochastic models, model risk and sensitivity studies, behaviour of policy holders). He completed his PhD in 2004 on Contribution to the study of univariate and multivariate processes of the theory of ruin. He is an associate editor of Mathematics and Economics, Methodology and Computing in Applied Probability, American Journal of Algorithms and Computing, and Risks, as well as the French Actuarial Bulletin. Prof Loisel is also co-editor of the European Actuarial Journal.*

Spiridon Penev

University of NSW
https://web.maths.unsw.edu.au/~spiro/

Talk title: On robust index tracking

Abstract: Index tracking is a form of asset management. A tracking error is typically expressed as expectation of a function of the difference between the returns of the index and of the portfolio and the goal is to minimize the tracking error. Typically, a quadratic loss is used to define the tracking error. When there is an uncertainty in the distribution of the assets, a robust version of the optimization problem needs to be adopted by looking at a performance in a tubular neighbourhood of the nominal distribution. We use Bregman divergence in describing the deviation between the nominal and actual distribution of the components of the index. In this setting, we derive the optimal robust index tracking strategy in a semi-analytical form as a solution of a system of nonlinear equations. We also experiment with different losses. Numerical results are presented that allow us to compare the performance of the robust strategy with the optimal non-robust strategy. We show that, especially during market downturns, the robust strategy can be very advantageous.

Bio: *Professor Spiridon Penev expertise and research interest are on Wavelet Methods in nonparametric curve estimation, Edgeworth expansions and Saddlepoint Approximation Methods, Structural Equation Models, Inference in semiparametric models and applications in Stochastic Risk Modelling. His research interests include statistical theory, applied statistics, operations research and risk theory. He completed his PhD in Mathematical Statistics from Humboldt University, Berlin, before working for 10 years at the Technical University of Sofia, Bulgaria becoming an Associate Professor in 1991. In 1992 he began an association with UNSW, starting as a lecturer and becoming an Associate Professor in 2011. He teaches courses in Inference, Multivariate Analysis, Categorical Data Analysis, Statistical Methods in Social and Market Research, Design and Analysis of Experiments, Regression.*

Pavel Shevchenko

Macquarie University
https://researchers.mq.edu.au/en/persons/p-shevchenko

Talk title: Optimal decisions in retirement under expected utility stochastic control framework

Abstract: In this paper we develop a retirement model under the expected utility stochastic control framework to find optimal decisions with respect to the consumption, risky asset allocation, access to annuities, reverse mortgage and the option to scale housing. The model is solved numerically using Least-Squares Monte Carlo method adapted to handle optimal stochastic control problems in the expected utility models. To demonstrate the applicability of the framework, the model is applied in the context of the Australian retirement system. Few retirees in Australia utilise financial products in retirement, such as annuities or reverse mortgages. Since the government-provided means-tested Age Pension in Australia is an indirect annuity stream which typically is higher than the average consumption floor, it is argued that this is the reason why Australians do not annuitise. In addition, in Australia where assets allocated to the family home are not included in the means tests of Age Pension, the incentive to over allocate wealth into housing assets is high. This raises the question whether a retiree is really better off over allocating into the family home, while accessing home equity later on either via downsizing housing or by taking out a reverse mortgage. Our findings confirm that means-tested pension crowds out voluntary annuitisation in retirement, and that annuitisation is optimal sooner rather than later once retired. We find that it is never optimal to downscale housing with the means-tested Age Pension when a reverse mortgage is available; only when there is no other way to access equity then downsizing is the only option.

Reference: Johan G. Andréasson, Pavel V. Shevchenko (2018), Optimal annuitisation, housing decisions and means-tested public pension in retirement under expected utility stochastic control framework. Preprint, available at https://ssrn.com/abstract=3174459.

