QUANTITATIVE METHODS IN FINANCE CONFERENCE

QMF 2019

Hilton Sydney, 17-20 December 2019

UTS Quantitative Finance Research Centre

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Quantitative Finance Research Centre

Welcome to the Quantitative Methods in Finance 2019 (QMF2019) Conference.

QMF 2019 continues the mission of providing a forum to communicate recent advances in Quantitative Finance. We are delighted that we are able to again attract a large number of excellent speakers and participants. It is a special year for QMF, as the founder and longstanding chairperson of this conference series, Professor Eckhard Platen, turned 70 this year. We salute Eckhard for creating such a premier event in the international conference calendar – its enduring success is just one of his many achievements.

The 2019 selection of speakers showcases another year of the latest in innovative research. Additionally, we hope that you will take this opportunity to meet other experts in your field and to network with both new and existing associates. With the numerous submissions we are pleased about the popularity of this conference series. However, we regret that not every submission was offered an opportunity to be presented.

This year's conference dinner (on Thursday from 6:30pm) will take place at L'Aqua, on the rooftop of Cockle Bay Wharf, with views over Cockle Bay and Darling Harbour. Those attending the dinner will have included this in your package when you registered for the conference.

Upon registration you will receive a conference bag containing:

- Your name badge
- A conference program
- Your conference dinner ticket(s) if you included this in your registration

Please check carefully in which session you will be presenting, and – if applicable – which session you will be chairing. The conference notice board will be updated each day of the conference and we recommend you check for changes to the program on a daily basis. Presenters and chairpersons need to pay particular attention to possible changes to their session times.

We gratefully acknowledge funding support by the New South Wales Government. Furthermore, as in previous years, we thank the UTS School of Mathematical and Physical Sciences, Springer-Verlag, World Scientific, Taylor & Francis, and the journal *Quantitative Finance* – who have given generously to ensure QMF2019 is a success.

We would like to extend a warm welcome to first time attendees, as well as our long term supporters, and hope you will enjoy QMF2019, the hospitality of the Hilton Sydney and the City of Sydney.

Professor
Erik Schlögl
Director,
Quantitative
Finance
Research Centre

Professor
Anthony Dooley
Head of the
School of
Mathematical and
Physical Sciences

Bruti-Liberati Visiting Fellowship Fund

The Bruti-Liberati Visiting Fellowship Fund provides funding to an outstanding researcher with no more than 12 years post-PhD experience, to visit UTS for up to six weeks, and to contribute to the area of Quantitative Finance. The recipient is invited to give the *Nicola Bruti-Liberati Lecture,* at the annual *Quantitative Methods in Finance* (QMF) conference, and is expected to publish a research paper in a leading international journal, acknowledging the visit. The Bruti-Liberati Visiting Fellow is selected by a Committee of members of the Quantitative Finance Research Centre at UTS.

Support for the Fund

Friends of Dr Bruti-Liberati and those interested in supporting outstanding research in Quantitative Finance are invited to contribute to the Fellowship Fund.

Please view the website: **https://www.uts.edu.au/research-and-teaching/our-research/quantitative-finance-research/news-and-events/bruti-liberati**

Dr Nicola Bruti-Liberati

Nicola Bruti-Liberati was a Senior Research Associate at the UTS School of Finance and Economics, specialising in mathematical and computational finance and numerical methods for stochastic differential equations. Nicola died tragically in a traffic accident on his way to work on 28 August 2007, aged 32. Born in Milan, Italy, Nicola became interested in Quantitative Finance during his tertiary education. In March 2001 he was awarded the Laureat in Economics and University Medal from Bocconi University, Milan. Nicola then travelled to New York where he completed a Master of Arts in Mathematics of Finance at Columbia University. In 2002, Nicola came to UTS to commence his PhD on "Numerical Methods for the Solution of Stochastic Differential Equations with Jumps in Finance", at the Quantitative Finance Research Centre. His supervisor, Professor Eckhard Platen, became his mentor and friend. While at UTS, Nicola made many friends, published a large number of excellent papers and became internationally known in the field as a talented researcher. Nicola submitted his PhD thesis in April 2007, receiving outstanding evaluations from his examiners. In May 2008 he posthumously received the Chancellor's Award for the *Best PhD Thesis at UTS in 2007.* The world of quantitative financial research is significantly poorer for the premature loss of this talented and hard working young researcher. His modest and friendly nature are greatly missed and fondly remembered by his colleagues, family and friends.

Sponsors of the Fund

Edmondo and Teresa Bruti Liberati, Ellie Suh, The UTS Business School, The Quantitative Methods in Finance Conference, The Quantitative Finance Research Centre at UTS, Eckhard and Katrin Platen, Christina Nikitopolous-Sklibosios, The Department of Mathematical Sciences at UTS, Hearne Scientific Software, Eugenie Marcantoni, Maria Carla Galavotti, Angelo Benessia, Enid Charlton, Mathworks, Jackie and Massimo Piccardi and Constantinos Kardaras.

The 2019 Bruti-Liberati Lecture will be given by:

Martin Larsson

Associate Professor at Carnegie Mellon University, Department of Mathematical Sciences

MSc in Engineering Mathematics, Lund University, Sweden, 2008

Master of Advanced Studies in Finance, ETH Zürich and University of Zürich, Switzerland, 2008

Ph.D. in Operations Research under the supervision of Robert Jarrow, Cornell University, United States of America, 2012

Martin Larsson completed a Master's degree in Engineering Mathematics at Lund University, Sweden. He obtained his Ph.D. in Operations Research from Cornell, under the supervision of Robert Jarrow. His research focuses on the theory and applications of finite- and infinite-dimensional affine and polynomial processes, which provide an excellent tradeoff between mathematical tractability and statistical flexibility. He recently gained an interest in stochastic portfolio theory. Furthermore, he is interested in probability theory, stochastic processes, and a very broad range of applications in mathematical finance and financial engineering, including machine learning.

Selected Publications :

- E. Abi Jaber, M. Larsson and S. Pulido, *Affine Volterra processes*, **Annals of Applied Probability**, forthcoming.
- D. Filipovic, M. Larsson and A. Trolle, *On the relation between linearity-generating processes and linear-rational models*, **Mathematical Finance**, forthcoming.
- D. Filipovic, M. Larsson and F. Statti, *Unspanned stochastic volatility in the multi-factor CIR Model*, **Mathematical Finance**, forthcoming.
- C. Cuchiero, M. Larsson and S. Svaluto-Ferro, *Polynomial jump-diffusions on the unit simplex*, **Annals of Applied Probability**, 28(4), 2451-2500, 2018.
- R. Jarrow and M. Larsson, *On aggregation and representative agent equilibria*, **Journal of Mathematical Economics**, 74, 119-127, 2018.
- B. Acciaio, M. Larsson and W. Schachermayer, *The space of outcomes of semi-static trading strategies need not be closed,* **Finance and Stochastics**, 21(3), 741-751, 2017.
- B. Acciaio and M. Larsson, *Semi-static completeness and robust pricing by informed investors*, **Annals of Applied Probability**, 27(4), 2270-2304, 2017.
- D. Filipovic, M. Larsson and A. Trolle, *Linear-rational term structure models*, **Journal of Finance**, 72(2), 655-704, 2017.
- D. Filipovic and M. Larsson, *Polynomial diffusions and applications in finance*, **Finance and Stochastics**, 20(4), 931-972, 2016.

- R. Jarrow and M. Larsson, *Informational efficiency under short-sale constraints*, **SIAM Journal on Financial Mathematics**, 6(1), 804-824, 2015.
- A. Capponi and M. Larsson, *Default and systemic risk in equilibrium*, **Mathematical Finance**, 25(1), 51-76, 2015.
- M. Larsson, *Strict local martingales, filtration shrinkage and the Föllmer measure,* **Annals of Applied Probability**, 24(4), 1739-1766, 2014.
- R. Jarrow, Y. Kchia, M. Larsson and P. Protter, *Discretely sampled variance and volatility swaps versus their continuous approximations,* **Finance and Stochastics**, 17(2), 305-324, 2013.
- R. Jarrow and M. Larsson, *The meaning of market efficiency*, **Mathematical Finance**, 22(1), 1-30, 2012

Bruti-Liberati Visiting Fellows:

2019 *Martin Larsson, Carnegie Mellon University, Pittsburgh, USA*

2018 *Christa Cuchiero, University of Vienna, Vienna, Austria*

2017 *Nicolas Perkowski, Humboldt-Universität zu Berlin, Berlin, Germany*

2016 *Claudio Fontana, University Paris Diderot (Paris VII), France*

2015 *Yu-Jui Huang, Dublin City University, Dublin, Ireland*

2014 *Samuel Cohen, University of Oxford, Oxford, UK*

2013 *Johannes Ruf, University of Oxford, Oxford, UK*

2012 *Francesca Biagini, Ludwig-Maximilian-University, Munich, Germany*

2012 *Johannes Muhle-Karbe, ETH Zürich, Zürich, Switzerland*

2011 *Jan Obloj, University of Oxford, Oxford UK*

2010 *Martino Grasselli, University of Padova, Padova, Italy*

2009 *Andrea Roncoroni, ESSEC Business School, Paris, France*

2008 *Constantinos Kardaras, University of Boston, Boston, USA*

GARP Best Paper Award at QMF 2019

The Global Association of Risk Professionals (GARP) is pleased to announce a **GARP Best Paper Award** which will be given at the **Quantitative Methods in Finance 2019 Conference** to an outstanding paper in financial or energy risk management. The winner(s) of the Award will share a US $1,500 cash prize. Completed papers may be made available to GARP members through the GARP website. This distribution will not in any way preclude publication of the paper elsewhere and authors will retain the property rights over the paper. For more information on GARP, please visit https://www.garp.org/#!/home

All contributed (i.e., parallel session) papers presented at QMF 2019 are eligible to be entered for consideration for the award. To enter their paper for consideration for the award, authors should e-mail their paper (as a PDF file) to **QMF@uts.edu.au** by 2 January 2020. Receipt will be acknowledged within two business days. The winning paper will be announced in February 2020.

QMF 2019

Tuesday 17th December

8:00am-8:30am Registration & Coffee

State Room

8:30 AM	Opening of the conference by Professor Anthony Dooley, Head of the School of Mathematical and Physical Sciences, University of Technology Sydney

Chair: Anthony Dooley

8:40 AM	***Platen*** *University of Technology Sydney, Australia* **The Natural Evolution of a Stock Index**
9:20 AM	***Frey*** *Wirtschaftsuniversität Wien, Austria* **Conditionally Affine processes with Markov Modulated Mean Reversion Level and Applications in Credit Risk**
10:00AM	***Barone Adesi*** *Università della Svizzera Italiana, Switzerland* **Estimating the Pricing Kernel**
10:40 AM	Morning Tea

Chair: Stéphane Crépey

11:10 AM	***Garvin*** *Rigetti Computing, Australia* **Quantum Computing Applications for the Finance Industry**
11:50 AM	***Stahl*** *HDI, Germany* **A Fresh Look on the Linkage of Model Uncertainty and Validation**
12:30 PM	Lunch

Chair: Giovanni Barone Adesi

1:40 PM	***Ruf*** *London School of Economics, United Kingdom* **Neural Network Based Discrete Hedging**
2:20 PM	***Crépey*** *Université Paris-Saclay, Evry, France* **Balance Sheet XVA by Deep Learning and GPU**

3:00 AM	Afternoon Tea
Chair: Ernst Eberlein	
3:30 PM	***Elliott*** *University of South Australia, Australia and University of Calgary, Canada* **Hedging Options in a Doubly Markov-Modulated Financial Market via Stochastic Flows**
4:10 PM	***Tankov*** *ENSAE Paris, France* **Mean-Field Games of Optimal Stopping and Two Industry Dynamics Problems**

QMF 2019

Wednesday 18th December

8:10am-8:40am Registration & Coffee

State Room

Chair: Martino Grasselli

8:40 AM	***Eberlein*** *University of Freiburg, Germany* **Variable Annuities in a Lévy-based Hybrid Model with Surrender Risk**
9:20 AM	***Fukasawa*** *Osaka University, Japan* **The Edgeworth Expansion for Continuous Martingale Marginals**
10:00AM	***Lleo*** *NEOMA Business School, France* **Two to Tango: Market Data and Expert Opinions in Portfolio Construction**
10:40 AM	Morning Tea

Chair: Martin Schweizer

11:10 AM	***Tappe*** *University of Freiburg, Germany* **The fundamental theorem of asset pricing for self-financing portfolios**
11:50 AM	***Runggaldier*** *University of Padova, Italy* **On Arbitrage under Portfolio Constraints in Discrete-time Models**
12:30 PM	Lunch

