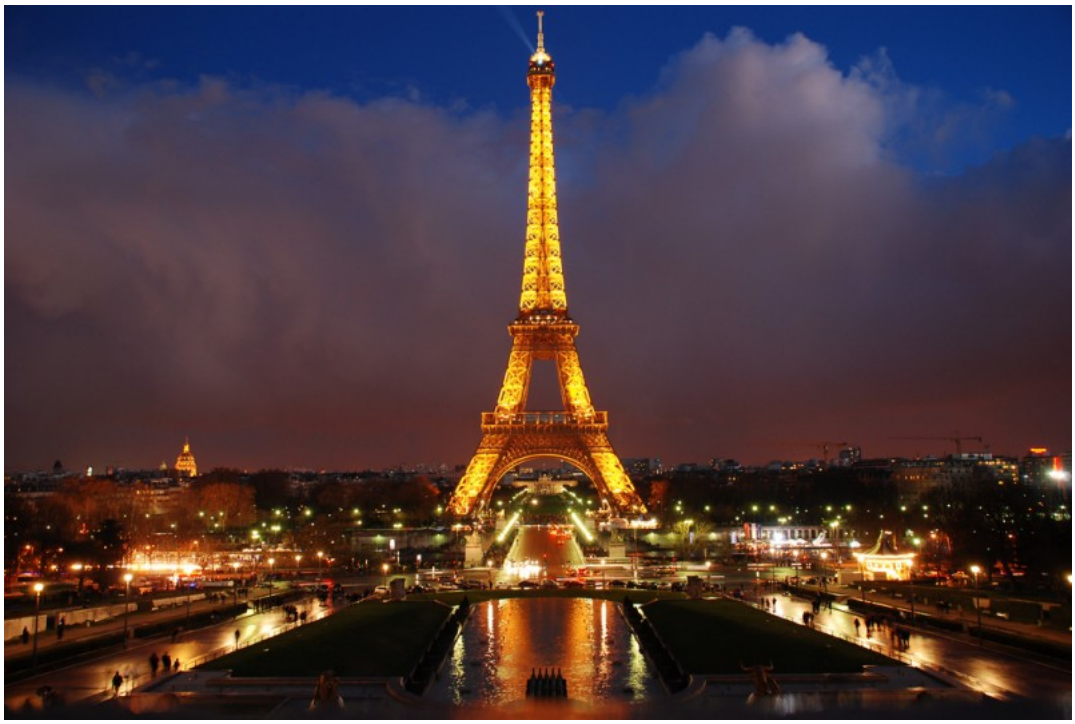
9th General AMaMeF Conference

Book of Abstracts

Paris, 11–14 June 2019



Contents

Welcome

Welcome to the 9th General AMaMeF Conference on Mathematical Finance!

AMaMeF is the acronym standing for Advanced Mathematical Methods in Finance. Under this name a research network has been funded by the ESF from 2005 to 2010 (and also by various national scientific organizations). Many European countries had representatives on the steering committee of the network, headed by Bernt Øksendal with Giulia di Nunno as co-chair. Under the auspices of AMaMeF numerous conferences, workshops and other scientific activities have been organized. Of these the annual General AMaMeF Conferences have been the biggest.

After the end of the funding period, AMaMeF continued as an unfunded European scientific network and activities are still organized under its flag, such as the General Conferences, but also the annual Winter Schools in The Netherlands and the Actuarial and Financial Mathematics Conferences in Belgium. A brief survey of AMaMeF as it is now is available on `http://amamef.impan.pl/index.html`, including a listing of the current members of its Acting Board chaired by Robert Stelzer.

The General AMaMeF Conferences are now organized in a roughly two-yearly schedule. Recent previous meetings took place in Amsterdam (June 19-23, 2017) and Lausanne (September 7-10, 2015). The program consists of plenary, invited and contributed lectures, and posters, addressing a full range of subjects in mathematical finance and its many applications.

The invited program of the present conference was constructed by a program committee consisting of: Fred Espen Benth (Oslo university), Carole Bernard (Grenoble school of Management), Bruno Bouchard (University Paris Dauphine), Soren Christensen (University of Hamburg), Christa Cuchiero (Vienna University), Paul Glasserman (Columbia University), Xin Guo (UC Berkeley), Jan Obloj (Oxford University), Gilles Pagès (Sorbonne University), Huyên Pham (Université de Paris), Robert Stelzer (Chair, Ulm University), and Miklós Rásonyi (Alfréd Rényi Institute of Mathematics).

The main financial sponsors of the conference were LPSM (Laboratoire de Probabilités, Statistique et Modélisation, CNRS, UMR 8001), Sorbonne University, Université Paris Diderot, LAMME at Evry University, ENSIIE (École Nationale Supérieure d'Informatique pour l'Industrie et l'Entreprise), the Chaire Risques Financiers (Société Générale), the Institut Louis Bachelier, and the Natixis foundation.

We wish you an interesting conference and a pleasant stay in Paris.

Local organising committee

Huyên PHAM, Chair (LPSM, University Paris Diderot)
Zorana GRBAC (LPSM, University Paris Diderot)
Idris KHARROUBI (LPSM, Sorbonne University)
Thomas LIM (LaMME, ENSIIE Evry)
Gilles PAGES (LPSM, Sorbonne University)
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Huyên PHAM (University Paris Diderot)
Miklós RASONYI (Alfréd Rényi Institute of Mathematics)

Sponsors

Events and practical information

Conference venue
The conference will be held in the Campus des Cordeliers, in the heart of the Latin quarter, 6th arrondissement of Paris. The talks will take place in three different rooms: the plenary talks and invited sessions in Amphithéâtre Farabeuf and the contributed sessions in Salle des thèses and Salle Déjerine. On Wednesday and Thursday the poster sessions will be organized in the central area.

The address of the conference venue is 15 Rue de l'École de Médecine, 75006 Paris, and it can be easily reached by public transportation (Métro, Line 10, Station Cluny - La Sorbonne and RER, Lines B and C, Station Saint-Michel-Notre-Dame).

Registration desk
The reception desk will be open on Tuesday from 08:30 to 16:00 and situated in the entrance hall. On Wednesday-Friday an information desk will be open during the breaks and lunches in the room reserved for this.

Lunches
Buffet-style lunches will be provided in the central conference area (Salle Marie Curie) for all registered participants.

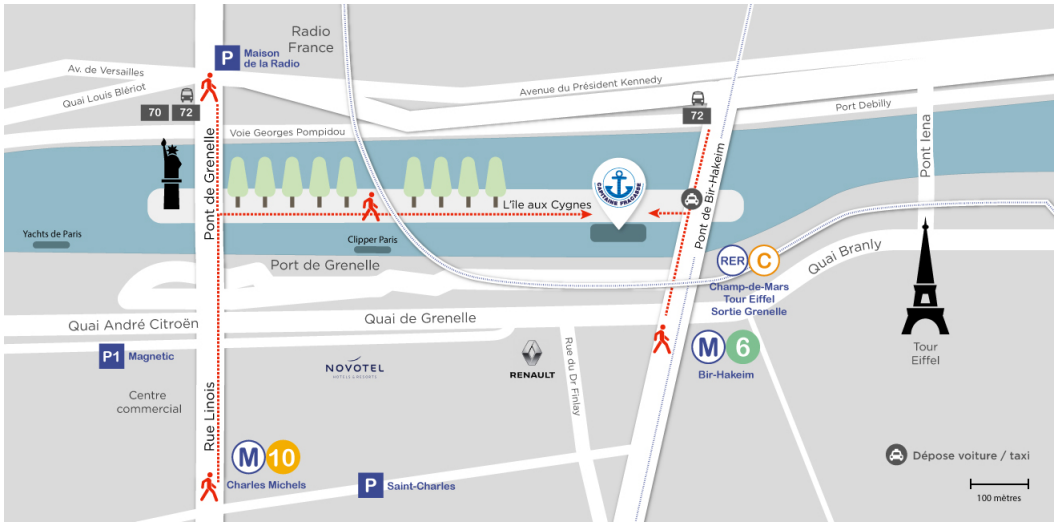
Welcome reception
The cocktail reception will take place on Tuesday, June 11 from 18:30 until 20:00 in Salle Marie Curie.

Publisher exhibitions
Springer will be present with book exhibitions in Salle Marie Curie.

Internet access
A wireless internet connection in campus can be accessed through eduroam.

Conference dinner

Dinner cruise on the Seine will be organized on Thursday, June 13 at le Capitaine Fracasse. The boarding will begin at 20:15 (8:15 p.m.) and the departure is planned at 20:45 (8:45 p.m.). The stopover is located at l'Ile aux cygnes, middle of the bridge of Bir-Hakeim, Paris 15ème. It can be accessed from the middle of the bridge Bir-Hakeim by stairs (1min walk) or from the middle of the bridge Grenelle by ramp (10min walk). The cruise lasts approximately 2 hours.



Public transportation

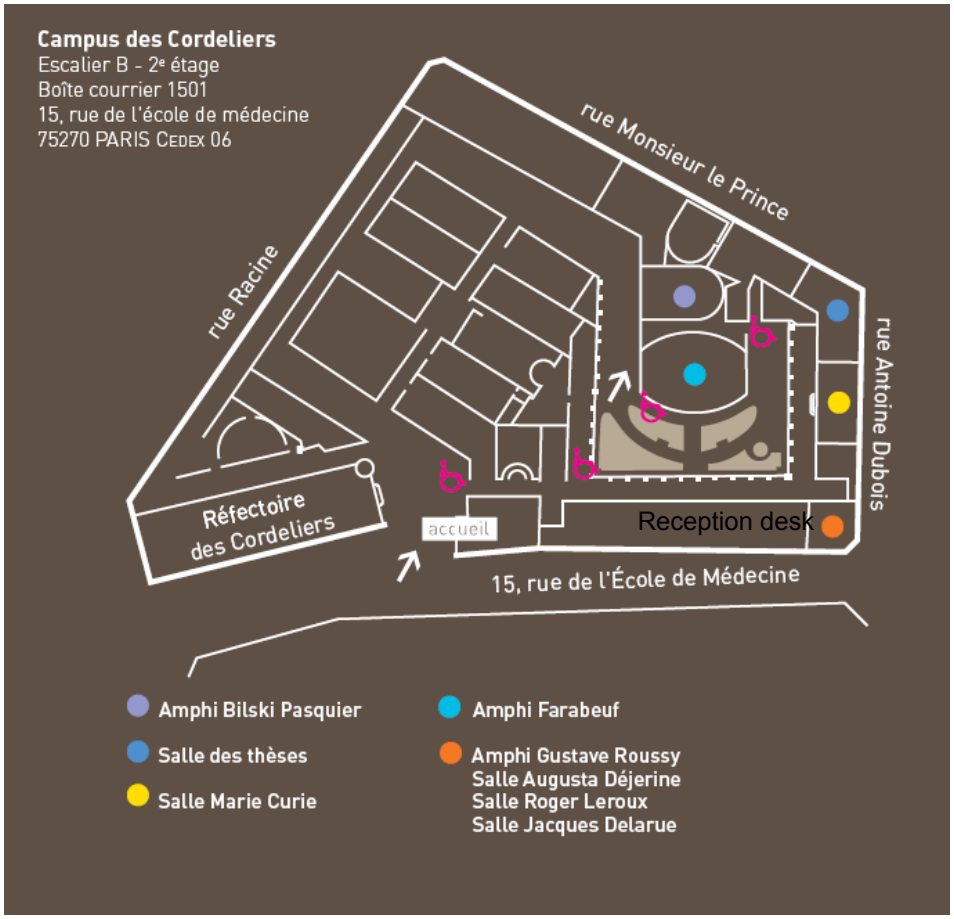
Information on public transportation in Paris including métro, RER, buses and trams can be found at `www.ratp.fr`.