Bio: *Prof Pavel Shevchenko is a world-renowned expert in the area of quantitative risk. He is a Professor in the Department of Actuarial Studies and Business Analytics at Macquarie University. Prior to joining Macquarie University in August 2016, he worked at CSIRO Australia (1999-2016) holding the position of a Senior Principal Research Scientist (2012-2016). Since 1999, Prof Shevchenko has worked in the area of financial risk, leading research and industry commercial projects on: modelling of operational and credit risks; longevity and mortality, retirement products; option pricing; insurance; modelling commodities and foreign exchange; and the development of relevant numerical methods and software. He received a MSc from the Moscow Institute of Physics and Technology in 1994 and a PhD from the University of New South Wales in 1999. He is currently associate editor of international journals (RISKS and Journal of Operational Risk) and member of the Retirement Incomes Working Group in the Institute of Actuaries of Australia. Prof Shevchenko has published extensively in academic journals, consulted for major financial institutions, and is a frequent presenter at industry and academic conferences. His publication records include one research monograph, two co-authored research monographs, over 60 journal papers, and over 80 technical reports.*

Qihe Tang

University of NSW
https://www.business.unsw.edu.au/our-people/qihetang

Talk title: CAT bond pricing under a product probability measure with POT risk characterization

Abstract: Frequent large losses from recent catastrophes have caused great concerns among insurers/reinsurers, who then turn to seek mitigations of such catastrophe risks by issuing catastrophe (CAT) bonds and thereby transferring the risks to the bond market. Whereas, the pricing of CAT bonds remains a challenging task, mainly due to the facts that the CAT bond market is incomplete and that the pricing usually requires knowledge about the tail of the risks. We propose a general pricing framework based on a product pricing measure, which combines a distorted probability measure that prices the catastrophe risks underlying the CAT bond with a risk-neutral probability measure that prices interest rate risk. We also demonstrate the use of the peaks over threshold (POT) method to uncover the tail risk. Finally, we conduct case studies using Mexico and California earthquake data to demonstrate the applicability of our pricing framework.

This talk is based on a paper: Tang, Q. and Yuan, Z., 2019. CAT Bond Pricing under a Product Probability Measure with POT Risk Characterization. *ASTIN Bulletin*, 49(2), pp.457-490.

Bio: *Qihe Tang joined the UNSW Business School as a Full Professor under the Strategic Hires and Retention Pathways (SHARP) scheme in July 2017. After earning his Ph.D. in statistics from the University of Science and Technology of China in 2001, he has worked at different places in the world including the University of Hong Kong (2001), the University of Amsterdam (2002-2004), the Concordia University (2004-2005), and the University of Iowa (2006-present). At the University of Iowa, he was promoted to Full Professor in July 2012, and he was conferred the F. Wendell Miller Endowed Professorship in July 2014 in honour of his scholarly work and professional contributions. Qihe Tang's expertise centers on extreme value theory for insurance, finance, and quantitative risk management. Recently, he has been working on various topics newly arising from the interdisciplinary area of insurance, finance, probability, and statistics. These topics include: (1) interplay of insurance and financial risks, (2) large credit portfolio losses, and (3) modeling, measuring, and managing catastrophe risks. His research on these topics has been constantly supported by external grants. Qihe Tang has recently been elected as an editor for Insurance: Mathematics and Economics. Currently, he is also an associate editor for the journals TEST, Applied Stochastic Models in Business and Industry, and Statistics & Probability Letters, and serves on the editorial boards of the journals Risks and Dependence Modeling. He has graduated a number of doctoral students who are now university professors all over the world.*

Peter Tankov

ENSAE ParisTech
https://www.lpsm.paris/pageperso/tankov/

Talk title: Price formation and optimal trading in intraday electricity markets

Abstract: We study price formation in intraday electricity markets in the presence of heterogeneous agents, asymmetric information and intermittent generation. We use stochastic control theory to identify optimal strategies of agents with market impact and exhibit the Nash equilibrium in closed form for a finite number of agents as well as in the asymptotic setting of mean-field games. We show that our model is able to reproduce some empirical facts observed in the market (price impact, volatility), and allows producers to deal with risks and costs related to intermittent renewable generation.