Time	Contributed talks - Wednesday 18 December 2019			
	Stateroom ***Chair: Neufeld***	**Room 2** ***Chair: Awiszus***	**Room 3** ***Chair: Kim***	**Room 4** ***Chair: Chong***
1:40pm	**Neufeld**	**Ignatieva**	**Kim**	**Chong**
	Neural Network based Approximation Algorithm for Semilinear Parabolic PDEs with Application to Pricing	Credit portfolio loss: Assessing the Number of Defaults with Generalised Pareto Distributions and Survival Archimedean Copulas	Risk on Post-M&A Performance: the information implication in time till deal completion	Holistic capital allocation principle
2:00pm	**Liu**	**Yoshiba**	**Jang**	**van Bilsen**
	Calibration Neural Network for financial asset price models	Value-at-risk and expected shortfall of stock portfolio using skew-t copulas	Systemic risk in market microstructure of crude oil and gasoline future prices: A Hawkes flocking model approach	Dynamic Consumption and Portfolio Choice under Prospect Theory
2:20pm	**Geertsema**	**Tichy**	**Wong**	**Shen**
	Machine Valuation	Extension of portfolio optimization problems to non-Gaussian framework	Game theoretic valuation of deposit insurance under jump risk: From too small to survive to too big to fail	Stackelberg Mutual Fund Management Game
2:40pm	**Seo**	**Awiszus**	**Wiesel**	**Kaneko**
	Financial Market Crash and Phase Transition: Through Model-Free Framework with Machine Learning	The Tradeoff of Diversity and Diversification	Sensitivity analysis of robust optimisation problems	J-REIT investment strategy with mobile statistics
3:00pm	Break			
	Chair: Nikitipoulos	***Chair: Tappe***	***Chair: Hanke***	***Chair: Buchmann***
3:30pm	**Nikitopoulos**	**Barroso**	**Hanke**	**Buchmann**
	Forecasting commodity markets volatility: HAR or Rough?	Let the Parametric Phoenix Fly	Quantitative Selection of Election Portfolios	A General Formulation for Convergence of Extremal Processes at Small Times
3:50pm	**Suardi**	**Takada**	**Luo**	**Mathys**
	A univariate approach to pricing spread options with stochastic volatility	NUPBR and Curvature	Characterization of Fully Coupled FBSDE in Terms of Portfolio Optimization	Intra-Horizon Expected Shortfall and Risk Structure in Models of Jumps
4:10pm	**Poonvoralak**	**Adachi**	**Tsang**	**Götz**
	Bayesian inference in GARCH(1,1) Model for Cryptocurrency	A Binomial Asset Pricing Model in a Categorical Setting	Discrete-time multi-period portfolio optimization under correlation uncertainty	VaR-models accounting for intraday-jumps
4:30pm	**Sala**	**McNelis**	**Pun**	**H. Lu**
	Implicit quantiles and implicit expectiles	Off-Shore Fears and On-Shore Risk: Exchange-Rate Pressures and Banking Contagion in China	Minimum Target-Range-based Risk Portfolios	Tail risk of US equity factors
4:50pm	**Zhang**			**Feng**
	Pricing and Hedging Performance of Pegged FX Markets Based on Regime Switching Model			Modeling of Persistent Extremes in Financial Markets and Winning Streak Paradox

QMF 2019

Thursday 19th December

8:10am-8:40am Registration & Coffee

State Room

Chair: Erik Schlögl

8:40 AM	***Larsson*** *Carnegie Mellon University, United States of America* **Deep Neural Networks, Generic Universal Interpolation, and Controlled ODEs**
9:20 AM	***Cuchiero*** *Wirtschaftsuniversität Wien, Austria* **Neural Network Approaches to Infinite Dimensional Calibration and Prediction Problems**
10:00 AM	***Obloj*** *University of Oxford, United Kingdom* **Robust Finance: a Data-driven Paradigm**
10:40 AM	Introducing the GARP Best Paper Award: GARP VP Business Development Asia Director, **Wendy Guo**
10:50 AM	Morning Tea

Chair: Dilip Madan

11:10 AM	***Kardaras*** *London School of Economics, United Kingdom* **Targeting Wealth Distributions under Drawdown Constraints**
11:50 AM	***Grasselli*** *University of Padova, Italy* **Is Volatility Rough?**
12:30 PM	Lunch

Time	Contributed talks - Thursday 19 December 2019			
	Stateroom	**Room 2**	**Room 3**	**Room 4**
	Chair: Walter	***Chair: Bondarenko***	***Chair: Bergault***	***Chair: Kikuchi***
1:40pm	**Walter**	**Bondarenko**	**Bergault**	**Kikuchi**
	The discontinuous turn in financial modelling: an historical perspective	Optimal life-contingent insurance under bid-ask spreads	Optimal market making on OTC markets: toward dimensionality reduction	Estimating the duration of the quantitative easing policy using a term structure model with a stochastic lower bound
2:00pm	**Taub**	**Y. Lu**	**Shimoshimizu**	**K. Lu**
	Real Options, Risk Aversion and Markets	Numerical methods for Guaranteed Minimum Withdrawal Benefits (GMWBs) as a continuous impulse control problem	Optimal Execution Strategy with Generalized Price Impact in a Continuous-Time Setting	Calibration of multivariate Lévy-driven Ornstein-Uhlenbeck processes
2:20pm	**Lee**	**Ziveyi**	**Nishide**	**Weber**
	Real option on finite time horizon under a regime-switching process with jumps	A Value-Based Longevity Index for Hedging Retirement Income Portfolios	Strategic Liquidity Provision in High Frequency Trading	Systemic Portfolio Diversification
2:40pm	**Mueller**	**Royters**	**Tao**	**Drapeau**
	Hedging volume risks from the infeed of renewable energies	Valuation Framework and Analysis of Home Equity Release Products in Continuous Time	On Detecting Spoofing Strategies in High Frequency Trading	Spatially Determined Optimal Price Design in a Ride Sharing Economy
3:00pm	Break			
	Chair: Liebmann	***Chair: Siu***	***Chair: Richards***	***Chair: Al Yahyaee***
3:30pm	**Liebmann**	**Siu**	**Richards**	**Al Yahyaee**
	Time-changes, selfsimilarity, mimicking marginals, and martingales	American option pricing and filtering with a hidden regime-switching jump diffusion	Score Test for Marks in Hawkes Processes	Who catches a cold when someone sneezes? A high-frequency analysis of asymmetric volatility connectedness among international stock markets
3:50pm	**Lei**	**Fergusson**	**Gudkov**	**Xi**
	Robust time-inconsistent stochastic control under ambiguous covariance matrix	Optimal Control of Pension Funds Under the Benchmark Approach	Pricing and Hedging of Guaranteed Minimum Benefits using Power Series Approximation Techniques	Vulnerable Variance Swaps: Smooth and Rough Volatilities
4:10pm	**Su**	**Nguwi**	**Wang**	**Takehra**
	Pricing VIX Derivatives with Infinite-Activity Jumps	Numerical methods for time-inconsistent stochastic control problems	Robust reinsurance contracts with mean-variance criteria in a three-factor interest rate model	Approximations to SABR-type models
4:30pm	**Choi**	**Schaefer**	**Tadese**	
	Finite mixture model approximation for the SABR distribution	Optimal Exercise Decisions under Inattention	Liquidation Costs in CCP: Equilibrium vs Auction	
4:50pm	**Garces**			
	Exchange Option Pricing under Stochastic Volatility and Jump-Diffusion Dynamics			

QMF 2019

Friday 20th December

8:10am-8:40am Registration & Coffee

State Room

Chair: Michael Schmutz

8:40 AM	***Fouque*** *University of California Santa Barbara, United States of America* **On Fairness of Systemic Risk Measures**
9:20 AM	***Koo*** *Ajou University, Korea* **Intertemporal Preference with Risk and Loss Aversion**
10:00AM	***Madan*** *University of Maryland, United States of America* **Efficient Exposure Frontiers**
10:40 AM	Morning Tea

Chair: Josef Teichmann

11:10 AM	***Schmutz*** *University of Bern and Swiss Financial Market Supervisory Authority (FINMA), Switzerland* **Green Assets and Brown Threats: How Can the Associated Risks Be Modelled?**
11:50 AM	***Schweizer*** *ETH Zürich, Switzerland* **Arbitrage Theory Reloaded**
12:30 PM	Lunch

Chair: Wolfgang Runggaldier

1:40 PM	***Teichmann*** *ETH Zürich, Switzerland* **Random Signature Methods in Finance**
2:20 PM	***Schlögl*** *University of Technology Sydney, Australia* **Term Rates, Multicurve Term Structures and Overnight Rate Benchmarks: a Roll-Over Risk Approach**

Conference Close

A Binomial Asset Pricing Model in a Categorical Setting

Takanori Adachi

Tokyo Metropolitan University, Japan

Abstract:

Adachi and Ryu introduced a category Prob of probability spaces whose objects are all probability spaces and whose arrows correspond to measurable functions satisfying an absolutely continuous requirement in [Adachi and Ryu, 2019]. In this paper, we develop a binomial asset pricing model based on Prob. We introduce generalized filtrations with which we can represent situations such as some agents forget information at some specific time. We investigate the valuations of financial claims along this type of non-standard filtrations.

Authors:
Takanori Adachi
Katsushi Nakajima
Yoshihiro Ryu

Who catches a cold when someone sneezes? A high-frequency analysis of asymmetric volatility connectedness among international stock markets

Khamis Al Yahyaee

Sultan Qaboos University, Oman

Abstract:

Using 5-minute interval data from 16 stock markets, we examine the direction and extent of asymmetric volatility connectedness among international equity markets. We analyze volatility connectedness through networks to identify the magnitude of volatility spillover and of connectedness. We decompose realized volatility into good and bad; volatility spillover is time-varying and asymmetric. Bad volatility dominates good volatility. Macroeconomic shocks (negative interest rate in Japan, economic stress in China, recession in Russia, and double-digit inflation in Brazil) increased volatility asymmetry. Asian markets are responsible for stronger negative spillover, thereby necessitating regulations to reduce strong negative volatility connectedness with Asian markets.

Authors:
Khamis Al Yahyaee
Walid Mesni
Debasish Maitra
Sang Kang

The Tradeoff of Diversity and Diversification

Kerstin Awiszus

Leibniz Universität Hannover, Germany

Abstract:

We consider a financial market in which trades impact asset prices. Leverage tracking of banks triggers deviations from fundamental values. Unless assets are homogeneous, full diversification does not minimize the distance of realized prices from their fundamental values. Instead, an optimal and nontrivial level of diversity can be computed.

Authors:
Agostino Capponi
Stefan Weber
Kerstin Awiszus

Estimating the Pricing Kernel

Giovanni Barone Adesi

Università della Svizzera Italiana, Switzerland

Abstract:

Estimating the markets beliefs about future returns by means of backward-looking historical data leads to an uninformative and hence unconditional physical measure. What is missing are the investors forward-looking beliefs, which are instead naturally captured by an option-based risk-neutral measure. The information gap between the two measures leads to an information premium and, accordingly with the theory, the two measures are therefore not comparable. This paper studies theoretically and empirically the impact of this misalignment of beliefs on the estimation of the pricing kernel and its connection with the pricing kernel puzzle. To study the misalignment, we propose a stock-and-option-based physical measure estimation. Starting from the classical approach, which relies on historical data only, the proposed measure also exploits the information coming from the daily option cross-section. As a natural test, the proposed measure is used to extensively investigate the shape of the 2002-2015 S&P 500 pricing kernel.

Authors:
Giovanni Barone Adesi
Carlo Sala
Antonietta Mira

Let the Parametric Phoenix Fly

Pedro Barroso

University of New South Wales, Australia

Abstract:

In international portfolios investors move away from domestic-only investing and diversify their allocation of assets by foreign equities. The exposure to foreign currencies adds an additional risk component which is managed in the currency overlay. To achieve an ideal weighting of the allocation of assets and the exposure to currencies, this study proposes a novel approach for a joint optimization. For the optimal weighting of equities we suggest to employ characteristics of momentum, value, and size strategies while currencies are allocated according to characteristics of carry trade, currency momentum, and currency value strategies. Relative to a benchmark and in an out-of-sample setting, we document an increase in the portfolios' Sharpe ratio by 30% after transaction and rebalancing costs. This relative improvement is primarily driven by the increase in portfolios' returns, while the portfolios' overall volatility remains unaffected.

Authors:
Pedro Barroso
Jurij Reicheneker
Michael Reicheneker

Optimal market making on OTC markets: toward dimensionality reduction

Philippe Bergault

Université Paris 1 Panthéon-Sorbonne, France

Abstract:

Market makers provide liquidity to other market participants. On OTC markets, an agent who wishes to sell or buy a given asset sends a request for quote (RFQ) to a market maker, who proposes in return a bid or ask quote to the agent. Hence market makers face a complex optimization problem with both static and dynamic components: their return, based on the bid-ask spread they quote and the frequency at which they provide liquidity, is challenged by the price risk they bear due to their inventory. The stochastic control problem introduced by Ho and Stoll (1981) and formalized mathematically by Avellaneda and Stoikov (2008) allows to consider the case of a market maker dealing with a single asset and assuming transactions of constant size, i.e., the quantities traded do not vary across trades . The Hamilton-Jacobi-Bellman equation of this problem was studied by Guéant, Lehalle and Fernandez-Tapia (2012) who showed that it can be reduced to a system of ordinary differential equations and solved with classical finite difference methods. This model was then generalized by Guéant (2017) to the case of multi-asset market making. The HJB equation can still be reduced to a system of ODEs, but the number of equations is then exponential in the number of assets: for a market maker dealing with more than two or three assets, it cannot be solved by classical finite difference schemes due to the curse of dimensionality. In this new paper, we propose a dimensionality reduction approach to solve the multi-asset problem. We also remove the assumption of constant trade size and allow the market maker to choose its spread as a function of the request's size. This yields a d-dimensional integro-differential Hamilton-Jacobi equation, that can often be reduced to a two or three dimensional equation. Numerical results are provided.

Authors:
Philippe Bergault
Olivier Guéant

Optimal life-contingent insurance under bid-ask spreads

Nikolay Bondarenko

Macquarie University, Australia

Abstract:

We re-examine optimal insurance when life insurance and/or life annuities carry loads. Richard (1975) and Pliska and Ye (2007) are the two classic contributions to this line of research. They extend the Merton portfolio model of an investor's life cycle by exploiting the insight that a long position in life insurance is effectively a short position in life annuities, and vice versa.