Campus des Cordeliers

Adresse : UPMC - Campus des Cordeliers
15, rue de l'école de médecine 75006 Paris

Accès :
- Métro: Ligne 4 ou 10 (station Odéon)
- Bus : Lignes 58 , 63, 70, 86, 87, 96

Lien du plan d'accès au campus des Cordeliers sur google maps



Program overview

	Tuesday 11	Wednesday 12	Thursday 13	Friday 14
Morning	8:30-9:00: Welcome 9:00-9:15: Opening 9:15-10:00: Plenary talk 10:00-10:30: Coffee break 10:30-12:30: Invited session & Contributed session	9:00-9:45: Plenary talk 9:45-10:15: Coffee break 10:15-12:15: Invited session & Contributed session	9:00-10:30: Invited session & Contributed session 10:30-11:00: Coffee break 11:00-12:30: Industry session	9:00-9:45: Plenary talk 9:45-10:15: Coffee break 10:15-11:45: Invited session & Contributed session 12:00-12:45: Plenary talk
Lunch		Poster	Poster	
Afternoon	14:00-15:30: Invited session & Contributed session 15:30-16:00: Coffee break 16:00-17:30: Invited session & Contributed session 17:45-18:30: Plenary talk	14:00-14:45: Plenary talk 15:00-16:30: Invited session & Contributed session 16:30-17:00: Coffee break 17:00-17:45: Plenary talk	14:00-16:00: Contributed session 16:00-16:30: Coffee break 16:30-17:15: Plenary talk	
Event	18:30-20:00: Cocktail reception		20:00-23:00: Conference/cruise dinner	

Detailed program

Tuesday, 11 June 2019

08:30–09:00	Registration and Welcome
09:00–09:15	Opening
09:15–10:00 Amphi Farabeuf	**Erhan Bayraktar** On the asymptotic optimality of the comb strategy for prediction with expert advice
10:00–10:30	Coffee break
10:30–12:30	
Amphi Farabeuf	**Invited session: Robust methods for pricing and hedging** (organizer: Jan Obloj, chair: Pietro Siorpaes) **Matteo Burzoni** Randomization in the robust superhedging duality with frictions **Laurence Carassus** No-arbitrage with multiple-priors in discrete time **Johannes Wiesel** Sensitivity analysis of robust optimisation problems
Salle des thèses	**Contributed session: Stochastic and rough volatility** **Stefan Gerhold** Small-time and large-time smile behaviour for the rough Heston model **Sophian Mehalla** Fast calibration of the Libor Market Model with Jacobi stochastic volatility **David Shkel** Model risk in a rough world **Martin Tegner** A probabilistic approach to local volatility

Salle Déjerine	**Contributed session: Statistical finance** **Matthieu Garcin** Selfsimilarity and stationarity in financial time series: estimating Hurst exponents and making predictions **Jian He** On-line parameter estimation for state space model **Jae Yun Jun Kim** Hedging option contracts with locally weighted regression, functional data analysis, and Markov chain Monte Carlo techniques **Lorenzo Mercuri** Finite mixture approximation of CARMA(p,q) model
12:30–14:00	Lunch break
14:00–15:30	
Amphi Farabeuf	**Invited session: Functional data analysis in finance** (organizer/chair: Robert Stelzer) **Michael Eichler** Non-stationary functional time series: an application to electricity supply and demand **Marco Lippi** Infinite-dimensional time series, common and idiosyncratic components **Florentina Paraschiv** A space-time random field model for electricity forward prices
Salle des thèses	**Contributed session: Stochastic control in finance and insurance** **Giorgio Ferrari** On a model for the optimal management of inflation **Emel Savku** An optimal consumption problem with regimes and memory **Maren Diane Schmeck** Mortality options: The point of view of the insurer
Salle Déjerine	**Contributed session: CVA/XVA/CCP** **Hamed Amini** Systemic risk and central clearing counterparty design **Fabio Antonelli** CVA and vulnerable options in stochastic volatility models **Andrea Pallavicini** Funding adjustments in equity linear products

15:30–16:00	Coffee break
16:00–17:30	
Amphi Farabeuf	**Invited session: Machine learning in finance** (organizer/chair: Rama Cont) **Emmanuel Bacry** Disentangling and quantifying market participant volatility contributions **Stéphane Crépey** Gaussian process regression for CVA computations **Côme Huré** Deep learning for stochastic control problems
Salle des thèses	**Contributed session: Portfolio optimization I** **Asma Khedher** Utility maximization under time change **Martin Schweizer** Solving quadratic optimisation problems without information **Lukasz Stettner** Construction of discrete time shadow price - inductive direct approach
Salle Déjerine	**Contributed session: Credit risk** **Alexander Herbertsson** Dynamic hedging of CDS index options in Markov chain models **John-John Ketelbuters** Time consistent evaluation of credit risk with contagion **Yves Rakotondratsimba** Delta-gamma approximation for the credit-valuation-adjustment of a vanilla option
17:45–18:30 Amphi Farabeuf	**Giorgia Callegaro** Optimal reduction of public debt under partial observation of the economic growth
18:30–20:00	Cocktail reception

Wednesday, 12 June 2019

09:00–09:45 Amphi Farabeuf	**Mathieu Rosenbaum** Recent advances on market making regulation
09:45–10:15	Coffee break
10:15–12:15 Amphi Farabeuf	**Invited session: Contemporary stochastic volatility modeling: high dimensional, local, rough** (organizer/ chair: Christa Cuchiero) **Eduardo Abi Jaber** Quadratic Volterra processes and multivariate stochastic (rough) volatility models **Julien Guyon** The joint S&P 500/VIX smile calibration puzzle solved: A dispersion-constrained martingale transport approach **Blanka Horvath** Deep learning volatility
Salle des thèses	**Contributed session: Option pricing and hedging** **Otto Konstandatos** Analytical valuation of performance-linked executive stock options **Peter Spreij** Accounting noise and the pricing of CoCos **Victoria Steblovskaya** Optimal hedging in a discrete time multi-asset incomplete market
Salle Déjerine	**Contributed session: Stochastic analysis and modeling in finance** **Sema Coskun** Modeling the electricity demand in the intraday market: An SDE approach **Silvia Lavagnini** Correlators of polynomial processes **Max Nendel** A semigroup approach to nonlinear Lévy processes **Anna Sulima** Representation theorem for Itô-Markov additive processes and completeness of the market

12:15–14:00	Lunch break and **poster session**
14:00–14:45 Amphi Farabeuf	**Giulia Di Nunno** Martingale random fields in time change models, the role of information in optimal portfolio problems
15:00–16:30 Amphi Farabeuf	**Invited session: McKean Vlasov equations and mean field games in finance** (organizer/chair: Xin Guo) **Haoyan Cao** Nonzero-sum stochastic games with impulse controls **Asaf Cohen** Fluctuations in finite state many player games **Christa Cuchiero** A neural network approach to calibration of local stochastic volatility models
Salle des thèses	**Contributed session: Credit risk and interest rate modeling** **Anna Aksamit** Martingale representation in credit risk modelling **Claudio Fontana** Term structure modeling for multiple curves with stochastic discontinuities **Charles Njike** Interbank credit risk modelling with self-exciting jump process
Salle Déjerine	**Contributed session: Portfolio optimisation II** **Suhan Altay** Optimal converge trading with unobservable pricing errors **Nathan Lassance** Portfolio selection with higher-order moments: A target-distribution approach **Bilgi Yilmaz** Single-family houses portfolio optimization under impact of large investors in housing markets
16:30–17:00	Coffee break
17:00–17:45 Amphi Farabeuf	**Johanna Ziegel** Robust forecast evaluation of expected shortfall

Thursday, 13 June 2019

09:00–10:30	
Amphi Farabeuf	**Invited session: High-dimensional computations in finance** (organizer/chair: Bruno Bouchard) **Michael Kupper** Computation of homogeneous martingale optimal transport via penalization and neural networks **Imanol Perez** Model-free pricing and hedging in discrete time with rough path signatures **Xavier Warin** Machine learning for PDEs
Salle des thèses	**Contributed session: Limit order book and algorithmic trading** **Dirk Becherer** Optimal execution with a view on price momentum for transient mutliplicative impact **Donatien Hainaut** A switching microstructure model for stock prices **Dragana Radojicic** A recurrent neural network approach in high-frequency trading
Salle Déjerine	**Contributed session: Robust finance** **Emanuela Rosazza Gianin** Dynamic robust Orlicz premia and Haezendonck-Goovaerts risk measures **David Prömel** MOT duality and robust finance shortfall **Ruchika Sehgal** A robust second order stochastic dominance portfolio optimization model
10:30–11:00	Coffee break

11:00–12:30	**Industry session: Technology and AI in quantitative**
Amphi Farabeuf	**finance** (organizer/chair: Michel Crouhy)
	Charles-Albert Lehalle
	Machine learning and artificial intelligence for financial markets
	Thierry Roncalli
	Machine learning algorithms & portfolio optimization
	Sébastien Choukroun
	Tokens on a blockchain: a need for models
12:30–14:00	Lunch break and **poster session**
14:00–16:00	
Amphi Farabeuf	**Contributed session: Numerical and machine learning methods in finance**
	Riccardo Brignone
	Conditional Monte Carlo methods under stochastic volatility models
	Ngoc Huy Chau
	Stochastic gradient hamiltonian Monte Carlo for non-convex learning in the big data regime
	Andrea Fiacco
	On the approximation of Lévy driven Volterra processes and their integrals
	Nabil Kahale
	Randomized dimension deduction for Monte Carlo simulations
Salle des thèses	**Contributed session:**
	Valeria Bignozzi
	Risk measures based on benchmark loss distributions
	Alessandro Calvia
	Risk measures and progressive enlargement of filtrations: a BSDE approach
	Ludovic Mathys
	Intra-horizon expected shortfall and risk structure in models of jumps
	Ilaria Peri
	On the properties of Λ-quantiles

Salle Déjerine	**Contributed session: Equilibrium models** **Jose Corcuera** Pathwise Kyle equilibrium model **Martin Herdegen** Equilibrium asset pricing with transaction costs **Caroline Hillairet** Aggregation of heterogeneous consistent progressive utilities **Rodolfo Prieto** Costly short sales and nonlinear asset pricing
16:00–16:30	Coffee break
16:30–17:15 Amphi Farabeuf	**Martin Larsson** The expressiveness of random dynamical systems
20:00–23:00	Dinner cruise on the Seine

Friday, 14 June 2019

09:00–09:45 Amphi Farabeuf	**Johannes Muhle-Karbe** Asset pricing, heterogenous beliefs, and liquidity
09:45–10:15	Coffee break
10:15–11:45 Amphi Farabeuf	**Invited session: Optimal transport and convex order for finance** (organizer/chair: Gilles Pagès) **Hadrien de March** Entropic approximation of Martingale Optimal Transport and application to building arbitrage-free implied volatility **Benjamin Jourdain** The inverse transform martingale coupling **Pietro Siorpaes** Structure of martingale transports in Banach spaces
Salle des thèses	**Contributed session: Stochastic control in finance** **Michele Giordano** Maximum principles for Volterra time change processes **Marcin Pitera** Risk sensitive dyadic impulse control for unbounded processes **Amel Redjil** Existence of stochastic optimal control in the G-framework
Salle Déjerine	**Contributed session: Arbitrage and statistical arbitrage** **John Armstrong** Expected shortfall is ineffective against tail-risk seekers **Nazem Khan** A dual characterisation of regulatory arbitrage for expected shortfall **Sergei Levendorskii** Static and semi-static hedging as contrarian or conformist bets
12:00–12:45 Amphi Farabeuf	**Mihail Zervos** Renegotiation-proofness in a principal agent model
12:45–13:15	Closing of the conference

Plenary talks

On the asymptotic optimality of the comb strategy for prediction with expert advice

Tuesday
June 11
09h15-10h00

Erhan Bayraktar

University of Michigan

For the problem of prediction with expert advice in the adversarial setting with geometric stopping, we compute the exact leading order expansion for the long time behavior of the value function. Then, we use this expansion to prove that as conjectured in Gravin, Peres and Sivan (2016), the comb strategies are indeed asymptotically optimal for the adversary in the case of 4 experts.