Bio*: Peter Tankov is a Professor of Qunatiative Finace at ENSAE ParisTech. His research interests include energy markets, energy mix scenarios, risk management and forecasting methodology for renewable energy, Lévy processes and their applications in finance, asymptotic methods in financial mathematics, and volatility surface and stochastic volatility models. He is an associate editor of Finance and Stochastics, Mathematical Finance***,** *SIAM Journal on Financial Mathematics, and Statistics and Risk Modeling*.

Susan Thorp

University of Sydney
https://business.sydney.edu.au/staff/susan.thorp

Talk title: Communicating risk

Abstract: Efficient investment depends on clear risk disclosures. Our experimental studies show that the propensity of individuals to violate some implications of expected utility varies with the mode of risk disclosure. When risk is described as the frequency of returns below or above a threshold we observe more violations than for range and probability-based descriptions. Investment decisions also depends on risk expectations. We also show the usefulness of one frequency based measure of risk expectation elicitation – the distribution builder – that can be widely applied to other settings. These results highlight the challenges of designing effective disclosure.

Bio: *Susan Thorp is Professor of Finance. Prior to joining the University of Sydney in 2015, she was Professor of Finance and Superannuation at the University of Technology Sydney. Susan has an honours degree in Economics from the University of Sydney, and a PhD in Economics from the University of New South Wales. Susan researches household and consumer finance with a particular focus on retirement savings and decumulation. She uses theoretical, empirical and experimental techniques to understand financial decision making. Much of this research has tested the way decision makers respond to advisors, disclosures and choice architecture. Financial econometrics is another concentration of Susan's research. She has studied the increased integration that occurs in financial markets during crises, with a recent focus on commodity markets.*

Jae Kyung Woo

University of NSW
https://www.business.unsw.edu.au/our-people/jae-kyung-woo

Talk title: Bayesian credibility under a bivariate prior on the frequency and the severity of claims

Abstract: In this talk, we propose a credibility model in which the (unobservable) risk profiles of the claim frequency and the claim severity follow a bivariate prior distribution with the dependency incorporated via a factorization structure of the joint density (e.g. Willmot and Woo (2012)). Given the risk pro les, the (conditional) marginal distributions of frequency and severity are assumed to belong to the exponential family, where nice results regarding conjugate priors in the univariate case are well-known in the literature. Based on these assumptions, a bivariate conjugate prior is proposed, and the bivariate posterior is derived and in turn, the Bayesian premium for the aggregate claim is given. As a special case, a bivariate mixture of Erlangs is considered as the prior distribution for the Poisson (claim number) and the exponential (individual claim amount) likelihoods, and more explicit results can be obtained including the predictive joint distribution of the claim number and the aggregate claim in the next period. Finally, numerical examples will be given to illustrate the effect of dependence on the Bayesian premium when the prior distribution is a bivariate gamma mixture. The standard deviation and the Value-at-Risk for next period's aggregate claim are computed as well.

This is joint work with Eric Cheung, Rosy Oh, and Weihong Ni.

Bio: *Before joining UNSW in July 2017, Jae Kyung (JK) Woo was a postdoctoral fellow at Mathematics & Statistics, Concordia University, and spent one year as Assistant Professor at Statistics, Columbia University. Then she moved to Statistics & Actuarial Science, the University of Hong Kong as Assistant Professor and worked for five years. She completed her MMath and Ph.D. at Statistics & Actuarial Science, the University of Waterloo and her undergraduate studies at Statistics & BBA, Ewha Womans University. Her research interests lie in the area of risk theory, reliability theory, aggregate claim analysis, Queueing theory, and renewal processes. She is a Fellow of the Society of Actuaries (FSA), and a Chartered Enterprise Risk Analyst (CERA) received from the SOA.*