The Richard-Pliska-Ye model implies that optimal participation in the market for life-contingent insurance is continuous (i.e. lifelong) even if insurance loads are heavy and the investor is close to being risk neutral. We find instead that a positive bid-ask spread induces two intervals during which the investor sits on the sidelines of the market for life-contingent insurance, one in midlife and the other at the end of life's maximal span. The intuition for the midlife nonparticipation interval is that self-insurance is a better deal for a time than either life insurance or life annuities. In the case of the late-life interval, once you confidently expect to live only for a few more years you become increasingly less inclined to buy a loaded life annuity to avoid the risk of outliving your resources, assuming you have a bequest motive.

Following Richard (1975) and Pliska and Ye (2007), among others, we assume a fixed planning horizon. To highlight the implications of introducing an ask price for life insurance, we abstract from risky investments, in line with Pliska and Ye (2007) but departing from Richard (1975), Ye (2008), Aase (2017) and many other contributions.

We solve this model piecewise, using dynamic programming to obtain solutions for the insured intervals. However, that method appears not to work for the nonparticipation intervals, so we turn to the martingale method for them.

Authors:
Nikolay Bondarenko
Geoffrey Kingston
Pavel Shevchenko

A General Formulation for Convergence of Extremal Processes at Small Times

Boris Buchmann

Australian National University, Australia

Abstract:

We study the behaviour of large values of extremal processes at small times, as the analogue of the Gnedenko-Fisher-Tippet theorem which characterises the possible limiting distributions of maxima of independent and identically distributed random variables. In a general setting, we state necessary and sufficient conditions for local convergence of such maxima, linearly normalised, to the Frechet or Gumbel distributions; Weibull distributions turn out not to be possible. Moreover, assuming second order regular variation, we show that local asymptotic normality for the intermediate order statistics holds, and derive explicit formulae for the normalising constants for tempered stable processes. We also adapt Hill's estimator of the tail index to our small time setting and establish asymptotic normality under second order regular variation conditions. Applications to the fine structure of asset returns and the possible infinite variation of financial returns processes are indicated, and the convergence of the estimator to normality is illustrated through simulations.

Authors:
Boris Buchmann
Ana Ferreira
Ross Maller

Finite mixture model approximation for the SABR distribution

Jaehyuk Choi

Peking University HSBC Business School, China

Abstract:

In this paper, we represent the stochastic-alpha-beta-rho (SABR) model distribution as a parsimonious finite mixture of base models: Bachelier, constant-elasticity-of-variance (CEV), or Black-Scholes model depending on the beta value. With the mixture model approach, European option prices and Greeks under the SABR model are computed as the weighted sum of those under the base model and Monte-Carlo simulations are performed easily. The mixture model parameters are obtained from jointly evaluating terminal volatility and integrated variance with leading orders of the Karhunen-Loève expansion of Brownian bridge and Gaussian quadrature. Numerical examples demonstrate the accuracy and efficiency of the method.

Authors:
Jaehyuk Choi
Byoung Ki Seo

Holistic capital allocation principle

Wing Fung Chong

University of Illinois at Urbana-Champaign, United States of America

Abstract:

Risk aggregation and capital allocation are of paramount importance in the business world, as they play critical roles in product pricing, risk assessment, risk management, project financing, performance management, financial reporting, regulatory supervision, and so on. The conventional approach, which is rooted in nearly all existing business practices involving risk assessment, is to sequentially perform the two components. More precisely, there is a "natural" sequence of actions: (i) identifying all risks involved; (ii) aggregating individual risks to determine required capital at a group level; and (iii) allocating the total capital back to the granular levels. In this talk, we challenge this conventional thinking underlying the current business practices and propose an alternative approach, which takes into account both aggregation and allocation simultaneously at both individual and aggregate levels.

Authors:
Wing Fung Chong
Runhuan Feng
Longhao Jin

Balance Sheet XVA by Deep Learning and GPU

Stéphane Crépey

Université Paris-Saclay, Evry, France

Abstract:

Since the 2008-09 financial crisis, derivative dealers charge to their clients various add-ons, dubbed XVAs, meant to account for counterparty risk and its capital and funding implications for banks. Two competing XVA paradigms are a replication framework and a cost-of-capital, incomplete market approach. Burgard and Kjaer once dismissed an earlier incarnation of the Albanese and Crépey holistic, incomplete market XVA model as being elegant but difficult to solve explicitly. We show that the model (set on a forward/backward SDE formulation) is not only elegant, but also able to be solved efficiently using GPU computing combined with AI methods in a whole bank balance sheet context. We calculate the Mark-to-Market process cube (or its increment, in the context of trade incremental XVA computations) using GPU computing and the XVA process cube using Deep Learning (including joint ES and VaR) Regression methods.

Authors:
Stéphane Crépey
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Neural Network Approaches to Infinite Dimensional Calibration and Prediction Problems

Christa Cuchiero

Wirtschaftsuniversität Wien, Austria

Abstract:

We consider calibration of local stochastic volatility models and yield curve prediction and view these problems from an optimal control perspective. We parameterize the controls with neural networks and learn them directly from data without performing any kind of interpolation. In case of the local stochastic volatility models this means to learn the leverage function from the implied volatility surface without using Dupire's local volatility function. In the context of (multiple) yield curve modeling we parameterize the volatility function in a Heath-Jarrow-Morton framework via neural networks to predict the yield curve evolutions over time. The common denominator is learning of infinite dimensional characteristics in stochastic models.

Authors:
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Wahid Khosrawi
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Spatially Determined Optimal Price Design in a Ride Sharing Economy

Samuel Drapeau

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Abstract:

In their price design, ride-sharing platforms have to consider two different aspects. On the one hand, guarantee a sufficient demand in terms of customers for rides to overall price. On the other hand, guarantee a sufficient supply in drivers to satisfy this demand in terms of revenue. The price for a trip depends on a fixed and proportional fee depending on the ride distance. The gains of a ride is then shared between the platform and the driver. The platform needs therefore to set ride costs as well as the share to the driver to maximize its revenue. To tackle this problem, we first derive a dynamic of the rides on a generic map that depends on demand and available drivers. This dynamic is non local since drivers may not be available for a some time due to long rides and be available on another location in the map afterwards. We provide results showing that the average amount of drivers available on the map converges to a steady state. This steady state depends on the structure of the map as well as the overall demand. With this at hand we consider the optimal price design in the following situations

- Monopolistic ride-sharing platform
- Oligopolistic ride-sharing platform

and derive from it how the price setting depends on the demand and supply elasticity, the geometry of the map as well as the related demand for rides.

Authors:
Samuel Drapeau
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Variable Annuities in a Lévy-based Hybrid Model with Surrender Risk

Ernst Eberlein

University of Freiburg, Germany

Abstract:

Variables annuities are unit-linked investment policies providing a post-retirement income, which is generated by the returns on a suitably managed financial portfolio. Various guarantees are applied with the aim of providing protection of the policyholders' saving accounts. Variable annuities are popular insurance products in the US, Japan, the UK, and are increasingly present in the other European markets as well.

The paper proposes a market consistent valuation framework for variable annuities with guaranteed minimum accumulation benefit, death benefit and surrender benefit features. The setup is based on a hybrid model for the financial market and uses time-inhomogeneous Lévy processes as risk drivers. Further, we allow for dependence between financial and surrender risks. The model leads to explicit analytical formulas for the quantities of interest, and practical and efficient numerical procedures for the evaluation of these formulas. We illustrate the tractability of this approach by means of a detailed sensitivity analysis of the fair value of the variable annuity and its components with respect to the model parameters. The results highlight the role played by the surrender behaviour and the importance of its appropriate modelling.

Authors:
Laura Ballotta
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Raghid Zeineddine

Hedging Options in a Doubly Markov-Modulated Financial Market via Stochastic Flows

Robert Elliott

University of South Australia, Australia and University of Calgary, Canada

Abstract:

The hedging of a European-style contingent claim is studied in a continuous-time doubly Markov-modulated financial market, where the interest rate of a bond is modulated by an observable, continuous-time, finite-state, Markov chain and the appreciation rate of a risky share is modulated by a continuous-time, finite-state, hidden Markov chain. The first chain describes the evolution of credit ratings of the bond over time while the second chain models the evolution of the hidden state of an underlying economy over time. Stochastic flows of diffeomorphisms are used to derive some hedge quantities, or Greeks, for the claim. A mixed filterbased and regime-switching Black-Scholes partial differential equation is obtained governing the price of the claim. It will be shown that the delta hedge ratio process obtained from stochastic flows is a risk-minimizing, admissible meanself-financing portfolio process. Both the first-order and second-order Greeks will be considered.

Authors:
Tak Kuen Siu
Robert J. Elliott

Modeling of Persistent Extremes in Financial Markets and Winning Streak Paradox

Runhuan Feng

University of Illinois at Urbana-Champaign, United States of America

Abstract:

A new class of stochastic processes with sticky extrema is proposed to model common phenomena of winning and losing streaks in financial markets including equity, commodity, foreign exchange, etc. Most stochastic process models for financial market data in the current literature focus on stylized facts such as fat-tailedness relative to normality, volatility clustering, mean reversion. However, none of existing financial models captures a frequently observable feature of persistent extremes -- financial indices often report record highs or lows in concentrated periods of time. The lack of persistent extremes in a stochastic model for asset valuation can have grave impact on the valuation and risk management of financial instruments. The new model in this paper enables us to measure and assess the impact of persistent extremes on European options whose values can be severely mispriced. In particular, the model in this paper reveals a paradox that investors who bet on the growth of financial market may be worse off with the presence of winning streaks in the market.

Authors:
Runhuan Feng
Pingping Jiang
Hans Volkmer

Optimal Control of Pension Funds Under the Benchmark Approach

Kevin Fergusson

University of Melbourne, Australia

Abstract:

This paper describes the optimal control of pension funds under the benchmark approach. In particular, we consider Markov control strategies which optimise over the employer's contribution rate into the fund and over the range of possible asset-allocation strategies, while maintaining solvency of the fund. The pension fund model is composed of four assets, cash, equities, bonds and property, as well as a model of benefit outgo that is linked to inflation.

Author:
Kevin Fergusson

On Fairness of Systemic Risk Measures

Jean-Pierre Fouque

University of California Santa Barbara, United States of America

Abstract:

In our previous paper "A Unified Approach to Systemic Risk Measures via Acceptance Set" (*Mathematical Finance* 2018), we have introduced a general class of systemic risk measures that allow random allocations to individual banks before aggregation of their risks. In the present paper, we address the question of fairness of these allocations and propose a fair allocation of the total risk to individual banks. We show that the dual formulation of the minimization problem identifying the systemic risk measure provides a valuation of the random allocations, which is fair both from the point of view of the society/regulator and from the individual financial institutions. The case with exponential utilities which allows for explicit computation is treated in details.

Authors:
Jean-Pierre Fouque
Francesca Biagini
Marco Frittelli
Thilo Meyer-Brandis

Conditionally Affine processes with Markov Modulated Mean Reversion Level and Applications in Credit Risk

Rüdiger Frey

Wirtschaftsuniversität Wien, Austria

Abstract:

In this talk we explore applications of conditionally affine processes with Markov modulated mean reversion level in the analysis of credit risk. Generalizing earlier work by Elliott and Siu (2009), we first show that affine transforms of such processes can be obtained in a semi explicit form, and we explain how this can be used to derive near-explicit pricing formulas for many credit derivatives. We discuss in detail two specific applications of conditionally affine models: first, we study the pricing of defaultable bonds with negative dependence between the default intensity of the issuer and the default-free short rate; moreover, we carry out a risk analysis of so-called European Safe Bonds (these are essentially CDO tranches backed by a portfolio of bonds issued by Euro area members). In both cases, by considering a Markov modulated mean reversion level we are able to capture salient features of credit-spread dynamics in a natural way, while preserving analytical and numerical tractability of the ensuing models.

Authors:
Rüdiger Frey

The Edgeworth Expansion for Continuous Martingale Marginals

Masaaki Fukasawa

Osaka University, Japan

Abstract:

The Edgeworth expansion is a refinement of the central limit theorem. Here we derive an expansion that can be seen as a refinement of the martingale central limit theorem. The preceding results by Mykland (1993) and Yoshida (1997) are partially improved to higher order. The formula is simply writtten in term of cumulants and Hermite polynomials. Applications to finance include an expansion of the at-the-money implied volatility under classical local-stochastic or rough volatility models.

Authors:
Masaaki Fukasawa
Elisa Alos

Exchange Option Pricing under Stochastic Volatility and Jump-Diffusion Dynamics

Len Patrick Dominic Garces

University of South Australia, Australia

Abstract:

There is substantial empirical evidence showing that the geometric Brownian motion assumption of the classical Black-Scholes-Merton model is inadequate in characterizing the full extent of asset price returns observed in the market. As such, recent years have seen a rise in the pricing of options and other financial derivatives using alternative asset price models, including jump-diffusion models, stochastic volatility models, and stochastic volatility jump-diffusion models.

To this end, we examine the price of European and American exchange options under the assumption of stochastic volatility and jump-diffusion (SVJD) dynamics for the underlying asset prices. We also describe parameter restrictions on the instantaneous variance processes and the instantaneous correlation coefficients to ensure that the variances do not explode or make excursions to zero in finite time under any probability measure equivalent to the market measure. Given the risk-neutral dynamics of asset prices and the instantaneous variances, we derive the exchange option pricing integro-partial differential equation (IPDE) and present appropriate initial, boundary, and smooth-fit conditions.

Using a change-of-numeraire approach, we obtain a representation for the European exchange option price in terms of probabilities (under probability measures equivalent to the risk-neutral measure) that the option is in-the-money. Our result has a form similar to Margrabe's formula for European exchange option prices under pure diffusion processes. We also analyze the American case and verify that the American exchange option price can be written in terms of an early exercise representation. We find that the associated early exercise premium can be decomposed into a diffusion and a jump part, consistent with earlier results on American calls and puts.

The analytical results presented here lay the foundation for a future numerical and statistical analysis of exchange option prices under SVJD dynamics.