Joint work with Ibrahim Ekren and Yili Zhang.

Optimal reduction of public debt under partial observation of the economic growth

Tuesday
June 11
17h45-18h30

Giorgia Callegaro

University of Padova

We consider a government that aims at reducing the debt-to-gross domestic product (GDP) ratio of a country. The government observes the level of the debt-to-GDP ratio and an indicator of the state of the economy, but does not directly observe the development of the underlying macroeconomic conditions. The government's criterion is to minimize the sum of the total expected costs of holding debt and of debt's reduction policies. We model this problem as a singular stochastic control problem under partial observation. The contribution of the paper is twofold. Firstly, we provide a general formulation of the model in which the level of debt-to-GDP ratio and the value of the macroeconomic indicator evolve as a diffusion and a jump-diffusion, respectively, with coefficients depending on the regimes of the economy. These are described through a finite-state continuous-time Markov chain. We reduce via filtering techniques the original problem to an equivalent one with full information (the so-called separated problem), and we provide a general verification result in terms of a related optimal stopping problem under full information. Secondly, we specialize to a case study in which the economy faces only two regimes, and the macroeconomic indicator has a suitable diffusive dynamics. In this setting we provide the optimal

debt reduction policy. This is given in terms of the continuous free boundary arising in an auxiliary fully two-dimensional optimal stopping problem.

Available online at: `https://arxiv.org/abs/1901.08356`

Wednesday
June 12
09h00-09h45

Recent advances on market making regulation

Mathieu Rosenbaum
École Polytechnique

In this talk, we present recent tools enabling regulators and exchanges to set relevant operating rules for financial markets, notably at the microstructure level. We first introduce the issue of optimal make-take fees, which consists in finding suitable contracts between market makers and exchanges to ensure the attractiveness of markets. Mathematically speaking, we formulate this question in term of a principal-agent problem that we solve in an original way. Then we present a new methodology allowing us for a ranking of market makers according to the quality of the liquidity they provide. In this approach, we use a very general modelling of limit order books via non-linear and state dependent Hawkes-like processes for which new ergordic properties are proved.

This talk is based on joint works with Omar El Euch, Thibaut Mastrolia, Othmane Mounjid, Pamela Saliba and Nizar Touzi.

Wednesday
June 12
14h00-14h45

Martingale random fields in time change models, the role of information in optimal portfolio problems

Giulia Di Nunno
University of Oslo

Time change is a powerful modelling technique of long history. Its main idea stands in the representation of complicated stochastic structures by known processes with a randomly perturbed time-line. We review the fundamental concepts to come to consider price dynamics driven by time changed Levy models within the framework of martingale random fields. These include examples of classical models for default risk, and also mean field dynamics or Volterra type structures. We then consider different optimal portfolio problems, which will be studied by means of maximum principles under enlarged or partial information. In fact, to achieve the results, we work with different information flows associated to the time changed noise, related backward stochastic differential equations, stochastic non-anticipative and anticipative derivatives and calculus.

Robust forecast evaluation of expected shortfall

Wednesday
June 12
17h00-17h45

Johanna Ziegel

University of Bern

Elicitability of a statistical functional means that it can be obtained as the minimizer of an expected loss function. Such a loss function can be used for forecast comparison or model selection, and allows for M-estimation and generalized regression. Prime examples of elicitable functionals are the mean or quantiles of a random variable. Expected Shortfall (ES), an important risk measure in banking and finance is not elicitable but becomes elicitable when considered jointly with a certain quantile, also called Value at Risk (VaR). We present a characterization of the large class of suitable loss functions for the pair of ES and VaR, and discuss the diffculty in choosing a specific loss function for forecast comparison or estimation. As an alternative for forecast comparison, we introduce a procedure that is robust with respect to the choice of the loss function. We present graphical checks (Murphy diagrams) of whether one forecast method dominates another, and propose an associated hypothesis test.

The expressiveness of random dynamical systems

Thursday
June 13
16h30-17h15

Martin Larsson

ETH Zürich

Deep neural networks perform exceedingly well on a variety of learning tasks, in particular in finance where they are quickly gaining importance. Training a deep neural network amounts to optimizing a nonlinear objective over a very large space of parameters. This would seem a hopeless task if an optimal or near-optimal solution were required. The fact that this can succeed suggests that the result is largely insensitive to the details of the optimization procedure, a perspective that is supported by empirical evidence. In this work we take a step toward a theoretical understanding of this phenomenon. In a simple model of deep neural networks as discretizations of controlled dynamical systems, we rigorously prove that any learning task can be accomplished even if a majority of the parameters are chosen at random.

Friday
June 14
09h00-09h45

Asset pricing, heterogenous beliefs, and liquidity

Johannes Muhle-Karbe
Imperial College London

This paper studies the equilibrium price of an asset that is traded in continuous time between N agents who have heterogeneous beliefs about the state process underlying the asset's payoff. We propose a tractable model where agents maximize expected returns under quadratic costs on inventories and trading rates. The unique equilibrium price is characterized by a weakly coupled system of linear parabolic equations which shows that holding and liquidity costs play dual roles. We derive the leading-order asymptotics for small transaction and holding costs which give further insight into the equilibrium and the consequences of illiquidity.

(Joint work with Marcel Nutz and Xiaowei Tan)

Friday
June 14
12h00-12h45

Renegotiation-proofness in a principal agent model

Mihalis Zervos
London School of Economics

We analyse renegotiation-proof incentive provision in a dynamic moral hazard model. We derive the optimal contract that induces the agent to act in the principal's interest while leaving no scope for mutually beneficial ex-post renegotiation. The contract involves the use of randomised termination if and only if the optimal full-commitment contract fails to be renegotiation-proof.

Invited sessions

Tuesday, June 11: Robust methods for pricing and hedging

Randomization in the robust superhedging duality with frictions

Tuesday
June 11
10h30-11h0

Matteo Burzoni

ETH Zürich

We prove the superhedging duality for a discrete-time financial market with proportional transaction costs under portfolio constraints and model uncertainty. Frictions are modelled through solvency cones as in the model initiated by Kabanov and adapted to the quasi-sure setup of Bouchard and Nutz. Our results hold under the condition of No Strict Arbitrage and under the efficient friction hypothesis. This is a joint work with Erhan Bayraktar.

No-arbitrage with multiple-priors in discrete time

Tuesday
June 11
11h00-11h30

Laurence Carassus

Université de Reims Champagne-Ardenne and Research Center Pôle Léonard de Vinci

We investigate different notions of arbitrage in a multiple-prior setting in discrete time. We revisit the so-called quasi-sure no-arbitrage condition and prove a geometric and a quantitative version of it. We also study three alternative notions and provide conditions for all these definitions to be equivalent. Finally, we propose two concrete examples illustrating these various concepts.

Joint work with R. Blanchard.

Tuesday
June 11
11h30-12h00

Sensitivity analysis of robust optimisation problems

Johannes Wiesel

University of Oxford

In this talk we model uncertainty through neighborhoods 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.

Tuesday, June 11: Functional data analysis in finance

Tuesday
June 11
14h00-14h30

Non-stationary functional time series: an application to electricity supply and demand

Michael Eichler

Maastricht University

One main feature of electricity spot prices is the frequent occurrence of spikes, that is, of periods of extreme prices that are typically short-lived and during which the spot price exceeds its normal level many times over. Such spikes occur usually if the supply and demand curves that determine the spot price meet in their steeper parts. For a better assessment of the risk in such situation we propose to include the complete supply and demand curves to forecast spot prices. We model the spread between the supply and demand curve as a functional time series. The approach is based on a decomposition into eigenfunctions and model eigenvalues by a dynamic factor model. We find that the form of the spread does not remain stable over time but mostly evolves slowly over time with possibly a few marked time points of sudden changes in the functional form of the spread.

Infinite-dimensional time series, common and idiosyncratic components

Tuesday
June 11
14h30-15h00

Marco Lippi

Einaudi Institute for Economics and Finance, Rome

Dynamic Factor Models consist of a countable infinity of stochastic processes. Under stationarity, the standard theory obtains asymptotic results taking finite n (the number of processes) and T (the number of observations) subsystems and letting n and T tend to infinity. A continuum infinity has also been considered, i.e. a process associating with each t a function defined in, say, $[0, 1]$. This is the so-called functional process.

The talk is about some theoretical issues regarding both the countable and the continuum infinity case. I discuss (i) the definition of an idiosyncratic component in the continuum case and (ii) the properties of an autoregressive process with a common and an idiosyncratic component for both the countable and the continuum case.

Also, some results obtained by Donato Ceci, a doctoral student in Rome, are presented. They include the determination of the maximum lag in a functional autoregressive model and some empirical findings.

A space-time random field model for electricity forward prices

Tuesday
June 11
15h00-15h30

Florentina Paraschiv

Norwegian University of Science and Technology

Structural models for forward electricity prices are of great relevance nowadays, given the major structural changes in the market due to the increase of renewable energy in the production mix. In this study, we derive a spatio-temporal dynamical model based on the Heath-Jarrow-Morton (HJM) approach under the Musiela parametrization, which ensures an arbitrage-free model for electricity forward prices. The model is fitted to a unique data set of historical price forward curves. As a particular feature of the model, we disentangle the temporal from spatial (maturity) effects on the dynamics of forward prices, and shed light on the statistical properties of risk premia, of the noise volatility term structure and of the spatio-temporal noise correlation structures. We find that the short-term risk premia oscillates around zero, but becomes negative in the long run. We identify the Samuelson effect in the volatility term structure and volatility bumps, explained by market fundamentals. Furthermore we find evidence for coloured noise and correlated residuals, which we model by a Hilbert space-valued normal inverse Gaussian Lévy process with a suitable covariance functional.