Authors:
Len Patrick Dominic Garces
Gerald Cheang

Quantum Computing Applications for the Finance Industry

David Garvin

Rigetti Computing, Australia

Abstract:

Quantum computing is an emerging technology with the potential to speed up large computational tasks. Quantum computing hardware is available now, having been developed by major corporations and technology startups like Rigetti. The financial applications of quantum computing should increase profit, reduce risk and enhance the customer experience. This presentation will cover the basics of quantum computing and some important quantum algorithms. It will highlight specific use cases relevant to the financial industry, presenting the mathematical formulation and possible business benefits.

Author:
David Garvin

Machine Valuation

Paul Geertsema

University of Auckland, New Zealand

Abstract:

We present a machine learning approach to firm valuation using extreme gradient boosting machines. Traditional manual valuation approaches are expensive and require professional judgement for the estimation of various valuation model inputs. By contrast our approach is completely automated and requires only historical accounting data. While we train the model on listed US stocks, the model does not use any market data as inputs. The machine learning model generates a median absolute percentage error of 17.5% in expanding window out-of-sample firm value predictions. This exceeds the performance of a sample of final-year finance students (58.4%), individual analyst forecasts of one-year-ahead firm value (20.8%) and IPO filing mid-point equity valuations (21.4%). In firm-month panel data the model error positively predicts future stock price performance in the next month and also over longer horizons of up to two years, suggesting that the model error is at least partially due to misvaluation by the market, not the model. A zero-cost trading strategy based on this difference earns 10.2% per year (t-statistic 3.49). Our results show that contemporary machine learning methods can yield estimates of firm value that are competitive with human-level performance.

Authors:
Paul Geertsema
Helen Lu

VaR-models accounting for intraday-jumps

Pit Götz

Martin-Luther Universität Halle-Wittenberg, Germany

Abstract:

In this paper, Value-at-Risk (VaR) models that account for intraday-jumps are developed. The VaR is modelled directly as a quantile and the respective model-parameters can therefore be estimated by using a quantile-regression based approach. In order to analyse the dynamic of the impact of intraday-jumps on market risk, linear and non-linear models are developed and evaluated.

It is assumed that the underlying time continuous log-price process follows a generic jump-diffusion process. Based on this assumption a significant jump-size estimator is used and the significant jump-sizes per day are included in the models.

The evaluation of the models is done by fitting the model parameters on high frequency datasets of DAX returns and on FOREX Euro - Dollar exchange rates. As an evaluation frame, the two approaches, fixed-size rolling window and data separation are used.

The empirical results of this work show that VaR- models, that account for intraday jumps, are useful to forecast market risk. Rolling window-forecasts show better results, when it comes to the independence of hit-sequences, the data separated forecasts are less volatile over the forecasting period.

Given our analysis, the simplest, linear models, with and without jumps have to be discarded, because they fail the backtests, but the more complex models, including auto-regression and non-linearity, do pass them. The results are good especially during times of high market-volatility.

With these empirical results it can be concluded, that the functional relation of market risk and intraday-jumps, based on VaR forecasting, is most likely non-linear, since the non-linear models have better out-of sample forecasting results. The direction of the jumps is also an important factor, since upward and downward jumps have different impacts on the VaR forecasts, which is consistent with the leverage effect, as in GJR-GARCH models and the volatility-feedback effect.

Author:
Pit Götz

Is Volatility Rough?

Martino Grasselli

University of Padova, Italy

Abstract:

Using a large dataset on major indexes and FX rates, we test the roughness of the volatility using different estimators and including the estimation error in the analysis. In particular, we analyze the stability of the Hurst parameter with respect to the time scale. Our results lead to new stylized facts that should be included in any rough model.

Authors:
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Pricing and Hedging of Guaranteed Minimum Benefits using Power Series Approximation Techniques

Nikolay Gudkov

ETH Zurich, Switzerland

Abstract:

Majority of the developed economies are experiencing population ageing with people living longer due to advances in medicines and lifestyle quality. Such developments have been putting a lot of pressure on governments and pension fund providers who are exposed to the resulting longevity risk. Variable annuities(VAs) constitute a class of financial products designed to tackle challenges associated with both investment and longevity risk. These contracts enable policyholders to participate in financial markets via linked funds and at the same time provide protection against long-term life contingencies. In this paper, we devise a numerical technique for pricing Guaranteed Minimum Benefit (GMB) riders embedded in Variable Annuities. The method utilises multidimensional transforms of the characteristic function for the underlying stochastic process and enables to express solutions to pricing partial differential equations in terms of power series with coefficients known in the closed form. Our results demonstrate the high computational efficiency of the series approximation method for the computation of prices and hedge ratios of GMBs under the stochastic volatility and stochastic interest rate modelling framework. The findings of the paper can help insurers with efficient quantification of various risks associated with GMBs in Variable Annuities.

Authors:
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Jonathan Ziveyi

Quantitative Selection of Election Portfolios

Michael Hanke

University of Liechtenstein, Liechtenstein

Abstract:

We combine stock prices with data from political betting markets in order to assess individual stock price sensitivity to potential election outcomes. Selecting stocks before the elections based on this sensitivity, we build portfolios that generate large positive returns after the election date conditional on the election outcome. This outperformance persists for several days after the elections, leading to positive returns even for investors who build their portfolios once the election outcome becomes known. The approach is illustrated using data from the US presidential elections 2016 and the Brexit referendum 2016.

Predicting the movement of the entire stock market in the wake of elections seems to be difficult, although there is some evidence for an increase in political uncertainty to be accompanied by negative aggregate returns. At the individual stock level, however, market participants seem to expect some stocks to benefit and others to suffer from a particular election outcome. Such stocks have been suggested by blogs and the media. Conditional on the anticipated election outcome, commentators recommended certain stocks or industries based on qualitative arguments. For instance, those who believed Trump to win the elections were advised to buy Microsoft, Apple and Cemex, while those who saw higher chances for Clinton were told to buy solar, oil and biotech stocks, as well as Netflix and Goldman Sachs.

In this paper, we describe an alternative approach to selecting stocks into such "election portfolios". In contrast to the qualitative arguments that were previously used as a basis for picking stocks or industries for this purpose, our approach is purely quantitative. Based on an estimation of each stock's sensitivity to changes in risk-neutral election outcome probabilities, we replace subjective arguments by market expectations implied in stock prices. We apply our approach to two recent political events, covering both US and UK stocks.

Authors:
Michael Hanke
Sebastian Stoeckl
Alex Weissensteiner

Credit portfolio loss: Assessing the Number of Defaults with Generalised Pareto Distributions and Survival Archimedean Copulas

Katja Ignatieva

University of New South Wales, Australia

Abstract:

This paper develops a comprehensive model for assessing the number of defaults $N_X(p)$ in a credit portfolio of d_X obligors each with a probability of default p using survival Archimedean copulas that capture the dependence structure between losses in the credit portfolio. We compute the probability function and the moments for 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 X and Y with the number of default $N_X(p)$ and $N_Y(p)$, respectively, we develop a flexible dependence structure combining Archimedean copulas to model the dependency within each credit portfolio, with the multivariate generalised Pareto distribution introduced in Hendriks and Landsman (2017) to model the dependency between these credit portfolios. 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 $P(N_X(p) \geq n_X | N_Y(p) \geq n_Y)$ and its limiting properties when default probability p is small.

Authors:
Katja Ignatieva
Zinoviy Landsman
Qihe Tang

Systemic risk in market microstructure of crude oil and gasoline future prices: A Hawkes flocking model approach

Hyun Jin Jang

UNIST, Korea

Abstract:

We propose a novel class of Hawkes-based model that assesses two types of systemic risk in high-frequency price processes: the endogenous systemic risk within a single process and the interactive systemic risk between a couple of processes. We examine the existence of systemic risk at a microscopic level via an empirical analysis of the futures markets of the West Texas Intermediate (WTI) crude oil and gasoline and perform a comparative analysis with the conditional value-at-risk as a benchmark measure of the proposed model. Throughout the analysis, we uncover remarkable empirical findings in terms of the high-frequency structure of the two markets: for the past decade, the level of endogenous systemic risk in the WTI market was significantly higher than that in the gasoline market. Moreover, the level at which the gasoline price affects the WTI price was constantly higher than in the opposite case. Although the two prices interact with each other at the transaction-unit level, the degree of relative influences on the two markets, that is, from the WTI to the gasoline and vice versa, was very asymmetric, but that difference has reduced gradually over time.

Author:
Hyun Jin Jang

J-REIT investment strategy with mobile statistics

Takuya Kaneko

KDDI Research and ICU, Japan

Abstract:

In our presentation, we introduce our investment strategy to J-REIT (Japan REIT) by utilizing mobile statistics. We counted the number of mobile phone users mesh by mesh and utilized them to estimate occupancy rate of specific hotels which are included in J-REIT. Firstly, we checked its correctness by comparing with actual monthly occupancy rate on IR data. And after that, we utilized daily occupancy rate for investment. We supposed that we have long position when the standardized occupancy rate (SCR) is high (SCR is greater than upper threshold) and we have short position when the SCR is low (SCR is smaller than lower threshold). Otherwise, we supposed to have sideline strategy. We had very good performance result such as annual return's being better than 24% and sharp ratio's being better than 14 (see page no. 48 in our slide written in Japanese). These results came just from training data calibration. But we standardized daily data with only historical data and also decided/change daily threshold with historical data. We introduce detail settings and further experimental results in our presentation.

Authors:
Takuya Kaneko
Rui Kimura
Yutaro Mishima

Targeting wealth distributions under drawdown constraints

Constantinos Kardaras

London School of Economics, United Kingdom

Abstract:

In a continuous-path semimartingale model, we consider an arbitrary distribution on the positive real line representing desired log-returns on investment. Under drawdown constraints, we explicitly obtain a wealth process and a stopping time that achieve the previous distribution. Importantly, the wealth process involves a mutual fund in the cash account and the growth-optimal wealth process in a model-independent way (as long as these two funds are provided by the market). The stopping rule depends only on directly observable quantities and the target distribution. Certain optimality properties of the given solution will be discussed.

Author:
Constantinos Kardaras

Estimating the duration of the quantitative easing policy using a term structure model with a stochastic lower bound

Kentaro Kikuchi

Shiga University, Japan

Abstract:

This study investigates market expectations on the duration of quantitative and qualitative monetary easing (QQE) by the Bank of Japan based on a new term structure interest rate model. The model is constructed as a quadratic Gaussian term structure model with a negative lower bound following a Brownian bridge process on random intervals introduced by Bedini et al. [2017] where the process is modeled as what converges to zero at the future date when QQE ends. This model not only captures negative yield curves observed in the Japanese government bond (JGB) market for the recent years but also incorporates the duration until negative yield curves disappear associated with the end of QQE. Using the recent JGB zero coupon rate data, we estimate the model parameters after specifying the probability distribution of the duration until negative yield curves disappear. This clarifies the development of market expectations on the duration of QQE.

Author:
Kentaro Kikuchi

Risk on Post-M&A Performance: the information implication in time till deal completion

Changki Kim

Korea University Business School, Korea

Abstract:

The literature has of late redirected focus from aggregate level research on M&A activity to deal-specific level research. Prime among them relates to the optimum time required between deal announcement and deal completion. Bhagwat, Dam, and Harford (2016) posit that firm values substantially change between deal announcements and actual closing risking renegotiation or termination, indicating that this may lead to the abandonment of many deals resulting in a decrease in the level of deal activity. A question that remains to be answered is, even for those deals that eventually close, does waiting longer to close a deal benefit the acquirer or the newly formed company post-merger? In this paper, we investigate whether the time it takes till deal completion is a significant indicator of post-M&A performance and a determinant of the risk of failure. Our results show that deals that take an optimum time to negotiate and implement are more likely to perform well supporting the due diligence hypothesis, but when the time till completion takes too long, it is a warning indication of poor post-merger performance and subsequently failure supporting the overdue hypothesis.

Authors:
Changki Kim
Ephraim Thompson

Intertemporal Preference with Risk and Loss Aversion

Hyeng Keun Koo

Ajou University, Korea

Abstract:

We study a model of intertemporal preference which has both risk aversion and loss aversion and can be represented by a utility function exhibiting a minimal departure from the time-separable von Neumann-Morgenstern utility. The preference is globally concave, and thus shows risk aversion over all choices. Thus, it is different from a typical preference in the prospect theory, which exhibits risk seeking for losses (see e.g., Kahneman and Tversky 1979, Tversky and Kahneman 1991). It has, however, loss aversion by overweighting losses where gains losses are calculated from the previous level of consumption. We will discuss asset pricing implications of the model and applications to long-term asset management.

Author:
Hyeng Keun Koo

Deep Neural Networks, Generic Universal Interpolation, and Controlled ODEs

Martin Larsson

Carnegie Mellon University, United States of America

Abstract:

Deep neural networks perform exceedingly well on a variety of learning tasks, in particular in finance where they are quickly gaining importance. A recent paradigm views deep neural networks as discretizations of controlled ordinary differential equations. We make use of this perspective to link expressiveness of deep networks to the notion of controllability of dynamical systems. Using this connection, we study an expressiveness property that we call universal interpolation, and show that it is generic in a certain sense. We also show that universal interpolation holds for certain deep neural networks even if large numbers of parameters are left untrained, and instead chosen randomly. This lends theoretical support to the observation that training with random initialization can be successful even when most parameters are largely unchanged through the training.

Author:
Martin Larsson

Real option on finite time horizon under a regime-switching process with jumps

Younhee Lee

Chungnam National University, Korea

Abstract:

In this talk, we deal with a real option on finite time under a regime-switching jump-diffusion model. The objective of the investor is to decide an optimal investment time to maximize the expected value of a given payoff function. It is concerned with a Hamilton-Jacobi-Bellman equation and can be solved numerically. A number of numerical experiments are performed to describe phenomena with the regime-switching jump-diffusion model.