Tuesday, June 11: Machine learning in finance

Disentangling and quantifying market participant volatility contributions

Tuesday
June 11
16h00-16h30

Emmanuel Bacry

CEREMADE - Paris Dauphine

Using labeled orders on the Cac40 index future provided by Euronext, we quantify market participants contributions to the volatility in the diffusive limit. To achieve this result we leverage the branching properties of Hawkes point processes. We find that fast intermediaries (e.g., market maker type agents) have a smaller footprint on the volatility than slower, directional agents. The branching structure of Hawkes processes allows us to examine also the endogenous nature of each agent's behavior. We find that high-frequency traders are more endogenously driven than other types of agents.

Gaussian process regression for CVA computations

Tuesday
June 11
16h30-17h00

Stéphane Crépey

Université d'Évry

Modeling counterparty risk is computationally challenging because it requires the simultaneous evaluation of all the trades with each counterparty under both market and credit risk. We present a multi-Gaussian process (GP) regression approach, which is well suited for OTC derivative portfolio valuation involved in CVA computation. Our approach avoids nested simulation or simulation and regression of cash flows by offline learning of a Gaussian metamodel for the mark-to-market cube of a derivative portfolio. The uncertainty in portfolio valuation arising from the Gaussian process approximation can be quantified numerically. Leveraging on such CVA-GP framework, we illustrate numerically the model risk on CVA related to the unknown dependence between market and credit, and we estimate the value-at-risk of a CVA in the future. Joint work with Matthew Dixon (Illinois Tech, Chicago).

Deep learning for stochastic control problems

Tuesday
June 11
17h00-17h30

Côme Huré

LPSM, Université Paris Diderot

We develop new algorithms for high-dimensional stochastic control problems based on deep learning and dynamic programming (DP). We first approximate the optimal policy by means of neural networks, and then the value function by Monte Carlo regression according to performance or hybrid iteration, and regress now or later method in the DP recursion. Consistency and rate of convergence for the control and value function estimates are analyzed. Numerical results on various applications as valuation of energy storage, smart grid management and resolution of a semi-linear PDE in dimension 100 are presented.

Joint work with Huyên Pham, Achref Bachouch, Nicolas Langrené.

Wednesday, June 12: Contemporary stochastic volatility modeling: high dimensional, local, rough

Quadratic Volterra processes and multivariate stochastic (rough) volatility models

Wednesday
June 12
10h15-10h45

Eduardo Abi Jaber

École Polytechnique Université Paris Saclay

We introduce a new class of tractable Volterra processes. These processes do not fall, in general, in the class of Affine Volterra processes as introduced in A.J., Larsson & Pulido '19. Still, we show that the Fourier-Laplace transform is known up to a solution of a deterministic integral equation. As applications, we construct multivariate stochastic (rough) volatility models of Wishart and Stein-Stein type. We also discuss the practical implementation of these models.

Wednesday
June 12
10h45-11h15

The joint S&P 500/VIX smile calibration puzzle solved: A dispersion-constrained martingale transport approach

Julien Guyon

NYU Courant, Columbia University and Bloomberg

Since VIX options started trading in 2006, many researchers and practitioners have tried to build a model that jointly and exactly calibrates to the prices of S&P 500 (SPX) options, VIX futures and VIX options. So far the best attempts, which used continuous-time jump-diffusion models on the SPX, could only produce an approximate fit. In this talk we solve this puzzle using a discrete-time model. Given a VIX future maturity T1, we build a joint probability measure on the SPX at T1, the VIX at T1, and the SPX at T2 = T1 + 30 days which is perfectly calibrated to the SPX smiles at T1 and T2, and the VIX future and VIX smile at T1. Our model satisfies the martingality constraint on the SPX as well as the requirement that the VIX at T1 is the implied volatility of the 30-day log-contract on the SPX. In particular, this proves that the SPX and VIX markets are jointly arbitrage-free. The discrete-time model is cast as a dispersion-constrained martingale transport problem and solved using the Sinkhorn algorithm, in the spirit of De March and Henry-Labordere (2019). We explain how to handle the fact that the VIX future and SPX option monthly maturities do not perfectly coincide, and how to extend the two-maturity model to include all available monthly maturities.

Wednesday
June 12
11h15-11h45

Deep learning volatility

Blanka Horvath

King's College London

We present a consistent neural network based calibration method for a number of volatility models-including the rough volatility family-that performs the calibration task within a few milliseconds for the full implied volatility surface.

The aim of neural networks in this work is an off-line approximation of complex pricing functions, which are difficult to represent or time-consuming to evaluate by other means. We highlight how this perspective opens new horizons for quantitative modelling: The calibration bottleneck posed by a slow pricing of derivative contracts is lifted. This brings several model families (such as rough volatility models) within the scope of applicability in industry practice. As customary for machine learning, the form in which information from available data is extracted and stored is crucial for network performance. With this in mind we discuss how our approach addresses the usual challenges of machine learning solutions in a financial context (availability of training data, interpretability of results for regulators, control over generalisation errors). We present specific architectures for price approximation and calibration and optimize these with respect different objectives regarding accuracy, speed and robustness. We also find that including the intermediate step of learning pricing functions of (classical or rough) models before calibration significantly improves network performance compared to direct calibration to data.

The talk is based on work with A. Muguruza and M. Tomas, available at
https://papers.ssrn.com/sol3/papers.cfm/abstract_id=3322085

Wednesday, June 12: McKean Vlasov equations and Mean Field games in finance

Nonzero-sum stochastic games with impulse controls

Wednesday
June 12
15h00-15h30

Haoyang Cao
UC Berkeley

We consider a general class of nonzero-sum N-player stochastic games with impulse controls, where players control the underlying dynamics with discrete interventions. We adopt a verification approach and provide sufficient conditions for the Nash equilibria (NEs) of the game. We then consider the limit situation of N approaching, that is, a suitable mean-field game (MFG) with impulse controls. We show that under appropriate technical conditions, the MFG is an epsilon-NE approximation to the N-player game, with epsilon being an order of one over square root of N. As an example, we analyze in details a class of stochastic games which extends the classical cash management problem to the game setting. In particular, we characterize the NEs for its two-player case and compare the results to the single-player case, showing the impact of competition on the player's optimal strategy, with sensitivity analysis of the model parameters.

Fluctuations in finite state many player games

Wednesday
June 12
15h30-16h00

Asaf Cohen
University of Michigan

We consider an n-player symmetric stochastic game with weak interactions between the players. Time is continuous and the horizon and the number of states are finite. We show that the value function of each of the players can be approximated by the solution of a differential equation called the master equation. Moreover, we analyze the fluctuations of the empirical measure of the states of the players in the game and show that it is governed by a solution to a stochastic differential equation.

A neural network approach to calibration of local stochastic volatility models

Wednesday
June 12
16h00-16h30

Christa Cuchiero

Vienna University of Economics and Business

Exactly calibrated local stochastic volatility models are practically important instances of Mc Vlasov SDEs whose existence and uniqueness is in general a challenging open question. For their calibration both PDE and Monte Carlo methods building on propagation of chaos have been proposed. We tackle the calibration problem by a novel approach, namely by parameterizing the leverage function with neural networks and learning it from the implied volatility surface without using Dupire's local volatility function. We compare our procedure with the particle method and draw some theoretical conclusions.

Thursday, June 13: High-dimensional computations in finance

Computation of homogeneous martingale optimal transport via penalization and neural networks

Thursday
June 13
09h00-09h30

Michael Kupper

University of Konstanz

We present a widely applicable approach to solving optimal transport problems via neural networks. The core idea is to penalize the optimization problem in its dual formulation and reduce it to a finite dimensional one which corresponds to optimizing a neural network with smooth objective function. Our focus is on a homogeneity condition for (martingale) optimal transport, which can be seen as a consistency of the transportations across various time periods. The talk is based on joint work with Stephan Eckstein.

Model-free pricing and hedging in discrete time with rough path signatures

Thursday
June 13
09h30-10h00

Imanol Perez Arribas

University of Oxford

We use signatures from rough paths to study the problem of pricing and hedging in discrete time in a framework where minimal assumptions about the market are made. This is done in by introducing a family of fictitious, non-tradable payoffs called signature payoffs, in the spirit of Arrow-Debreu. This family of (exotic) payoffs is able to approximate other exotic derivatives and if market prices for a rich enough class of exotic payoffs are available, it allows to price other potentially illiquid derivatives in a model-free manner.

Machine learning for PDEs

Thursday
June 13
10h00-10h30

Xavier Warin
EDF Labs

Recently machine learning technique have been proposed to solve high dimensional nonlinear partial differential equations (PDEs).

We present a survey of recently proposed methods based on Feyman Kac or the BSDE representation of Semi Linear PDEs.

Starting form the work of E, Han and Jentzen, we explain how to solve the BSDE by minimization of loss functions defined recursively by backward induction.

The methodology is extended to variational inequalities arising in optimal stopping problems. We analyze the convergence of the deep learning schemes and provide error estimates in terms of the universal approximation of neural networks. Numerical results show that the algorithm gives very good results till dimension 50 (and certainly above), for both PDEs and variational inequalities problems.

At last we propose an original scheme to solve the Feyman Kac representation of the BSDE and we show its accuracy.

Friday, June 14: Optimal transport and convex order for finance

Entropic approximation of Martingale Optimal Transport and application to building arbitrage-free implied volatility

Friday
June 14
10h15-10h45

Hadrien De March
Entrepreneur First Paris 1

We present recent results about new algorithms specially suited to solve numerically Martingale Optimal Transport. Then we give several convergence speed results. Finally we present an application of this technology to building smooth arbitrage-free implied volatility surfaces.

The inverse transform martingale coupling

Friday
June 14
10h45-11h15

Benjamin Jourdain
CERMICS-ENPC

We exhibit a new martingale coupling between two probability measures μ and ν in convex order on the real line. This coupling is explicit in terms of the integrals of the positive and negative parts of the difference between the quantile functions of μ and ν. The integral of $|y-x|$ with respect to this coupling is smaller than twice the Wasserstein distance with index one between μ and ν. When the comonotonous coupling between μ and ν is given by a map T, it minimizes the integral of $|y-T(x)|$ among all martingales couplings.

Friday
June 14
11h15-11h45

Structure of martingale transports in Banach spaces

Pietro Siorpaes
Imperial College London

In 2015 Beiglböck, Nutz and Touzi studied the martingale optimal transport problem and showed that in dimension one there is no duality gap and that the dual problem admits an optimizer. In two recent pre-prints, De March and Touzi and De March obtained similar results in finite dimension. A key step towards these achievements is the characterization of the polar sets of the family of all martingale couplings. Here we study this characterization in Banach spaces using different techniques, e.g. the theory of random sets and posets.

Invited industry session

Thursday, June 13: Technology and AI in quantitative finance

Machine learning and artificial intelligence for financial markets

Thursday
June 13
11h00-11h30

Charles-Albert Lehalle

CFM

During this talk I will first detail the potential positioning of new approaches, driven by data sciences and machine leaning, in the business models of market participants. In line with the "FaIR" research program of the Louis Bachelier Institute and following a seminal paper by Robert Merton in 1995, I will split potential innovation in three categories: improving clients services, using data to have a better connection to real economy, and risk management. Depending on the time I will have, I will go through three corresponding applications : classification of clients using high frequency characteristics of their activity, using satellite images, and decision support for online monitoring of hundreds of trading algorithms.