Author:
Younhee Lee

Robust time-inconsistent stochastic control under ambiguous covariance matrix

Qian Lei

Nanyang Technological University, Singapore

Abstract:

This paper studies robust time-inconsistent stochastic control problems under ambiguous covariance matrix. Time-inconsistency is caused in various ways by a general objective functional and does not admit the Bellman optimality principle. Moreover, a set of nondominated probability measures generated by uncertain covariance matrix is analyzed under the McKean-Vlasov dynamics environment. We apply a game-theoretical framework of subgame perfect Nash equilibrium to study the time-consistent equilibrium strategies. We characterize the robust equilibrium control and equilibrium value function by a system of Bellman–Isaacs equations in the Wasserstein space of probability measures. We also prove a verification theorem to support our robust control. Finally, the general analytical framework is utilized to study the robust continuous-time mean-variance portfolio selection problem where the model ambiguity stems from volatilities and correlation between two risky assets.

Authors:
Qian Lei
Chi Seng Pun

Time-changes, selfsimilarity, mimicking marginals, and martingales

Thomas Liebmann

Germany

Abstract:

In this talk, we focus on two aspects of time-change constructions: Selfsimilarity and the martingale property.

Time-changes are a powerful tool to construct new stochastic processes from known building blocks and to analyze their properties. For instance, a broad variety of Lévy processes can be constructed by subordination, that means by running possibly multiple multi-dimensional Lévy process under multiple stochastic clocks given by independent and increasing Lévy process. Many types of more general stochastic processes arise when other kinds of processes run under other stochastic clocks.

Constructing various selfsimilar processes via time-changes we en passant encounter a technique to construct a variety of different processes with the same marginal distributions. Building blocks used in this construction are, for instance, stable and Sato processes.

Author:
Thomas Liebmann

Calibration Neural Network for Financial Asset Price Models

Shuaiqiang Liu

TU Delft, Netherlands

Abstract:

We proposed a data-driven approach, namely CaNN (Calibration Neural Network), to calibrate financial asset price models or extract implied market information based on available financial option prices. The framework consists of two parts: a forward pass in which we train the weights of the ANN off-line, valuing options under many different asset model parameter settings; and a backward pass, in which we evaluate the trained ANN-solver on-line, aiming to find the weights of the neurons in the input layer. The rapid on-line learning in combination with the use of an adapted parallel global optimization method, tackles the computation bottleneck and provides a fast and reliable technique for calibrating model parameters while avoiding, as much as possible, getting stuck in local minima. Numerical experiments confirm that this machine learning method can be employed to calibrate parameters of high-dimensional stochastic volatility models or extract implied information efficiently and accurately.

Authors:
Shuaiqiang Liu
Cornelis W. Oosterlee
Anastasia Borovykh

Two to Tango: Market Data and Expert Opinions in Portfolio Construction

Sébastien Lleo

NEOMA Business School, France

Abstract:

Financial markets have no shortage of expert opinions. Quinlan & Associates reckon that banks and brokerages emailed nearly 40,000 pieces of research every week in 2016. These emails are just one example. Expert opinions can take many forms from analyst research, to economist reports, valuation appraisal of private equity companies, blogs, tweets, webinars, and pundit interviews.

In today's Big Data world, the sheer volume, velocity and variety of expert opinions prompt again the question of their place and relevance in portfolio construction. While expert opinions already featured in static portfolio selection models by Markowitz (1959) and Black and Litterman (1992), their inclusion in dynamic portfolio selection models is much more recent.

This talk focuses on advances in continuous-time portfolio construction models combining expert opinions and market data.

We discuss two main modelling frameworks. Expert opinions arrive at discrete times in the framework by Gabi et al. while experts opinions generate a continuous process in the framework by Davis and Lleo.

We show how to solve two fundamental hurdles: the aggregation of market data and expert opinions into consistent estimates, and the effect of behavioural biases on expert opinions. Stochastic filtering provides an effective and elegant solution to the aggregation problem. Expert opinions need to be carefully preprocessed to address the effect of behavioural biases.

Our results show that expert opinions have profound implications for investment management. The asset allocation is subjective and the Kelly portfolio is no longer universal. Flexible fractional Kelly results need to replace traditional fund separation theorems.

Author:
Sébastien Lleo

Tail risk of US equity factors

Helen Lu

University of Auckland, New Zealand

Abstract:

Using Extreme Value Theory, we investigate the absolute and conditional tail-risks of 18 factors in US equities between 1967 and 2016. The Hill index is used to estimate Value-at-Risk and Expected Shortfalls. We find that the momentum and low-volatility strategies display excess left-tail risks, but other factor strategies show only moderate left-tail risks. To measure extreme downside systematic risk, we estimate conditional-co-crash (CCC) probabilities between factors and the market portfolio over windows of one-, five- and 22-tradings days. The CCC probability between a factor and the market tends to increase as the evaluation window lengthens, thus reducing diversification potential to the investor. CCC probabilities differ drastically across factors and vary over time. In the last decade, the CCC probabilities with the market have reached record high levels for several factors, among which are the size, value, industry reversal, momentum reversal and seasonality factors. By contrast, the factors profitability, gross-profit, investment, equity-issuance, earning-yield, leverage-risk and low-volatility display low CCC probabilities in all sub-sample periods. Using the historical CCC probabilities, investors could have improved portfolio performance during stock market crashes.

Authors:
Paul Geertsema
Helen Lu
Philip Stork

Calibration of multivariate Lévy-driven Ornstein-Uhlenbeck processes

Kevin Lu

Australian National University, Australia

Abstract:

Suppose that a Ornstein-Uhlenbeck processes is driven by a multivariate Lévy process from a parametric family. We study calibration for the stationary solution of such Lévy-driven Ornstein-Uhlenbeck processes based on discrete-time observations. We derive a likelihood function using Fourier inversion, develop a stepwise procedure for estimation, and highlight our results in a stimulation study. This extends the work of Valdivieso, Schoutens, Tuerlinckx (2009) to the multivariate setting.

Weak subordination is an operation that creates time-changed Lévy processes while allowing the subordinate to have dependent components. We focus on the case where the background driving Lévy process is a weak variance alpha-gamma process, a weakly subordinated process that is a multivariate generalisation of the variance gamma process.

Ornstein-Ulenbeck processes have been applied to model, for example, interest rates, exchange rates, and stochastic volatility, and we discuss financial applications of our work.

Authors:
Kevin Lu
Boris Buchmann

Numerical methods for Guaranteed Minimum Withdrawal Benefits (GMWBs) as a continuous impulse control problem

Yaowen Lu

University of Queensland, Australia

Abstract:

We propose an epsilon-monotone Fourier method for solving a continuous impulse stochastic control formulation for valuation problem of Guaranteed Minimum Withdrawal Benefits (GMWBs) under jump diffusion models. We prove the convergence of our scheme to the viscosity solution of the continuous formulation, although the proposed method is not strictly monotone in the viscosity sense. Numerical experiments indicating the accuracy of the proposed method are presented.

Authors:
Yaowen Lu
Duy-Minh Dang
Peter Forsyth
George Labahn

Characterization of Fully Coupled FBSDE in Terms of Portfolio Optimization

Peng Luo

University of Waterloo, Canada

Abstract:

We provide a verification and characterization result of optimal maximal sub-solutions of BSDEs in terms of fully coupled forward backward stochastic differential equations. We illustrate the application thereof in utility optimization with random endowment under probability and discounting uncertainty. We show with explicit examples how to quantify the costs of incompleteness when using utility indifference pricing, aswell as away to find optimal solutions for recursive utilities.

Authors:
Peng Luo
Samuel Drapeau
Dewen Xiong

Efficient Exposure Frontiers

Dilip Madan

University of Maryland, United States of America

Abstract:

Risk is described by the instantaneous exposure to changes in valuations induced by the arrival rate of economic shocks. The arrival rate measure is typically not a probability measure and often the aggregate arrival rate across all shocks is infinite. Risk management and portfolio theory are consequently recast as managing this exposure risk. There is no risk free exposure with all fixed income securities subject to the risks of instantaneous changes in their valuations. The reference return in the economy is that of a zero risk gradient return, typically estimated as negative. Required returns on assets with low risk gradients are then negative. It is also observed that required returns are robust to positions on the efficient frontier as well the construction of the frontier itself. Both equity and fixed income security frontiers are constructed as illustrations of efficient risk positions.

Author:
Dilip Madan

Intra-Horizon Expected Shortfall and Risk Structure in Models of Jumps

Ludovic Mathys

University of Zurich, Switzerland

Abstract:

The present article deals with intra-horizon risk in models of jumps. Our general understanding of intra-horizon risk is similar to the approach taken by Bakshi and Panayotov (2010). In particular, we believe that quantifying market risk by strictly relying on point-in-time measures cannot be deemed a satisfactory approach in general. Instead, we argue that complementing this approach by studying measures of risk that capture the magnitude of losses potentially incurred over the full length of a trading horizon is necessary when dealing with (m)any financial positions. To address this issue, we propose an intra-horizon analogue to the expected shortfall for general profit-and-loss processes and discuss some of its properties. Our intra-horizon expected shortfall is well-defined for (m)any popular classes of Lévy processes encountered when modeling market dynamics and constitutes a coherent measure of risk, as introduce in Cheridito et al. (2004). On the computational side, we provide a simple method to derive the intra-horizon expected shortfall inherent to popular Lévy dynamics. Our general technique relies on results for maturity-randomized first-passage probabilities and allows for a derivation of diffusion and jump risk contributions. These theoretical results are finally discussed in an empirical analysis, where Lévy models are calibrated to data and our intra-horizon expected shortfall is compared to other measures of risk.

Authors:
Ludovic Mathys
Walter Farkas
Nikola Vasiljevic

Off-Shore Fears and On-Shore Risk: Exchange-Rate Pressures and Banking Contagion in China

Paul McNelis

Fordham University, United States of America

Abstract:

This paper assesses the effects of global uncertainty measures transmitted, through signals from the off-shore Hong Kong spot market for the Chinese currency, listed as CNH, on the volatility of share prices of Chinese banks and the overall risks of Chinese banking stability.

Authors:
Paul McNelis
Jennifer Lai

Hedging volume risks from the infeed of renewable energies

Gernot Mueller

University of Augsburg, Germany

Abstract:

We first have a look at the German energy market where (as on many other energy markets) the share of renewable energies is growing fast. We briefly summarize some models for electricity prices, e.g. the model developed in Benth et al. (2014) and its extension in Buchmann and Mueller (2019). Since the renewable energies play a key role in the price process we propose a model for solar power infeed and develop a future which can be used to hedge volume risks. All models are applied to data from the European Energy Exchange EEX.

Authors:
Gernot Mueller
Daniel Lingohr

Neural Network based Approximation Algorithm for Semilinear Parabolic PDEs with Application to Pricing

Ariel Neufeld

Nanyang Technological University, Singapore

Abstract:

In this talk we present a deep learning based algorithm to approximately solve high-dimensional semilinear parabolic PDEs efficiently, which typically occur when pricing financial derivatives. The idea is to reformulate the PDE under consideration as a stochastic learning problem involving deep artificial neural network approximations for the solution of the PDE. Moreover, we discuss first convergence results of stochastic gradient descent type optimization algorithms, which are fundamental tools in machine learning applications.

Authors:
Ariel Neufeld
Arnulf Jentzen
Patrick Cheridito
Sebastian Becker
Christian Beck

Numerical methods for time-inconsistent stochastic control problems

Jiang Yu Nguwi

Nanyang Technological University, Singapore

Abstract:

In this paper, we develop numerical methods to solve time-inconsistent stochastic control problems. The numerical methods are mainly based on the Markov chain approximation of diffusion process. Then, the convergence of the objective function is proven in the sense of weak convergence. However, contrary to the classical control theory, the "optimal" control is defined via game-theoretic framework as equilibrium control in the time-inconsistent control theory. Using the technique from Pontryagin's maximum principle, we prove that the limit point of the sequence of the equilibrium control for the approximating Markov chain is indeed an equilibrium control for the diffusion process. Finally, we use continuous-time mean-variance portfolio selection problem to compare our results with the results from the existing literature. Then, we utilize our numerical methods to solve a time-inconsistent problem where no analytical solution is known.

Author:
Jiang Yu Nguwi

Forecasting commodity markets volatility: HAR or Rough?

Christina Nikitopoulos Sklibosios

University of Technology Sydney, Australia

Abstract:

Commodity is one of the most volatile markets and forecasting its volatility is an issue of paramount importance. Based on a high-frequency intra-day futures price dataset of 22 commodities and by employing the fractional stochastic volatility and the HAR-RV models, we confirm that the volatility of commodity markets features long memory and volatility components over different horizons are economically and statistically significant. High volatility persistence is evident across all commodities, with weekly volatility dominating in the energy markets and monthly volatility leading the other commodity markets. Fractional stochastic volatility models have a marginal advantage in monthly forecasts, while HAR-RV models consistently outperform in short horizons for most commodities.

Authors:
Christina Nikitopoulos Sklibosios
Mesias Alfeus

Strategic Liquidity Provision in High Frequency Trading

Katsumasa Nishide

Hitotsubashi University, Japan

Abstract:

We construct a Kyle-type market model in which fast and slow traders are present. We will show with numerical calculations that a fast trader who has an advantage in trade frequency plays a role as a liquidity provider in the sense that he takes the opposite position against a slow trader if the difference in frequency is significant. Our results seem generally consistent with empirical results reported by previous studies.

Authors:
Takaki Hayashi
Katsumasa Nishide

Robust Finance: a Data-driven Paradigm

Jan Obloj

University of Oxford, United Kingdom

Abstract:

How do we quantify the impact of making assumptions? How do we value information (data)? How do we capture the interplay between risk (described by a familiar model) and uncertainty (about the model itself)? In this talk I introduce the robust paradigm which strives to answer such questions. The framework is designed to interpolate between model-independent and model-specific settings and to allow to address and quantify the model risk. I explain briefly the theoretical underpinnings and how classical fundamental notions and theorems in quantitative finance extend to the robust setting. I then focus on simple proof-of-concept examples which showcase methodologies and possible applications. First, I use vanilla option prices, together with agent-prescribed bounds on key market characteristics, to drive the interval of no-arbitrage prices and the associated hedging strategies. The setting can be seen as a constrained variant of the classical optimal transportation problem and comes with a natural pricing-hedging duality. I discuss numerical methods based on LP methods and on a deep NN implementation. Second, I use of time series of returns to consider dynamic robust risk estimation. I explain how to construct non-parametric statistical estimators of key quantities (e.g., superhedging prices, 10-days V@R). Using these juxtaposed with option prices offers new information signals for change-of-regime detection.

Authors:
Jan Obloj
M. Burzoni
S. Eckstein
M. Frittelli
G. Guo
Z. Hou
T. Lim
M. Maggis
J. Wiesel

The Natural Evolution of a Stock Index

Eckhard Platen

University of Technology Sydney, Australia

Abstract:

A parsimonious model for the long-term dynamics of a well-diversified total return stock index, the S&P500, will be derived. The index is modeled as growth optimal portfolio. Its real value evolves, in some market time, as the product of a scaled squared Bessel process of dimension four with an exponential function of time. The derivative of market time turns out to be a linear function of the squared derivative of a moving average of a proxy for the single driving Brownian motion. The model explains accurately the long-term index dynamics for monthly and daily S&P500 observations and allows the extraction of the Brownian motion path. It is highly tractable and permits almost exact simulation. The resulting model volatility is rough for natural reasons.

Authors:
Eckhard Platen
Renata Rendek

Bayesian inference in GARCH(1,1) Model for Cryptocurrency

Wantanee Poonvoralak

Sasin At Chulalongkorn University, Thailand

Abstract:

The cryptocurrency financial market is known to be one of the most popular and volatile financial market in recent years. It is different from others financial markets due to that fact it can verifies transactions through its peer to peer network instead of using a trusted central party. Hence, numbers of GARCH models using statistical inferences have been used to examine the volatility effects of this currency. We collected the most recent cryptocurrency with time period from 28th April 2013 to 21st March 2019 from the top 2 as listed on the 21st March 2019, they are the Bitcoin (BTC) and Ethereum (ETH) with highest market capitalization of $71,048,680,219 and $14,548,360,669 respectively. We start by appling the simple univariate GARCH(1,1) and Student t-GARCH(1,1) models using statistical inferences to see whether the cryptocurrency can be treated as the other financial currenceise such as the Foreign Exchange (FX) series. We then propose the Bayesian inference in GARCH (1,1) model. We aim to provide empirical results to help the financial engineer, statisticians, and mostly BASEL committees to make more informed decisions about modelling in cryptocurrency and to whether it should be uses as part of the regulatory market risk management.

Author:
Wantanee Poonvoralak

Minimum Target-Range-based Risk Portfolios

Chi Seng Pun

Nanyang Technological University, Singapore

Abstract:

In this talk, I will introduce a new class of deviation risk measure and the corresponding risk-minimizing portfolio optimization problem. Instead of measuring the expected deviation of a daily return from a single target value, we propose to measure its deviation from a range of values centered on the single target value. By relaxing the definition of deviation, the proposed risk measure is robust to the variation of data input and thus the resulting risk-minimizing portfolio suffers less turnover rate and is resilient to outliers. To construct a practical portfolio, we propose to impose an ℓ_2-norm constraint on the portfolio weights to stabilize the portfolio's out-of-sample performance. We show that for some special cases of our proposed risk measure, we can recast the corresponding portfolio optimization as a support vector regression problem, which can be effectively computed even in high dimensions. Moreover, we present some theoretical results on the robustness of our minimum target-range-based risk portfolios. Simulation and empirical studies are conducted to examine the out-of-sample performance of the proposed portfolios.

Authors:
Chi Seng Pun
Lei Wang

Score Test for Marks in Hawkes Processes

Kylie-Anne Richards

University of Technology Sydney, Australia

Abstract:

A score statistic for detecting the impact of marks in a linear Hawkes self-exciting point process is proposed, with its asymptotic properties, finite sample performance, power properties using simulation and application to real data presented. A major advantage of the proposed inference procedure is the Hawkes process can be fit under the null hypothesis that marks do not impact the intensity process. Hence, for a given record of a point process, the intensity process is estimated once only and then assessed against any number of potential marks without refitting the joint likelihood each time. Marks can be multivariate as well as serially dependent. The score function for any given set of marks is easily constructed as the covariance of functions of future intensities fit to the unmarked process with functions of the marks under assessment. The asymptotic distribution of the score statistic is chi-squared distribution, with degrees of freedom equal to the number of parameters required to specify the boost function. Model based, or non-parametric estimation of required features of the marks marginal moments and serial dependence can be used. The use of sample moments of the marks in the test statistic construction do not impact size and power properties.

Author:
Kylie-Anne Richards

Valuation Framework and Analysis of Home Equity Release Products in Continuous Time

Michelle Royters

University of New South Wales, Australia

Abstract:

This paper develops a continuous-time valuation framework for home-equity release products in Australia. The products considered include reverse mortgages and home reversion contracts. A bulk of valuation frameworks developed to date have been in discrete-time utilising econometric methods which are product specific making it difficult to compare products and devise hedging strategies. A continuous-time valuation framework allows for easy comparison of various home-equity release products while at the same time facilitating the design of dynamic hedging strategies which can be used as tools for mitigating various risk sources impacting these products. An economic scenario generator (ESG) is used to simulate underlying stochastic variables for pricing, namely; interest rates, house prices and mortality rates. Modelling all three variables in continuous time assists with combining the variables in the framework for pricing and assists in deriving closed-form or semi-closed form pricing formulae. The ESG is used to facilitate the computations of prices for embedded financial guarantees associated with the products, evaluate hedging programs and perform sensitivity and scenario analysis to assist in measuring and assessing capital requirements. The closed-form and semi-closed form solutions for the various equity release products aid in computational efficiency thus reducing the computational costs associated with alternative simulation-based approaches. The paper also analysis the demand for home-equity products under the continuous-time life-cycle framework where the utility function includes habit formation. This facilitates the analysis of how the living standards of Australians during their working life will influence their demand for such products in retirement.

Authors:
Michelle Royters
Jonathan Ziveyi
Pengyu Wei

Neural Network Based Discrete Hedging

Johannes Ruf

London School of Economics, United Kingdom

Abstract:

We design a neural network, named HedgeNet, that directly outputs a hedging strategy given relevant information as input. This network is trained to minimize the hedging error, instead of the usual difference between the market price and the predicted price. By first assessing its performance on out-of-sample simulation data, the network is able to achieve an error close to the Black-Scholes benchmark and to find similar strategy. Training a HedgeNet on real S&P 500 options daily trading data, the network is able to reduce the mean squared hedging error by 9% compared to the Black-Scholes hedging evaluated at the implied volatility. We also examine the best and the worst scenario for the network, in terms of an error histogram and a strategy plot. We therefore validate the limited success of the neural network approach to the discrete hedging task.

Authors:
Johannes Ruf
Weiguan Wang

On Arbitrage under Portfolio Constraints in Discrete-time Models

Wolfgang Runggaldier

University of Padova, Italy

Abstract:

There has been some interest in finding financial models that allow for weaker no-arbitrage concepts than the classical no-free lunch with vanishing risk, but still allow to solve the classical problems of pricing and hedging as well as portfolio optimization. Such models should thus allow for classical arbitrage, but this arbitrage should not be too large, i.e. not arbitrarily scalable. Most studies concern continuous-time models. Here we show how discrete-time models may allow for further insight as soon as one introduces restrictions on the allowable investment strategies. In the context of some simple examples we investigate the interplay between trading restrictions and the support as well as the dependence structure of the driving random quantities.

Authors:
Wolfgang Runggaldier
Claudio Fontana

Implicit quantiles and implicit expectiles

Carlo Sala

ESADE Business School, Spain

Abstract:

We compare option implied quantiles and option implied expectiles on a 5-year dataset of prices of weekly S&P500 options. We compute these quantities by means of a fully non-parametric methodology, following Barone-Adesi et al (2019) and Bellini et al. (2018). We study the relative position of inverse quantile and expectile curves, and compute implicit Interquantile and Interexpectile Differences, that are compared with a weekly VIX-like index. Finally, we investigate the forecasting power of these quantities either on future log-returns or on future realized variances.

Authors:
Carlo Sala
Fabio Bellini
Edit Rroji

Optimal Exercise Decisions under Inattention

Mick Schaefer

Universität Hamburg, Germany

Abstract:

In decision problems, frictions as well as constraints play an increasingly important role. Especially, optimal timing problems can be affected by potentially 'non-rational' behavior of the decision maker. A relevant problem of this kind is the valuation of real options. Limited cognitive resources and external restrictions may result in a suboptimal exercise timing. The term inattention can summarize such frictions and constraints. In this paper, we address this issue by proposing a Markovian model to value American-style contracts of agents with limited attention. Exercise decisions are not admissible continuously but at random intervention times only. An optimal stopping problem provides the contract value.
It is converted to optimal control giving a novel access to an adapted least squares Monte-Carlo method that overcomes issues in treating multi-dimensional settings.
As example for a real option, we determine the value of an Executive Stock Option in a jump diffusion setting and find that limited attention increases the company's costs of employing it as incentive pay.

Authors:
Mick Schaefer
Alexander Szimayer

Term Rates, Multicurve Term Structures and Overnight Rate Benchmarks: a Roll-Over Risk Approach

Erik Schlögl

University of Technology Sydney, Australia

Abstract:

Modelling the risk that a financial institution may not be able to roll over short-term borrowing at the market reference rate, we derive the dynamics of (interbank) reference term rates (e.g., LIBOR) and their spread vis-à-vis benchmarks based on overnight reference rates, e.g., rates implied by overnight index swaps (OIS). This is particularly relevant to the current debate around the transition of replacing the former by the latter. The model endogenously generates different interest rate term structures for each tenor, that is, for each different choice of the length of the interest rate accrual period, be it overnight (e.g., OIS), three–month LIBOR, six–month LIBOR, etc.

Authors:
Alex Backwell
Andrea Macrina
Erik Schlögl
David Skovmand

Green Assets and Brown Threats: How Can the Associated Risks Be Modelled?

Michael Schmutz

University of Bern and Swiss Financial Market Supervisory Authority (FINMA), Switzerland

Abstract:

The interest rate environment, now low for some time, poses serious long-term challenges to the insurance sector, resulting in changes being made to the product design and to investment strategies. This ongoing process is compounded by the next set of long-term challenges stemming from climate change and climate policy change, increasingly the subject of debate among the financial industry and regulators. The most obvious associated risks are physical risks. In the case of investment portfolios transition risks may arise when moving towards a greener economy, e.g. because it will be more expensive for some sectors of the economy to do business. This factor may trigger substantial shifts in asset values. These risks are related to serious modelling challenges. Other modelling challenges arise from investments in green infrastructure. A number of these modelling challenges are presented, and some initial attempts to address them are discussed.

Author:
Michael Schmutz

Arbitrage Theory Reloaded

Martin Schweizer

ETH Zürich, Switzerland

Abstract:

We consider a general setup for a financial market and ask for a natural definition of absence of arbitrage (AOA). Our new AOA concept ensures semimartingale properties, has an economically appealing dual characterisation, and remains invariant under changes of numeraire.

Authors:
Martin Schweizer
Daniel Balint

Financial Market Crash and Phase Transition: Through Model-Free Framework with Machine Learning

Byoung Ki Seo

UNIST, Korea

Abstract:

Recent studies have attempted to understand market crash using the concept of phase transition in statistical physics. This study finds certain behavior in the financial market such as the critical phenomena that occur during phase transition. We apply model-free framework using convolutional neural network methods instead of the complex mathematical models studied previously. The results show that the financial market crash has a similar behavior to the phase transition of particles. Furthermore, we find that the similar behavior between financial market crash and phase transition gives better understanding on the market crash and detecting it.

Authors:
Byoung Ki Seo
Hyeonung Jang
Yongseok Jho

Stackelberg Mutual Fund Management Game

Yang Shen

University of New South Wales, Australia

Abstract:

This paper investigates a Stackelberg game between a mutual fund manager (he) and an individual investor (she), where the mutual fund manager manages an active fund and the investor can only allocate her wealth among a risk-free asset, the active mutual fund, and a passive index fund. The passive index fund is composed of a fixed portfolio of all the securities in the market. Assume that the mutual fund manager has the stock selection and market timing abilities, and he only invests the assets under management to the risk-free asset and a subset of profitable risky assets in the market. The investor aims at maximizing the expected constant relative risk aversion (CRRA) utility of her terminal wealth, while the active mutual fund manager's objective is to maximize the expected value of the accumulative discounted management fees from the investor. By applying the dynamic programming principle approach, we solve the associated Hamilton-Jacobi-Bellman (HJB) equations and get the closed-form expressions of Stackelberg equilibrium strategies for both the investor and the mutual fund manager. Finally, we provide some numerical examples to analyze the effects of key parameters on the equilibrium strategies.

Author:
Yang Shen

Optimal Execution Strategy with Generalized Price Impact in a Continuous-Time Setting

Makoto Shimoshimizu

Osaka University, Japan

Abstract:

In this paper, we analyze a continuous-time analog of the optimal trade execution problem with generalized price impacts, which was recently discussed in Ohnishi and Shimoshimizu (2019) for a discrete-time setting. The market model considers transient price impacts of random trade execution volumes posed by small traders as well as a large trader.