Machine learning algorithms and portfolio optimization

Thursday
June 13
11h30-12h00

Thierry Roncalli

Amundi Asset Management

Portfolio optimization has been popularized by Markowitz because it consists in solving quadratic programming (QP) problems. This implies that the solution is mainly driven by the inverse of the covariance matrix of asset returns. In order to obtain asset allocation that is more sensitive to risk factors and less to arbitrage factors, we need to change or adapt the mean-variance objective function. This implies to solve non-linear optimization problems that include logarithmic barriers (risk budgeting portfolios), p-norm penalizations (regularized portfolios), etc. In this presentation, we show how large-scale or global optimization algorithms developed in the context of machine learning (svm, lasso, on-line learning, p¿n problem, hyperparameters' calibration) may help to solve these allocation problems. In particular, we will focus

on cyclical coordinate descent (CCD), alternative direction method of multipliers (ADMM), Dykstra's algorithm and Bayesian optimization with GPs.

Thursday
June 13
12h00-12h30

Tokens on a blockchain: a need for models

Sébastien Choukroun
PwC

Société Générale has been the first large bank to emit a token on a public blockchain in April 2019. Besides, Binance has been the fastest unicorn ever, being valuated at 1 billion dollar 6 months after launch by emitting a token named Binance Coin. An overview of such projects and their impacts, both for banks and firms looking for funding, will be presented. In addition, a focus on stablecoins will be performed. Then, a discussion on the emerging needs for models will conclude the presentation.

Contributed talks

Tuesday, June 11: Stochastic and rough volatility

Small-time and large-time smile behaviour for the rough Heston model

Tuesday
June 11
10h30-11h00

Stefan Gerhold

Technische Universität Wien

We characterize the asymptotic small-time and large-time implied volatility smile for the rough Heston model introduced by El Euch, Jaisson and Rosenbaum. We show that the asymptotic short-maturity smile scales in qualitatively the same way as a general rough stochastic volatility model, and is characterized by the Fenchel-Legendre transform of the solution a Volterra integral equation (VIE). The solution of this VIE satisfies a space-time scaling property which simplifies its computation. We also compute a power series in the log-moneyness variable for the asymptotic implied volatility, which yields tractable expressions for the vol skew and convexity, thus being useful for calibration purposes. Furthermore, we derive formal asymptotics for the small-time moderate deviations regime and a formal saddlepoint approximation for call options in the large deviations regime. This goes to higher order than previous works for rough models, and in particular captures the effect of the mean reversion term. In the large maturity case, the limiting asymptotic smile turns out to be the same as for the standard Heston model, for which there is a well known closed-form formula in terms of the SVI parametrization.

Tuesday
June 11
11h00-11h30

Fast calibration of the Libor Market Model with Jacobi stochastic volatility

Sophian Mehalla

Ecole des Ponts ParisTech

Since the work of Devineau et al. (2017), the numerical efficiency of density expansions has been shown for calibrating the Libor Market Model with Stochastic Volatility and Displaced Diffusion (DD-SV-LMM), in which the stochastic volatility is a CIR process. In this previous work, the affine property of the so-called freezing approximation of the DD-SV-LMM, which reduces to an Heston-type model as studied by Wu and Zhang (2006), is used to derive analytical formulas for the moments computation which are at the core of density expansion techniques.

In this talk, we propose an extension of the density approximation techniques to the Libor Market Model freezing approximation where the stochastic volatility follows a Jacobi process, inspired by the work of Ackerer et al. (2017). This framework is well suited to Gram-Charlier expansions as the convergence of the related series can be proved in this context. Such dynamics driven by the Jacobi process, which approximates the original one driven by the CIR process, is not affine and belongs to the class of polynomial dynamics whose moments calculation is tractable. In this setting, the presentation will be dedicated to a theoretical and numerical study related to the efficiency and accuracy (speed of convergence) of the calibration procedure based on Gram-Charlier type approximations, as well as the error analysis related to the density expansion itself, and regarding the difference from the standard Libor Market Model with CIR volatility.

References:

- Ackerer, D., Filipović, D., & Pulido, S. (2017). The Jacobi stochastic volatility model. Finance and Stochastics, 1-34.

- Devineau, L., Arrouy, P. E., Bonnefoy, P., & Boumezoued, A. (2017). Fast calibration of the Libor Market Model with Stochastic Volatility and Displaced Diffusion. To appear in the Journal of industrial and management optimization.

- Wu, L., & Zhang, F. (2006). LIBOR market model with stochastic volatility. Journal of industrial and management optimization, 2(2), 199.

Model risk in a rough world

Tuesday
June 11
11h30-12h00

David Shkel
University of Hagen

In derivative pricing, the risk that different models yield different prices for exotic derivatives even though they are calibrated to the same plain vanilla options is denoted as model risk. Throughout the literature, model risk is seen as significant and necessary to be dealt with. The main focus of the existing literature lies on single asset derivatives, while only very few papers deal with multi-asset options. We add to the existing literature by analyzing model risk in the case of multi-asset derivatives and, additionally, we provide an empirical study based on multi barrier reverse convertibles (MBRCs), a prominent type of retail derivatives in Switzerland.

We calculated prices for multi-asset options with representatives of three different model classes, namely, the general α-Variance Gamma model proposed by Guillaume (2013), the multi-variate Heston model proposed by Dimitroff et al. (2011), and a multi-asset rough Bergomi model, which is an extension of the model proposed by Bayer et al. (2016). To quantify model risk, we apply the coherent model risk measure of Cont (2006), which is defined as the range of model prices. Commonly, multi-asset models are calibrated to volatility surfaces and historical return correlations. We additionally consider a second approach by calibrating the models to implied correlations, calculated via the method proposed by Buss and Vilkov (2012). Through this approach we are able to analyze an additional model risk component, introduced by the uncertainty of future correlations. All models are calibrated to 100 combinations of members of the Swiss market index to achieve results for a broad range of different stocks. We calculate option prices for a wide variety of multi-asset options written on two to four underlyings, which leads to a final set of nearly 30 million option prices.

The results reveal that model risk takes on significant amounts and increases with the number of underlyings for all kind of analyzed options. But this increase is not linear, since the change from three to four underliyngs is a multiple of the change from two to three underlyings. Model risk based on historical correlations is about two percent in relation to the average prices of plain vanilla options (e.g. worst-of puts) written on two or three underlyings. If a fourth underlying is included, model risk rises to over 13.

References:

Bayer, C., P. Friz, and J. Gatheral (2016). Pricing under rough volatility. Quantitative Finance 16, 887-904.

Buss, A. and G. Vilkov (2012). Measuring equity risk with option-implied correlations. Review of Financial Studies 25, 3113-3140.

Cont, R. (2006). Model uncertainty and its impact on the pricing of derivative instruments. Mathematical Finance 16, 519-547.

Dimitroff, G., S. Lorenz, and A. Szimayer (2011). A parsimonious multi-asset Heston model: calibration and derivative pricing. International Journal of Theoretical and Applied Finance 14, 1299-1333.

Guillaume, F. (2013). The αVG model for multivariate asset pricing: calibration and extension. Review of Derivative Research 16, 25-52.

Tuesday
June 11
12h00-12h30

A probabilistic approach to local volatility

Martin Tegner
University of Oxford

The focus of this talk is a nonparametric approach for local volatility. We look at the calibration problem in a probabilistic framework based on Gaussian process priors. This gives a way of encoding prior believes about the local volatility function and a model which is flexible yet not prone to overfitting. Besides providing a method for calibrating a (range of) point-estimate(s), we draw posterior inference from the distribution over local volatility. This leads to a principled understanding of uncertainty attached with the calibration. Further, we seek to infer dynamical properties of local volatility by augmenting the input space with a time dimension. Ideally, this provides predictive distributions not only locally, but also for entire surfaces forward in time. We apply our approach to S&P 500 market data.

Tuesday, June 11: Statistical finance

Tuesday
June 11
10h30-11h00

Selfsimilarity and stationarity in financial time series: estimating Hurst exponents and making predictions

Matthieu Garcin
Leonard de Vinci, Pôle universitaire

A simple statistic can describe the scaling properties of a time series: it is the Hurst exponent. One also often links the value of the Hurst exponent to the persistence of the series and consequently to one's ability to forecast it: if $H = 1/2$ there is no autocorrelation, if $H > 1/2$ the series is persistent, and if $H < 1/2$ the series is anti-persistent. However, the interpretation of the Hurst exponent is strongly dependent on the model describing the dynamic. In particular, the case of stationary models is of practical interest, for example, in finance, in the fixed income world. We present two fractal stationary models in which the Hurst exponent is involved: a fractional Ornstein-Uhlenbeck process and the Lamperti transform of a fractional Brownian motion. We expose the specificities of the estimation of the Hurst exponent for these models as well as the consequences in the interpretation of what is a Hurst exponent in this case and of how one can forecast a stationary series. In particular, we analyse the theoretical differences in the forecasting method between series with $H > 1/2$

and series with $H < 1/2$, using accuracy metrics that are relevant in the perspective of a portfolio manager.

On-line parameter estimation for state space model

Tuesday
June 11
11h00-11h30

Jian He

Universiteit van Amsterdam

State space models are widely used in financial modelling areas, however, the estimation of the parameters in state space model is a very challenge task. We introduce an algorithm to estimate the posterior distribution of the static parameters of a state space model. This proposed algorithm is in a semi-recursive manner and has two-layer structure: the first layer provides the estimation on the posterior distribution of the static parameters by using particle filter and the second layer provides the estimation of the posterior distribution of the state variables. Moreover, we also introduce a dynamic kernel framework in the first layer for the parameter sampling, which gives the freedom to control the convergence speed of the algorithm. The main advantage of this proposed algorithm is the faster convergence speed and the less computational complexity, compared to the other similar algorithms such as the recursive nested particle filter and the SMC2. The experiments shows that this algorithm can also be extended to estimate piecewise-constant parameters. Finally, we prove that, for the state space model with certain structure, the estimated posterior distribution of the unknown static parameters and of the state valuables converges to the actual distributions in L^p norm.

Hedging option contracts with locally weighted regression, functional data analysis, and Markov chain Monte Carlo techniques

Tuesday
June 11
11h30-12h00

Jae Yun Jun Kim

ECE Paris

When investing in derivatives portfolios (such as options), the delta-gamma approximation (DGA) is often used as a risk management strategy to reduce the risk associated with the price movements of the underlying asset. However, this approximation is locally accepted only for small changes of the underlying asset price. When these changes become large, the option prices estimated by the DGA significantly differ from those of the market (or those that are estimated using, for instance, the Black-Scholes model). On the other hand, in order to properly hedge the investment in option contracts at any time instant before the maturity, one needs to forecast both the price of the underlying asset price (or, equivalently, its return) and the implied volatility of option contract (for some maturity, risk-free interest rate, and strike). In this work, we first define (and illustrate) the above three problems: 1) the limited performance of the DGA for large changes of the underlying asset price, 2) forecast of the underlying asset price (or, equivalently, its return), and 3) forecast

of the implied volatility of option contract. Afterwards, we define a framework to resolve each of these problems. 1) We propose to hedge the risk in option contract investment using the locally weighted regression (LWR). 2) We forecast the return of the underlying asset price using the functional data analysis (FDA) techniques. 3) We forecast the implied volatility of option contract using the Markov chain Monte Carlo (MCMC) techniques. Finally, we compare the performance of our method to that of some other existing methods.