Our problem is formulated as a stochastic continuous control problem over a finite horizon of maximizing the expected utility from the final wealth of the large trader with Constant Absolute Risk Aversion (CARA) von Neumann-Morgenstern (vN-M) utility function. By examining the Hamilton-Jacobi-Bellman (HJB) equation, we characterize the optimal value function and optimal trade execution strategy, and conclude that the trade execution strategy is a time-dependent affine function of two state variables: the remained trade execution volume of the large trader and, so called, the residual effects of past price impacts caused by both of the large trader and other small traders. Further, the time-dependent coefficients could be derived from a solution of a system of Ordinary Differential Equations (ODEs) with terminal conditions, which is numerically tractable.

Authors:
Makoto Shimoshimizu
Masaaki Fukasawa
Masamitsu Ohnishi

American option pricing and filtering with a hidden regime-switching jump diffusion

Tak Kuen Siu

Macquarie University, Australia

Abstract:

The valuation of an American-style contingent claim is discussed in a hidden Markov regime-switching jump-diffusion market, where the evolution of a hidden economic state process over time is described by a continuous-time, finite-state, hidden Markov chain. A two-stage procedure is introduced to discuss the American option valuation problem. Firstly, filtering theory is employed to transform the market with hidden quantities into a filtered market with complete observations. Then the valuation problem is done in the filtered market. A probabilistic approach to the American option pricing is considered, where a decomposition formula for the price of an American put option is given as the sum of its European counterpart and an early exercise premium. A quadratic approximation to the American put price and a semi-analytical solution to a perpetual American put price are also obtained.

Authors:
Tak Kuen Siu
Robert Elliott

A Fresh Look on the Linkage of Model Uncertainty and Validation

Gerhard Stahl

HDI, Germany

Abstract:

The scene is set by summarizing important criteria for validation. The focus will be on the current state of affairs, how model uncertainties should be treated and managed. We deep dive into practical examples about model uncertainties related to the Monte-Carlo-sample size, how regulators treat model uncertainty for life models and how model uncertainties may be treated within operational risk. Furthermore, a methodological focus is on the application related to the uncertainties stemming from the specification of a particular copula function. Last but not least, it will be shown that also the standard formula of Solvency II is prone to model uncertainty.

Author:
Gerhard Stahl

Pricing VIX Derivatives with Infinite-Activity Jumps

Shu Su

Auckland University of Technology, New Zealand

Abstract:

In this paper, we investigate a two-factor VIX model with infinite-activity jumps, which is more realistic to reduce the errors in pricing VIX derivatives, comparing with Mencía and Sentana (2013). Our two-factor model features infinite-activity pure jump Lévy processes, central tendency, and stochastic volatility. We specify infinite-activity pure jump Lévy processes as two cases: the variance gamma (VG) process and the normal inverse Gaussian (NIG) process. We apply the combined estimation approach of unscented Kalman filter (UKF) and quasi-maximum log-likelihood estimation (QMLE) to our model and compare extensive performance among types of two-factor models with different jump processes. We find empirical evidence that the model with infinite-activity jumps superior to the models with finite-activity jumps, particularly in pricing VIX options. As a result, infinite-activity jumps should not be ignored in terms of pricing VIX derivatives.

Author:
Shu Su

A univariate approach to pricing spread options with stochastic volatility

Lenny Suardi

University of New South Wales, Australia

Abstract:

This paper proposes a method of pricing spread options with a stochastic volatility component using a univariate approach, that addresses the possibility of a negative value for the underlying assets (i.e., the spread). We derive the characteristic function and the option price that accommodates this possibility based on the Heston model. For the empirical analysis, we use heating oil crack spread options data from the New York Mercantile Exchange (NYMEX). We define two groups of time to maturity: 60 days or less are classed as short term options and more than 60 days, as long term options. For each group of time to maturity, we try to minimize the sum of squared errors between our proposed pricing formula and the market data. We also calibrate the market data based on the basic Heston model. Our calibration process shows that our pricing results perform quite well with a slightly higher sum of squared error compared to the basic Heston model in both groups of expiry.

Authors:
Lenny Suardi
David Colwell
Ramaprasad Bhar

Liquidation Costs in CCP: Equilibrium vs Auction

Mekonnen Tadese

Shanghai Jiao Tong University, China

Abstract:

One of the mandates of the CCP is to reduce the potential risk arising from the defaults of clearing members. In the case of default, the CCP should liquidate the defaulter's portfolio either on the exchange or by transferring the mandate to other surviving members, through an auction for instance. In this work, we compare the two approaches, liquidation on the market versus auction. In the case of a direct liquidation on the market, we use a Radner equilibrium to derive an equilibrium price for financial securities before and after some member makes default. We analyse the loses of CCP by comparing the two different equilibria both in the absence and presence of collateral. We then compare the resulting losses with respect to an auction approach and the stability of the system.

Authors:
Mekonnen Tadese
Samuel Drapeau
Stéphane Crépey
Liming Yin

NUPBR and Curvature

Hideyuki Takada

Toho University, Japan

Abstract:

We present a new concept called Geometric Arbitrage Theory (GAT) to construct fundamental theory to describe no-arbitrage condition in terms of geometric quantity. In GAT, arbitrage is seen as curvature of a principal fibre bundle representing the market which defines the quantity of arbitrage associated to it. For a generic market dynamics given by a multidimensional Ito process we specify and prove the equivalence between (NFLVR) and expected utility maximization. As a by-product we provide a geometric characterization of the (NUPBR) condition given by the zero curvature (ZC) condition.

Authors:
Hideyuki Takada
Simone Farinelli

Approximations to SABR-type models

Kohta Takehra

Tokyo Metropolitan University, Japan

Abstract:

SABR model is one of most successful models in finance, in spite of its shortcomings, both for practitioners and academic researchers. Recently, to overcome these well-known shortcomings or to adjust current financial market, many "modified" versions of the original SABR models, such as λ-SABR model, ZABR model or the shifted SABR model, has been proposed. However, for most of these models, while some have approximation formulae for themselves, relationship between/among them and the original one is unclear. On the other hand, since the original model is still popular in the market and sometimes even the quotes are made with that model, these relationships are quite important in practice. In this work, we try to approximate those "SABR-family" models around the original SABR, in order to make interpretation of the approximations clear. In the procedures, we apply an asymptotic expansion approach and Fourier series expansion technique to evaluate the approximation terms concretely. The result helps us to interpret "distances" between the modified and original SABR models.

Author:
Kohta Takehra

Mean-Field Games of Optimal Stopping and Two Industry Dynamics Problems

Peter Tankov

ENSAE Paris, France

Abstract:

In this talk, we shall first discuss the mean-field games of optimal stopping of the "war of attrition" type, introduced in [1] and present the "relaxed stopping time" approach to these games, developed in [2]. We shall then describe an application of these games to two industry dynamics problems: the first one concerns the sharing of a water resource among several producers in a water-intensive industry, whose aim is to find the optimal time of switching to a new, less water-intensive technology. The second one concerns the long-term dynamics of the electricity industry, where the renewable producers look for the optimal moment to enter the market and the conventional producers look for the optimal moment to exit. The interaction between the two types of producers takes place through the market price determined by an exogenous demand curve and the merit order supply curve, and our model allows to determine the price, the renewable penetration and the CO2 emissions level in an endogenous fashion.

[1] Bertucci, C. (2018). Optimal stopping in mean field games, an obstacle problem approach. J. Math. Pures Appl., 120, 165-194.

[2] Bouveret, G., Dumitrescu, R., & Tankov, P. (2018). Mean-field games of optimal stopping: a relaxed solution approach. arXiv:1812.06196.

Authors:
Peter Tankov
R. Aïd
G. Bouveret
R. Dumitrescu

On Detecting Spoofing Strategies in High Frequency Trading

Xuan Tao

Shanghai Jiao Tong University, China

Abstract:

The development of high frequency and algorithmic trading allowed to reduce considerably the bid ask spread by increasing liquidity in limit order books. Beyond the problem of optimal placement of market and limit orders, the possibility to cancel orders for free leaves room for price manipulation, in particular for spoofing strategies. It is an empirical evidence that volume imbalance on both side of the limit order book reflecting offer and demand has an impact on subsequent price movements. Spoofers use this effect to artificially modify the imbalance by posting limit orders and then execute market orders at subsequent better prices while canceling at a high speed their previous limit orders. In this work we set up a model to determine where a spoofer would place its limit orders to maximize its gains as a function of the imbalance impact on the price movement. We study the solution of this non local optimization problem as a function of the imbalance. With this at hand, we calibrate on real data from TMX the imbalance as a function of its depth and recent history to a mixture binomial distribution of the resulting price movement. Based on this calibration and results, we then provide some methods as how to detect within the limit order book eventual spoofing behavior while the real trader ID is (partially) unknown.

Authors:
Xuan Tao
Lan Ling
Andrew Day
Samuel Drapeau

The fundamental theorem of asset pricing for self-financing portfolios

Stefan Tappe

Albert Ludwig University of Freiburg, Germany

Abstract:

The fundamental theorem of asset pricing (Delbaen and Schachermayer 1994, *Math. Ann.* 300(3), 463-520) tells us that the existence of an equivalent local martingale measure (ELMM) is essentially equivalent to the absence of arbitrage. More precisely, the cone of admissible wealth processes satisfies "no free lunch with vanishing risk" (NFLVR) if and only if an ELMM exists.

A related version of the fundamental theorem, which uses the concept "no unbounded profit with bounded risk" (NUPBR), states that the family of non-negative wealth processes satisfies NUPBR if and only if an equivalent local martingale deflator (ELMD) for the cone of non-negative wealth processes exists. We refer to (Takaoka and Schweizer 2014, *Finance Stoch.* 18(2), 393-405) for this result, and also to (Kardaras 2012, *Finance Stoch.* 16(4), 651-667) for an earlier one-dimensional version.

After reviewing all the required no-arbitrage concepts, the goal of this talk is to present a version of the fundamental theorem of asset pricing which concerns the smaller cone of non-negative self-financing strategies. Our main result says that the cone of non-negative self-financing strategies (corresponding to the market, which might be complemented by a savings account) satisfies NUPBR if and only if there exists an ELMD for the market which is a (multiplicative) special semimartingale. In this case, the mentioned savings account appears in the multiplicative decomposition of the deflator.

Authors:
Stefan Tappe
Eckhard Platen

Real Options, Risk Aversion and Markets

Bart Taub

University of Glasgow, United Kingdom

Abstract:

We analyze the effect of risk aversion and the presence of financial markets on the optimal exercise of real options. Using value matching and smooth pasting conditions, we generalize results of Sodal and Shackleton (2005) for the one-dimensional complete market case and extend their framework to a multi-dimensional incomplete market setup, identifying the minimal martingale measure as the appropriate reference measure, which is consistent with the Capital Asset Pricing Model (CAPM). Further, we look at so called myopic look-ahead rules within the context of financial markets and of the CAPM in particular and provide a characterization of the optimal exercise rule in terms of the capital market line of the CAPM. Finally we demonstrate via numerical examples that it is crucial to take these aspects of financial markets into account when exercising real options, as otherwise large financial losses can occur.

Authors:
Bart Taub
Christian Ewald

Random Signature Methods in Finance

Josef Teichmann

ETH Zürich, Switzerland

Abstract:

In abstract terms signature methods allow to write non-linear adapted functionals on path spaces, like solutions of stochastic differential equations or estimators, as linear functionals on signature space. Random signatures are low dimensional replicas of signature, which also make a bridge to the world of reservoir computing. We present several (machine learning) techniques based on random versions of signature in Finance: learning unknown stochastic dynamics, classification of market signals, prediction of market factors and portfolio decisions based on it.

Author:
Josef Teichmann

Extension of portfolio optimization problems to non-Gaussian framework

Tomas Tichy

Technical University Ostrava, Czech Republic

Abstract:

The standard portfolio optimization problem is based on Gaussian framework and assumes the parameters of mean and variance accompanied with linear measure of dependency. Such strong simplification can, however, lead to suboptimal recommendations. Outside the Gaussian framework, for example, Ortobelli and Tichy (2015) proposed usage of alternative dependency / association measures and/or deviation measures, which could lead to significant improvement of the performance. On the other hand, Torri et al. (2017) used the tlasso estimator (Finegold and Drton, 2011) to estimate the covariance matrix of asset returns under a multivariate t-Student distribution, an assumption in line with the presence of fat tails, and obtained quite good out-of-sample performances. We underline that, despite the focus in the literature is on the mean-variance framework, the usage of graphical models for the estimation of sparse precision matrices (and in general the inverse of scatter parameters of multivariate distributions) can be used in the context of any portfolio optimization that requires such parameters. In the current research we implement portfolio strategies based on non-Gaussian and even non-t-Student markets, estimating scatter parameters using graphical and hybrid models and evaluate their performance using US stock market data.

Author:
Tomas Tichy

Discrete-time multi-period portfolio optimization under correlation uncertainty

Man Yiu Tsang

The Chinese University of Hong Kong, China

Abstract:

The use of distributional ambiguous models for portfolio optimization is of paramount interest in the literature as this would protect investors from suffering from enormous losses when compared with the non-robust counterparts. Two classes of uncertainty set construction prevail, namely distance-type constraints and moment constraints. We consider the latter case with ambiguity on asset correlations which could be quantified via corresponding confidence intervals based on historical data. We employ a class of coherent risk measures known as spectral risk measure, including the popular measure conditional value-at-risk (CVaR) as a particular case, as our objective function. Specific choices of spectral risk measure permit flexibility for capturing risk preferences of different investors. For the multi-period optimization problem, the prominent stochastic dual dynamic programming (SDDP) algorithm is adapted with some modifications. In particular, our new formulation accounts for the unknown worst-case distribution in each iteration. We verify the convergence property of this algorithm under the setting of finite scenarios. It is expected that the optimal solution favours a certain degree of anti-diversification due to dependence ambiguity, which coincides with recent findings in ambiguous portfolio optimization models.