Tuesday
June 11
12h00-12h30

Finite mixture approximation of CARMA(p, q) model

Lorenzo Mercuri
University of Milan

In this paper, we show how to approximate the transition density of a CARMA(p, q) model driven by a time changed brownian motion based on the Laguerre polynomial. We apply this result in two situations. Firstly we derive an analytical formula for option prices when the log price follows a CARMA(p, q) model. We also propose an estimation procedure based on the approximated likelihood density. We apply our results on real data.

Tuesday, June 11: Stochastic control in finance and insurance

Tuesday
June 11
14h00-14h30

On a model for the optimal management of inflation

Giorgio Ferrari
Bielefeld University

Consider a central bank that can increase and decrease the level of the key interest rate in order to manage the inflation rate. This evolves as an Ornstein-Uhlenbeck process, whose mean-reversion level is linearly affected by the current value of the controlled key interest rate. The central bank's problem is modeled as a degenerate two-dimensional singular stochastic control problem, in which the aim is to minimize the total expected cost of having the inflation rate and the key interest rate not aligned with given target values, plus the total expected costs of interventions on the key interest rate. We solve the problem by combining viscosity-theory and free-boundary analysis. We find that the optimal solution is is triggered by two continuous and monotone curves solving a system of functional equations. These equations are determined as necessary optimality conditions, once a second-order smooth-fit property of the control problem's value function is proved. This talk is based on a joint work with Salvatore Federico and Patrick Schuhmann.

An optimal consumption problem with regimes and memory

Tuesday
June 11
14h30-15h00

Emel Savku
École Polytechnique

The main reason that regime-switching models received a lot of attention by the researchers is the ability of these models to capture the different modes of the financial market easily. Moreover, in the real world, investors tend to look at the historical performance of the risky assets. Hence, we study on a stochastic optimal control problem for a delayed Markov regime switching jump-diffusion model, which combines both of these motivations. We establish necessary and sufficient maximum principles for such a system and prove the existence-uniqueness theorem for the adjoint equations which are represented by an anticipated backward stochastic differential equation with jumps and regimes. We illustrate our results by a problem of optimal consumption problem from a cash flow with delay and regimes.

Mortality options: The point of view of the insurer

Tuesday
June 11
15h00-15h30

Maren Diane Schmeck
Bielefeld University

The basic idea behind insurance is to diversify risks. If a systematic risk is involved, this idea does not work well any more. So the idea arose to transfer the insurance risk to financial markets. Even though not perfectly linked to the own portfolio, these securitisation products work similarly to a reinsurance contract. For an investor, the products give a possibility to diversify an investment portfolio. Also insurers may act as investor and in this way diversify their own risk to regions where they have not underwritten contracts.

The literature on securitisation products considers either the point of view of an investor, or the product is used to perform a Markovitz optimisation. From the point of view of an insurer, this only partially answers the question how to choose a securitisation portfolio. We will here use utility theory and stochastic control in discrete time to determine the optimal portfolio. In order to simplify the presentation we consider the case of a mortality catastrophe bond. Similar consideration would also apply for other securitisation products.

Tuesday, June 11: CVA/XVA/CCP

Tuesday
June 11
14h00-14h30

Systemic risk and central clearing counterparty design

Hamed Amini

Georgia State University

We examine the effects on a financial network of multilateral clearing via a central clearing counterparty (CCP) from an ex ante and ex post perspective. The CCP is capitalized with equity and a guarantee fund. We propose a CCP design which improves aggregate surplus, increases the utility of the banks and of the CCP and reduces the expected shortfall losses on the endusers. We determine the CCP's equity and guarantee fund policies as a Nash bargaining solution. A simulation study based on aggregate market data shows that under our proposed design with hybrid guarantees there exists a unique Pareto optimal equity and guarantee fund policy of the CCP, which reduces systemic risk. (joint work with Damir Filipovic and Andreea Minca)

Tuesday
June 11
14h30-15h00

CVA and vulnerable options in stochastic volatility models

Fabio Antonelli

University of L'Aquila

In this work we want to provide a general principle to evaluate the CVA (Credit Value Adjustment) for a vulnerable option, that is an option that is subject to some default event, concerning the solvability of the option's issuer. This CVA, that leads to the correct evaluation of the option, is particularly important in presence of WWR (Wrong Way Risk), when a credit deterioration determines an increase of the vulnerable option's price.

In particular we are interested in evaluating the CVA in stochastic volatility models for the underlying's price, when the processes are correlated. By using a smart application of Ito's formula, we provide a formula for the SABR, Hull & White and Heston stochastic volatility models, showing explicitly how the pricing, in presence of independence among the processes, has to be corrected because of the processes correlation.

Funding adjustments in equity linear products

Tuesday
June 11
15h00-15h30

Andrea Pallavicini

Imperial College London

Valuation adjustments are nowadays a common practice to include credit and liquidity effects in option pricing. Funding costs arising from collateral procedures, hedging strategies and taxes are added to option prices to take into account the production cost of financial contracts so that a profitability analysis can be reliably assessed. In particular, when dealing with linear products, we need a precise evaluation of such contributions since bid-ask spreads may be very tight. In this paper we start from a general pricing framework inclusive of valuation adjustments to derive simple evaluation formulae for the relevant case of total return equity swaps when stock lending and borrowing is adopted as hedging strategy.

Tuesday, June 11: Portfolio optimization I

Utility maximization under time change

Tuesday
June 11
16h00-16h30

Asma Khedher

Univeristy of Amsterdam

We consider the problem of maximizing expected utility from terminal wealth in a semimartingale setting, where the semimartingale is written as a sum of a time changed Brownian motion and a finite variation process. To solve this problem we consider an initial enlargement of filtration and we derive a transformation rule for stochastic integrals w.r.t time-changed Brownian motions. The transformation rule allowed us to shift the problem to a maximisation problem under the enlarged filtration for models driven by a Brownian motion and a finite variation process. The latter could be solved by using martingale methods. Then applying again the transformation rule, we derive the optimal strategy for the original problem for a power utility under certain assumptions on the finite variation process of the semimartingale.

Solving quadratic optimisation problems without information

Tuesday
June 11
16h30-17h00

Martin Schweizer
ETH Zürich

Our initial goal is to solve the problems of mean-variance hedging (MVH) and mean-variance portfolio selection (MVPS) under restricted information. We work in a setting where the underlying price process S is a semimartingale, but not adapted to the filtration $\mathbb{G}$ which models the information available for constructing trading strategies. We choose as $\mathbb{G} = \mathbb{F}^{det}$ the zero-information filtration, so that strategies must be deterministic functions, and we assume that S is a time-dependent affine transformation of a square-integrable martingale. This class of processes includes in particular arithmetic and exponential Lévy models with suitable integrability. We give explicit solutions to the MVH and MVPS problems in this setting, and we show for the Lévy case how they can be expressed in terms of the Lévy triplet. Explicit formulas are obtained for hedging European call options in the Bachelier and Black–Scholes models. This is based on joint work with Danijel Zivoi and Mario Sikic.

Construction of discrete time shadow price - inductive direct approach

Tuesday
June 11
17h00-17h30

Lukasz Stettner
Institute of Mathematics - Polish Academy of Sciences

In the talk we consider the problem of market with general proportional transaction costs i.e. with general bid and ask prices in discrete time. We are looking for a price, called shadow price which is between bid and ask price and is such that optimal utility from terminal wealth is the same as on the market with bid and ask prices. The approach we present is direct, we are not using duality theory. Our method is based on induction with a sequence of recursive static models, which can be solved. Special attention will be devoted to multi asset case. The talk is based on the paper [RS], and further generalizations in which we consider concave not necessarily strictly concave utility functions.

T. Rogala, L. Stettner, Optimal strategies for utility from terminal wealth with general bid and ask prices, to appear 2019, Applied Mathematics & Optimization doi: 10.1007/s00245-018-9550-5

Tuesday, June 11: Credit risk

Dynamic hedging of CDS index options in Markov chain models

Tuesday
June 11
16h00-16h30

Alexander Herbertsson
University of Gothenburg

We study hedging of CDS index options in a credit risk model where the defaults times have intensities which are driven by a finite-state Markov chain representing the underlying economy. The hedging of the option on the CDS index is done with the CDS index itself using minimal variance hedging in the Markov chain model. In this setting we derive compact computationally tractable formulas for the gains processes both to the CDS index and the option on the CDS index which are used to find highly analytical and convenient expressions for the angle bracket processes to the corresponding quadratic variation and quadratic covariation processes for these two gains processes. The minimal variance hedging strategy is given by the ratio of the differentials of the two angle bracket processes. The evaluation of the parts involving the CDS index option is handled by translating the Cox-framework into a bivariate Markov chain. Due to the potentially very large, but extremely sparse matrices obtained in this reformulating, special treatment is needed to efficiently compute the matrix exponential arising from the Kolmogorov Equation based on results developed in Herbertsson (2018). The finite-state Markov chain model is calibrated to data with perfect fits, and several numerical studies of the minimal variance hedging strategies are performed as well as other related numerical studies.

Time consistent evaluation of credit risk with contagion

Tuesday
June 11
16h30-17h00

John-John Ketelbuters
Université Catholique de Louvain

A time-consistent evaluation is a dynamic evaluation according to which a risk that will be almost surely cheaper than another one at a future date should already be cheaper today. Common actuarial evaluations are usually not time-consistent. Pelsser and Ghalehjooghi (2016) derived time-consistent evaluations from actuarial evaluations that are not time-consistent. The aim of this paper is twofold. Firstly, we propose a model for credit insurance portfolios taking into account the contagion risk via self-exciting jump processes. Secondly, we use this model to extend the approach of Pelsser and Ghalehjooghi to credit insurance taking into account contagion risk. Starting from well known time-inconsistent actuarial evaluations, we derive partial differential equations for their time consistent analogue. We discuss numerical methods for solving these partial differential equations and their results. Our results allow to assess the impacts of both time-consistency and contagion risk on actuarial evaluations of credit insurance.

Tuesday
June 11
17h00-17h30

Delta-gamma approximation for the credit-valuation-adjustment of a vanilla option

Yves Rakotondratsimba

ECE Paris Graduate School of Engineering

The Credit-Valuation-Adjustment (CVA), considered as representing the market value of the counterparty default risk, is seen by OTC market participants as a derivative itself, which consequently must be managed.

Despite its inherent complexity, the CVA sensitivities with respect to the counterparty credit spread risk or to the underlying market risks have to be computed. Even CVA sensitivities with respect to the underlying asset are given here and there, the corresponding Delta-Gamma-Approximation (DGA) as the one for the option itself, seems to lack in the literature despites the obvious needs in the hedging replication of the CVA position or in the risk measurement determination.

We derive analytic formula approximations of the DGA for the CVA of an equity vanilla option, under the independence assumption between the underlying market risk, the counterparty default risk and the interest rate risk. Our three-steps-approach is essentially data-driven grounded, as no any specific stochastic processes are introduced to perform the scenarios required for the computation.

Indeed, first the standard DGA for an option is revisited and expanded in order to encompass high order greeeks and as well as to accommodate to large relative changes of the underlying asset. Next, using this finding for the option and assuming the availability of scenarios of the underlying equity price over some discrete future times, we develop full analytical approximation formulas leading to both the CVA value and its associated sensitivities with respect to the asset relative change. Finally, we provide an explicit approach to generate the forecast distribution for the equity price at multiple discrete future times just by using the historical data of equity prices but not a multi-output Gaussian process regression and learning.

Actually, our work aims to explore extension and alternative to standard approaches, with the hope that this would encourage to further research. In contrast with many available papers on CVA either insisting on the theoretical aspects or putting the emphasis on specific illustrative examples, we make here the effort to provide general formulas allowing the readers to carry by themselves the computations with the R codes accompanied with the paper.

Wednesday, June 12: Option pricing and hedging

Analytical valuation of performance-linked executive stock options

Wednesday
June 12
10h15-10h45

Otto Konstandatos

University of Technology Sydney

Executive Stock Options represent major items of corporate liability requiring fast and objective evaluation for reporting purposes. The International Accounting Standards Board IFRS9 financial reporting standard, which came into full effect on 1-Jan 2018, and its Australian implementation AASB9, requires public corporations to report their fair-value cost in financial statements. In this work we present a closed form analytical valuation for the fair value of an Executive Stock Option structure with very general market-based performance vesting conditions, which is fully consistent with the IFRS9 requirements. The need to align executive performance with employee reward, shareholder pressure and corporate governance issues have naturally led to the consideration of remuneration structures which incorporate performance conditions for the stock options granted to senior executives. Common market-based performance conditions require that total shareholder return of the company's stock exceed that of the company's peers, where 'peers' may be a competitor company, a small or large group of competitor companies or alternatively a broad market index. In this spirit we consider valuation with a performance-based vesting structure simultaneously incorporating a performance hurdle on the issuer's shareholder return, an out-performance of the return of a market competitor and also the out-performance of a broad market index. We incorporate post-vesting voluntary early exercise using the Hull and White (2004) characterisation. In our valuation framework we derive several lemmas which allow us to express our analytical results as highly symmetric portfolios of non-standard European instruments, greatly simplifying numerical implementation. Death, disability or ill health usually result in pre-vesting forfeiture or in post-vesting involuntary early exercise. Following IFRS9 requirements we incorporate such attrition by constructing probability-weighted portfolios of our analytical result derived from empirically determined survival functions. Our numerical results illustrate the effect of performance hurdles and survival adjustment on the theoretical fair-value valuation.

Wednesday
June 12
10h45-11h15

Accounting noise and the pricing of CoCos

Peter Spreij

University of Amsterdam

Contingent Convertible bonds (CoCos) convert into equity or are written down in times of distress. Existing pricing models assume conversion triggers based on market prices and assume that markets can observe relevant firm information. But existing CoCo triggers are based on accounting ratios and/or regulatory intervention. We incorporate that markets receive information through noisy accounting reports and distinguish between market and accounting values, and between automatic and regulator-mandated conversions. We also incorporate that coupon payments cannot exceed the Maximum Distributable Amount; this trigger explains the crash in CoCo prices after Deutsche Bank's profit warning in February 2016. We examine the impact of CoCo design, asset volatility and accounting noise on CoCo prices. Joint work with Mike Derksen and Sweder van Wijnbergen.

Wednesday
June 12
11h15-11h45

Optimal hedging in a discrete time multi-asset incomplete market

Victoria Steblovskaya

Bentley University

We consider a problem of optimal hedging of a path-independent multi-asset contingent claim in the framework of a discrete time incomplete market.

In the case of a finite probability space, we show that such a market model yields an infinite set of risk-neutral probabilities which comprise a convex polytope in a finite dimensional affine space. We then give an explicit and efficient algorithm for computing the boundaries of the no-arbitrage price interval for a contingent claim in question. In the case of a two-asset option in a two-dimensional binomial market, we give explicit formulas for the upper and the lower bounds of these prices, recovering in a more elegant way results of [1].

Extending this geometric approach to the problem of optimal hedging with non-self-financing hedging strategies, we extend the results of [1] to the case of a multi-asset contingent claim in a more general discrete time incomplete market, where the stock price ratios are distributed over a convex set in and the pay-off function of the option is convex.

We describe a hedging strategy as a function of model parameters and construct an algorithm which determines an optimal set of model parameters and as a result an optimal hedging strategy with respect to an investor relevant optimization criterion.

A similar geometric approach has been considered in [2] for self-financing strategies.

[1] A. Nagaev and V. Steblovskaya (2006): On a Two Dimensional Binary Model of a Financial Market and its Extension, Discrete Mathematics and Applications, 16, 2, 109-134.

[2] M. Motoczynski and L. Stettner (1998): On option pricing in the multidimensional Cox-Ross-Rubinstein model, Appl. Mathematicae 25, 55-72.

Wednesday, June 12: Stochastic analysis and modeling in finance

Modeling the electricity demand in the intraday market: an SDE approach

Wednesday
June 12
10h15-10h45

Sema Coskun

University of Kaiserslautern

In this study, we propose a model for the electricity demand in the German intraday market. The increase in percentage of renewable energy resources (e.g. from %31.6 in 2016 to %36.2 in 2017 [5]) in electricity production has a substantial effect on the German intraday market. The renewable energy production results in a more volatile environment due to forecast errors and the owner of a renewable energy resource tends to trade in the intraday market to be able to adjust the forecast and their position more precisely [1]. In particular, in the German intraday market the trading continues up to 30 minutes before the delivery, so the market participants have the opportunity to react to the forecasted offer of renewable energy even closer to real-time. This indeed makes the intraday market more attractive for the traders. For instance, the traded volume in German intraday market has increased from 41 TWh in 2016 to 47 TWh in 2017, i.e. %15.1 [4]. Hence, it can be concluded that intraday markets are gaining more importance and also growing by the increase of renewable energy resources. Therefore, it is necessary to introduce a model for the spot price or the electricity demand which closely captures the real dynamics of the intraday market.

With this motivation, we propose a statistical model for the electricity demand in the intraday market by following a similar approach to the one given in [3]. In our setting, statistical modeling refers to time series analysis of the actual consumption data in Germany which covers the time span from 07.10.2014 to 31.12.2017 with hourly resolution of 28368 data points. We exploit statistical information contained by the data in order to get an insight for the modeling concerns.

We primarily consider the Jacobi process, which is initially given in [2] as a model for the dynamic behaviour of the interest rate in a target zone as follows

$$dr_t = \alpha(r_\mu - r_t)dt + \beta\sqrt{(r_t - r_m)(r_M - r_t)}dW_t$$

where r_μ is the mean reversion level, r_m and r_M are lower and upper bounds bounds for the process r_t, respectively. We further modify the Jacobi process by utilizing the data analysis results. Finally, we present the model calibration results of the proposed model.

Keywords: Intraday market, Electricity demand, Stochastic Differential Equations

References:

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[5] Umweltbundesamt. Erneuerbare Energien in Deutschland - Daten zur Entwicklung im Jahr 2017. Technical report, Geschäftsstelle der Arbeitsgruppe Erneuerbare Energien-Statistik (AGEE-Stat) am Umweltbundesamt, 2017.

Wednesday
June 12
10h45-11h15

Correlators of polynomial processes

Silvia Lavagnini

Center of Mathematics for Applications (Oslo)

A process is polynomial if its extended generator maps any polynomial to a polynomial of equal or lower degree. Then its conditional moments can be calculated in closed form, up to the computation of the exponential of the so-called generator matrix. For this reason, polynomial processes find application in financial pricing. However, calculations become more tricky when introducing the concept of correlators, which involves the product of powers of the polynomial process considered at different time points. In this project, we provide a closed formula to such a problem, which holds for any finite number of time points. The strength of such a formula is that it only involves linear combinations of the exponential of the generator matrix, as it was in the one-dimensional case. The framework developed allows then for easy-to-implement solutions when it comes to financial pricing, for example in the case of Asian option or stochastic volatility models.

A semigroup approach to nonlinear Lévy processes

Wednesday
June 12
11h15-11h45

Max Nendel

Center for Mathematical Economics, Bielefeld University

We study the relation between Lévy processes under nonlinear expectations, nonlinear semigroups and fully nonlinear PDEs. First, we establish a one-to-one relation between nonlinear Lévy processes and nonlinear Markovian convolution semigroups. Second, we provide a condition on a family of infinitesimal generators $(A_\lambda)_{\lambda\in\Lambda}$ of linear Lévy processes which guarantees the existence of a nonlinear Lévy process such that the corresponding nonlinear Markovian convolution semigroup is a viscosity solution of the fully nonlinear PDE $\partial_t u = \sup_{\lambda\in\Lambda} A_\lambda u$. The results are illustrated with several examples.

Representation theorem for Itô-Markov additive processes and completeness of the market

Wednesday
June 12
11h45-12h15

Anna Sulima

Wroclaw University of Economics

I will present the results of paper [1] and [2] about representation theorem for Itô-Markov Additive Processes and use this theorem to prove the completeness of the market. The Itô-Markov additive process is governed by a finite-state continuous time Markov chain which allows one to modify the parameters of the Itô-jump process (in so-called regime switching manner). In addition, the transition of Markov chain triggers the jump depending on the states of Markov chain just prior to the transition. This family of processes includes Markov modulated Itô-Lévy processes and Markov additive processes. The chaotic representation of a square-integrable random variable is given as a sum of stochastic integrals with respect to some explicitly constructed orthogonal martingales. We identify the predictable representation of a square-integrable martingale as a sum of stochastic integrals of predictable processes with respect to Brownian motion and power-jumps martingales related to all the jumps appearing in the model. This result generalizes the seminal result of Jacod-Yor and is of importance in financial mathematics. The derived representation then allows one to enlarge the incomplete market by a series of power-jump assets and prove the completness of the market.

Joint work with prof. Z. Palmowski and prof. L. Stettner.

References:

1. Z. Palmowski, L. Stettner, A. Sulima [2019] Optimal portfolio selection in an Ito-Markov additive market, Risks 7(1) 34.

2. Z. Palmowski, L. Stettner, A. Sulima [2018] A note on chaotic and predictable representations for Ito-Markov additive processes, Stochastic Analysis and Applications 36(4) (2018), s. 622-638 .

Wednesday, June 12: Credit risk and interest rate modeling

Wednesday
June 12
15h00-15h30

Martingale representation in credit risk modelling

Anna Aksamit
The University of Sydney

We focus on the reduced form modelling approach to credit risk in which a credit event is an exogenous random time τ. We therefore work in the setting of the progressive enlargement $\mathbb{G}$ of a reference filtration $\mathbb{F}$ through the observation of the occurrence of a random time τ.

We study an integral representation property for some classes of $\mathbb{G}$-martingales stopped at τ. This problem is closely related to the classical problem of the stability of the predictable representation property studied first by Kusuoka in the particular set-up of a Brownian filtration $\mathbb{F}$, and then by Jeanblanc & Song in full generality.

Comparing to their result we limit ourselves to some particular set-ups but we attempt to derive explicit expressions for the predictable integrands, rather than merely to establish their existence and uniqueness. Moreover we go beyond the assumptions required by the previous results (e.g., we do not assume that $\mathcal{G}_\tau = \mathcal{G}_{\tau-}$).