Authors:
Man Yiu Tsang
Hoi Ying Wong
Tony Sit

Dynamic Consumption and Portfolio Choice under Prospect Theory

Servaas van Bilsen

University of Amsterdam, Netherlands

Abstract:

This paper explicitly derives the optimal dynamic consumption and portfolio choice of an individual with prospect theory preferences. The individual is loss averse, endogenously updates his reference level over time, and distorts probabilities. We show that the optimal consumption strategy is fairly insensitive to economic shocks. In particular, in case the individual sufficiently overweights unlikely unfavorable events, our model generates an endogenous floor on consumption. As a result, an individual with prospect theory preferences typically implements a (very) conservative portfolio strategy. Furthermore, we discuss implications of our results for the design of investment-linked annuity products.

Authors:
Servaas van Bilsen
Roger Laeven

The discontinuous turn in financial modelling: an historical perspective

Christian Walter

Kedge Business School, France

Abstract:

Heterodox economics has stressed the extreme importance of financial crises to understand the nature of finance. The fundamental role of financial crises has been emphasized by Benoît Mandelbrot. Heterodox modelling challenged a very important representation of the dominant paradigm of neoclassical finance, the continuity of stock market fluctuations.

I propose to focus on one aspect of this story that seems to me crucial: the "leptokurtic crisis" and its consequences in challenging the dominant paradigm of neoclassical finance. Leptokurtic means that the empirical distributions are more peaked than the Gaussian bell, with the result that extreme events like financial crises are more likely than under a Gaussian distribution. The Mandelbrot solution to solve the leptokurtic puzzle with fractals exploded the field of neoclassical modelling and launched violent controversies dividing the academic community into two opposite camps: pro and cons the discontinuity. The crisis started the quest for refinements of the Brownian representation that is for new models that could solve the leptokurtic problem with saving the "mild randomness" assumption of Brownian motion. Two distinct research programmes were currently established in financial modelling to tackle the leptokurtic issue: the first Mandelbrot programme based on stable Lévy processes and the alternative non-stable Lévy processes approach based on the Merton's view. I name these two programmes: the radical programme (RP) and the pragmatic programme (PP). During more than thirty years, these two programmes were incompatible in the sense that Mandelbrot and its opponents speak from "incommensurable" viewpoints in the Kuhn's words.

After presenting the main hinges of these debates, I will argue that, for solving the leptokurtic problem, Mandelbrot has introduced what I name the "discontinuous turn" in financial modelling: a discontinuity principle which clashes with the empirical grounding of neoclassical finance.

Author:
Christian Walter

Robust reinsurance contracts with mean-variance criteria in a three-factor interest rate model

Ning Wang

Macquarie University, Australia

Abstract:

A class of reinsurance contract problems is studied under a continuous-time principal-agent framework with mean-variance criteria, where a reinsurer and an insurer play the roles of the principal and the agent, respectively. The insurer and the reinsurer can manage risk through investing in a financial market which is supposed to consist of a risk-free asset, a risky asset and a zero-coupon bond. A key feature of our model is that a three-factor model is adopted to provide a flexible way to model the term structure of the interest rate. Both the insurer and the reinsurer concern about model uncertainty and intend to seek robust reinsurance contract and investment strategies by maximizing their respective mean-variance cost functionals. To articulate the time-inconsistency issue under the mean-variance optimization criteria, we formulate the optimization procedure of each decision maker as a non-cooperate game and discuss it using an extended Hamilton-Jacobi-Bellman (HJB) equation following the literature about the time-consistent control. Explicit expression for the robust reinsurance contract and semi-analytical expressions for the robust investment strategies and the value functions of the insurer and the reinsurer are obtained. Numerical results and their economic interpretations are discussed.

Authors:
Ning Wang
Tak Kuen Siu
Kun Fan

Systemic Portfolio Diversification

Marko Weber

National University of Singapore, Singapore

Abstract:

We study the implications of fire-sale externalities on balance sheet composition. Banks select their asset holdings to minimize expected execution costs triggered by the need to comply with regulatory leverage requirements. Our analysis highlights the fundamental trade-off between asset diversification at the level of each individual bank and systemic diversification. While sacrificing diversification benefits to reduce portfolio commonality increases the bank's idiosyncratic probability of liquidation, it also lowers the endogenous probability of a costly widespread sell-off. We show that leverage heterogeneity is socially beneficial because it amplifies banks' incentives in achieving systemic diversification. The socially optimal systemic diversification can be attained through a tax on banks' balance sheet concentration on illiquid assets.

Authors:
Marko Weber
Agostino Capponi

Sensitivity analysis of robust optimisation problems

Johannes Wiesel

University of Oxford, United Kingdom

Abstract:

In this talk we model uncertainty through neighbourhoods in Wasserstein distance within a one-period framework. We conduct a sensitivity analysis (of e.g. utility maximization) and obtain (semi-)explicit formulae, which we then compare to classical results.

Authors:
Johannes Wiesel
Jan Obloj
Samuel Drapeau
Daniel Bartl

Game theoretic valuation of deposit insurance under jump risk: From too small to survive to too big to fail

Tat Wing Wong

The Chinese University of Hong Kong, China

Abstract:

This study examines the valuation problem in deposit insurance as a game option between the deposit insurer and the insured bank with asymmetric bankruptcy costs. The asset-to-deposit ratio of the insured bank is modeled as an exponential Lévy process with a spectrally negative jump. The study examines a wide range of scenarios in which the optimal closure policies of both parties are fully characterized. Explicit solutions are derived under the exponential jump diffusion case. This model captures several important issues in banking supervision, including the too big to fail and too small to survive phenomena, bank reorganization, and regulatory forbearance.

Author:
Tat Wing Wong

Vulnerable Variance Swaps: Smooth and Rough Volatilities

Yiru Xi

The Chinese University of Hong Kong, China

Abstract:

Discrete variance swap is an important product traded over-the-counter (OTC) that provides investors direct access to volatility risk. Despite its popularity, limited research has been done about its pricing when considering the counterparty risk that arises from the issuer's possible default. In this paper, we borrow the concept of vulnerable options and consider pricing of vulnerable variance swap under stochastic volatility model. In light of the inadequacy of traditional stochastic volatility model in capturing option market dynamics, we also extend our result under rough volatility. Closed-form solutions have been obtained. The numerical study has demonstrated the significance of counterparty risk to variance swap's price.

Authors:
Yiru Xi
Hoi Ying Wong

Value-at-risk and expected shortfall of stock portfolio using skew-*t* copulas

Toshinao Yoshiba

Tokyo Metropolitan University, Japan

Abstract:

The multivariate Student-*t* copula is frequently used in financial portfolio risk management and other statistical areas when there is tail dependence in the data. It often is a good-fitting copula but can be improved on when there is tail asymmetry. We propose to use Azzalini–Capitanio (AC) and Generalized Hyperbolic (GH) skew-*t* copulas to incorporate asymmetric tail dependence of risk factors using the numerical implementation for maximum likelihood estimation proposed in Yoshiba (2018). We compare the parameters of the AC skew-*t*, GH skew-*t*, Student-*t*, Normal copulas using Akaike and Bayesian information criteria for the two groups of daily stock portfolio returns. Each group is given by the equally weighted portfolio which consists of three indices from TOPIX33 Sector Indices. The first portfolio consists of financial sectors portfolio with high correlation including banking, insurance, and securities sectors. The second consists of banking, air transportation, electricity sectors with low correlation. With validating the skewness of skew-*t* copulas both for the unfiltered returns and for the filtered returns by GARCH and EGARCH models, we investigate the behavior of the value-at-risk and expected shortfall of the two types of stock portfolio by employing several backtesting methods. The backtesting methods include the unconditional coverage test of Kupiec (1995), independence test, and the conditional coverage test of Christoffersen (1998) for value-at-risk, and the discrepancy measurement of Embrechts, Kaufmann, and Patie (2005) for expected shortfall. As the results, we show the value-at-risk with high confidence level is well captured by skew-*t* copulas especially in low correlated portfolio. We also show the discrepancy of expected shortfall is small when using skew-*t* copulas.

Author:
Toshinao Yoshiba

Stochastic Modeling and Optimization in Human-Machine Interaction Systems

Thaleia Zariphopoulou

University of Texas at Austin, United States of America

Abstract:

I will present and discuss a family of human-machine interaction models in optimal asset allocation, risk management and portfolio choice (robo-advising). Fundamental difficulties stem from the limited ability to quantify the human's risk preferences and describe their evolution, as well as the fact that the stochastic environment, in which the machine optimizes, adapts (continuously or discretely) to real-time incoming information. This creates a dynamically adaptive interplay with both asymmetric and incomplete exchange of information between the human and the machine. How and when the two parties should communicate, what performance metrics should be used, and how to solve the related non-standard real-time optimization problems are challenging questions that combine adaptive control, path-wise optimization, learning and inverse problems.

Authors:
Thaleia Zariphopoulou
Agostino Capponi
Sveinn Olafsson

Pricing and Hedging Performance of Pegged FX Markets Based on Regime Switching Model

Yunbo Zhang

Shanghai Jiao Tong University, China

Abstract:

Foreign exchange markets are the largest and most liquids in the world. Any classical model for pricing and hedging of derivatives assumes a free floating exchange rate. However, a consequent number of foreign exchanges are eventually pegged bringing some puzzling facts in terms of prices. Drapeau, Wang and Wang (2019) proposed an economically motivated particular regime-switching model to explain this puzzle and provide pricing and calibration of parameters to data. Following this work, we deepen the quantitative analysis by providing pricing and hedging formulas for this regime switching model using classical and Fourier techniques. We then derive and compare numerically the performance of different hedging strategies: Black and Scholes delta hedging, regime switching delta hedging, as well as mean variance hedging. The comparison is first performed and discussed on simulated data and then applied to the HKD-USD pegged market (daily 2014-2019). We design a recalibration procedure to fit the volatility surface, study the term structure of the parameters, and compare the different hedging strategies. The classical SABR model is used as a benchmark showing that the regime switching calibration performs better in this situation. It turns out that in terms of accuracy and computational costs the regime switching together with a Fourier method is the better approach in terms of pricing and hedging.

Authors:
Yunbo Zhang
Samuel Drapeau

A Value-Based Longevity Index for Hedging Retirement Income Portfolios

Jonathan Ziveyi

University of New South Wales, Australia

Abstract:

The availability of a longevity index that closely tracks the value of longevity-linked liabilities has the potential to significantly lower the costs and improve the efficiency of index-based longevity hedging techniques relative to standard mortality rate indices currently referenced in financial markets. This paper presents a universal value-based longevity index constructed from US economic and population data. To construct the index and examine its effectiveness in hedging retirement income portfolios, a multi-population affine term structure model for mortality evolution is adopted, along with a dynamic Nelson-Siegel model for the dynamics of interest rates. We present numerical experiments demonstrating that the proposed hedging framework generates a material reduction in basis risk relative to indices based purely on mortality rates. Beyond longevity risk, the paper notes that interest rate and inflation risks can also materially influence the value of longevity-linked liabilities. Finally, the paper bridges the literature gap between continuous and discrete-time multi-population mortality models and notes that the two modelling frameworks suggest relatively comparable hedging outcomes.

Authors:
Kevin Krahe
Michael Sherris
Andres M. Villegas
Jonathan Ziveyi

QMF 2019 Program Overview

	Tuesday 17-December	Wednesday 18-December	Thursday 19-December	Friday 20-December	
Plenary Sessions Stateroom	Platen	Eberlein	Larsson	Fouque	8:40
	Frey	Fukasawa	Cuchiero	Koo	9:20
	Barone Adesi	Lleo	Obloj	Madan	10:00
	Morning Tea				10:40
	Garvin	Zariphopoulou	Kardaras	Schmutz	11:10
	Stahl	Runggaldier	Grasselli	Schweizer	11:50
	Lunch				12:30
Stateroom	Ruf	Neufeld	Walter	Teichmann	1:40
		Liu	Taub		2:00
	Crépey	Geertsema	Lee	Schlögl	2:20
		Seo	Mueller		2:40
	Afternoon Tea				3:00
	Elliott	Nikitopoulos	Liebmann		3:30
		Suardi	Lei		3:50
	Tankov	Poonvoralak	Su		4:10
		Sala	Choi		4:30
			Garces		4:50
Room 2		Ignatieva	Bondarenko		1:40
		Yoshiba	Y. Lu		2:00
		Tichy	Ziveyi		2:20
		Awiszus	Royters		2:40
	Afternoon Tea				3:00
		Tappe	Siu		3:30
		Takada	Fergusson		3:50
		Adachi	Nguwi		4:10
		McNelis	Schaefer		4:30
			Zhang		4:50
Room 3		Kim	Bergault		1:40
		Jang	Shimoshimizu		2:00
		Wong	Nishide		2:20
		Wiesel	Tao		2:40
	Afternoon Tea				3:00
		Hanke	Richards		3:30
		Luo	Gudkov		3:50
		Tsang	Wang		4:10
		Pun	Tadese		4:30
					4:50
Room 4		Chong	Kikuchi		1:40
		van Bilsen	K. Lu		2:00
		Shen	Weber		2:20
		Kaneko	Drapeau		2:40
	Afternoon Tea				3:00
		Buchmann	Al Yahyaee		3:30
		Mathys	Xi		3:50
		Götz	Takehra		4:10
		H. Lu			4:30
		Feng			4:50