In the first part, we focus on the case where $\mathbb{F}$ is a Poisson filtration and we establish a predictable representation property with respect to three $\mathbb{G}$-martingales. In the second part, we relax the assumption that $\mathbb{F}$ is a Poisson filtration and we assume that τ is an $\mathbb{F}$-pseudo-stopping time. We establish integral representations with respect to some $\mathbb{G}$-martingales built from $\mathbb{F}$-martingales and, under additional hypotheses, we obtain a predictable representation property with respect to two $\mathbb{G}$-martingales.

This is joint work with Monique Jeanblanc and Marek Rutkowski.

Wednesday
June 12
15h30-16h00

Term structure modeling for multiple curves with stochastic discontinuities

Claudio Fontana
University of Padova

A key feature of interest rate markets is the presence of stochastic discontinuities, namely jumps at predetermined dates, for instance in correspondence to monetary policy meetings of the ECB. Typically, the timing of such events is known ex-ante, while their financial impact is not fully predictable. In this talk, we propose a general framework for incorporating stochastic discontinuities in the multi-curve post-crisis interest rate market. We study absence of arbitrage by means of NAFLVR and show that the proposed framework allows for a unified analysis of HJM and market models. Finally, we argue that affine semimartingales, as recently introduced in Keller-Ressel et al. (2018), represent a flexible class of driving processes.

Interbank credit risk modelling with self-exciting jump process

Wednesday
June 12
16h00-16h30

Charles Njike
UCLouvain

The credit crunch of 2007 caused major changes in the interbank market rates making existing interest rate theory inconsistent. We remind one way to reconcile practice and theory by modifying the arbitrage-free condition. In this framework, the simple forward Libor rate is not considered anymore as a risk-free rate and its dynamic is driven by the presence of the credit and liquidity risk within the interbank market. We model the simple forward Libor rate by taking into account the new market features through the multiple-curve approach. In this approach, we model the joint evolution of the default-free rates, assimilated to overnight interest swap rates, and the default times of the interbank market. To deal with the credit risk of this generic counterparty we use the reduced form approach and model the arrival rate of defaults by a self-exciting jump-diffusion process. We next deduce the dynamic of the simple spot forward Libor rates, and explicitly present the impact of jumps on the Libor dynamic. Then, we provide closed-form approximation pricing formulae for options on simple forward Libor rates and swap rates. Finally, we fit these models to OIS and IRS 6 months curve on 11 February 2019, and analyze the sensitivity of the implied cap volatility to parameters defining the self-excitation.

Wednesday, June 12: Portfolio optimization II

Optimal converge trading with unobservable pricing errors

Wednesday
June 12
15h00-15h30

Suhan Altay
Vienna University of Economics and Business

We study a dynamic portfolio optimization problem related to convergence trading, which is an investment strategy that exploits temporary mispricing by simultaneously buying relatively underpriced assets and selling short relatively overpriced ones with the expectation that their prices converge in the future. We build on the model of Liu and Timmermann (2013) and extend it by incorporating unobservable Markov-modulated pricing errors into the price dynamics of two co-integrated assets. We characterize the optimal portfolio strategies in full and partial information settings both under the assumption of unrestricted and beta-neutral strategies. By using the innovations approach, we provide the filtering equation that is essential for solving the optimization problem under partial information. Finally, in order to illustrate the model capabilities, we provide an example with a two-state Markov chain.

Wednesday
June 12
15h30-16h00

Portfolio selection with higher-order moments: A target-distribution approach

Nathan Lassance

Louvain Finance (LFIN) and UCLouvain

We introduce an information-theoretic approach to the portfolio-selection problem where the investor's preferences are captured via a target-return distribution. In turn, we look for the minimum-divergence portfolio, which is the portfolio whose return density is as close as possible to the target-return density, as measured by the Kullback-Leibler (KL) divergence. This functional approach provides a natural alternative to the standard maximum-utility approach. We study the generalized-normal target-return distribution, an extension of the Gaussian distribution allowing for varying levels of kurtosis. Several theoretical contributions are provided. First, in the base case of Gaussian asset returns, we show that the resulting minimum-divergence portfolio remains mean-variance efficient. Otherwise, the portfolio is also impacted by the higher-moment preferences embedded in the generalized-normal target return, and thus, will favour solutions with superior higher-moment properties that may no longer be mean-variance efficient. Second, for the Gaussian target return, we show that the KL divergence can be decomposed in a sum of three terms that respectively depend on the portfolio-return mean, variance and standardized entropy. The first two terms control the fit to the target-return first two moments. The third term controls the shape of the portfolio density and captures in a single term the whole uncertainty related to the higher-order moments. Third, when targeting a Dirac distribution, we obtain a novel parametrization of the mean-variance efficient frontier. With regards to finite-sample estimation, we provide a closed-form estimator of the objective function based on a Gaussian-mixture density estimator. We test our framework on several benchmark mean-variance efficient portfolios and compare them with the minimum-divergence portfolios obtained for a target return whose mean and variance match those of the benchmark portfolios. Our portfolios are shown to provide similar mean-variance trade-offs but combined with substantially less tail risk, including in crisis periods. Moreover, they outperform common higher-moment portfolio strategies as well.

Wednesday
June 12
16h00-16h30

Single-family houses portfolio optimization under impact of large investors in housing markets

Bilgi Yilmaz

Institute of Applied Mathematics, METU, Ankara

Following the 2008 financial crisis, some large investors, who are purchasing single-family houses, started creating large portfolios consisting of rental single-family houses, and securitizing these investments in capital, showed up in housing markets. This study attempts to explore a portfolio optimization to shed light on the systematic evidence of the effect of this new investor activity in housing markets. To this end, the study aims to optimize the portfolio by offering a stochastic model to

estimate house prices by considering the influence of large investors and the state of the economy. The results indicate that the investment strategies of these investors depend on the balance among economic state, maintenance, rent income, interest rate, and investment willingness to housing.

Keywords: Portfolio Optimization, Housing market, Large investors, Regime switching processes

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Thursday, June 13: Limit order book and algorithmic trading

Optimal execution with a view on price momentum for transient mutliplicative impact

Thursday
June 13
09h00-09h30

Dirk Becherer

Humboldt University, Berlin

We solve the optimal execution problem to sell a large financial asset position in an illiquid market where price impact is transient and possibly non-linear (in log-prices). The model can be seen as a multiplicative variant of the models by Obizhaeva/Wang (2013) or Predoiu/Shaikhet/Shreve (2011) with multiplicative price impact, non-negative prices, and unaffected price dynamics being geometric Brownian motion with possible non-zero drift.

Because of the non-zero drift, solution methods based on convex analysis are out of reach. We prove optimality for a fairly explicit solution for the three dimensional free boundary decribing the (no-)action regions for the singular control problem. To this end, we use calculus of variation to identify a candidate for the boundary surface and prove at first local optimality near the said boundary. Using this local optimality result, we can then extend the HJB variational inequality to the whole state space and thereby prove global optimality for the non-convex problem, similarly to B./Bilarev/Frentrup (2018).

Thursday
June 13
09h30-10h00

A switching microstructure model for stock prices

Donatien Hainaut
Université Catholique de Louvain

This article proposes a microstructure model for stock prices in which parameters are modulated by a Markov chain determining the market behaviour. In this approach, called the switching microstructure model (SMM), the stock price is the result of the balance between the supply and the demand for shares. The arrivals of bid and ask orders are represented by two mutually- and self-excited processes. The intensities of these processes converge to a mean reversion level that depends upon the regime of the Markov chain. The first part of this work studies the mathematical properties of the SMM. The second part focuses on the econometric estimation of parameters. For this purpose, we combine a particle filter with a Markov Chain Monte Carlo (MCMC) algorithm. Finally, we calibrate the SMM with two and three regimes to daily returns of the S&P500 and compare them with a non switching model.

Thursday
June 13
10h00-10h30

A recurrent neural network approach in high-frequency trading

Dragana Radojicic
Technical University of Vienna

The field of Artificial Intelligence has been used in various areas, and one of the many possible applications of machine learning is in the research regarding high-frequency trading. In order to develop a statistical arbitrage strategy, we describe the behavior present in the market, using the concepts of supervised and unsupervised learning. More precisely, we use different measures to extract the technical indicators that contain valuable information and hopefully can be used within a specially designed recurrent neural network to classify each time frame data as a point when it is suitable to buy/sell or idle.

Thursday, June 13: Robust finance

Dynamic robust Orlicz premia and Haezendonck-Goovaerts risk measures

Thursday
June 13
09h00-09h30

Emanuela Rosazza Gianin

University of Milano-Bicocca

Robust Orlicz premia and Haezendonck-Goovaerts risk measures have been introduced by Bellini, Laeven and Rosazza Gianin (2018) mainly to take into account ambiguity with respect to the probabilistic model P given a priori, by means of multiple priors, variational preferences, or homothetic preferences.

In this paper we extend to a dynamic setting the notions above and we extensively analyze the properties of the resulting dynamic risk measures. Furthermore, we characterize dynamic Orlicz premia that are time-consistent, and establish some relations between the time-consistency properties of dynamic robust Orlicz premia and the corresponding dynamic robust Haezendonck-Goovaerts risk measures.

MOT duality and robust finance

Thursday
June 13
09h30-10h00

David Prömel

University of Oxford

Without assuming any probabilistic price dynamics, we consider a frictionless financial market given by the Skorokhod space, on which Vanilla options are liquidly traded. In this robust setting we recover fundamental results from classical mathematical finance: the pricing-hedging duality and the fundamental theorem of asset pricing.

In order to obtain the robust pricing-hedging duality, we study martingale optimal transport (MOT) dualities: We obtain a dual representation of the Kantorovich functional (super-replication functional) defined for functions (financial derivatives) on the Skorokhod space using quotient sets (hedging set). Our representation takes the form of a Choquet capacity generated by martingale measures satisfying additional constraints to ensure compatibility with the quotient sets.

As an immediate consequence of the duality result, we deduce a general robust fundamental theorem of asset pricing.

Thursday
June 13
10h00-10h30

A robust second order stochastic dominance portfolio optimization model

Ruchika Sehgal

Indian Institute of Technology Delhi

Stochastic dominance criteria rank the random variables with uncertain prospects and are known to be consistent with the expected utility theory. Portfolio optimization with second-order stochastic dominance (SSD) constraints creates an optimal portfolio ideal for rational and risk-averse investors. The classical portfolio optimization models assume the input data to be known with certainty and overlook the situations where the problem structure along with the input parameters and the decision variables are non-deterministic. Moreover, return and risk evaluation in a portfolio depend on the correctness of the underlying distribution followed by returns of the assets. The parametric uncertainty in a portfolio optimization model typically arises in two ways: one concerning the realized returns of the assets and second owing to the probability distributions of the returns of the assets. Robust optimization techniques have been widely applied to construct optimal portfolios immune to such forms of parametric uncertainty.

In this paper, we construct a robust portfolio optimization model involving SSD constraints. We consider the input returns of the assets as uncertain parameters and vary them in the symmetric and bounded intervals to construct an optimal robust portfolio. Although the resulting optimization model is a linear program (LP), it involves an immensely large number of constraints. We apply the cutting plane algorithm to solve the robust model in a time efficient manner. The performance of the robust model is tested on several datasets from across the global markets. The robust model is shown to yield superior performance in terms of Sharpe ratio, and STARR ratio, and lower risk measured by standard deviation, worst return, violation area in SSD (VAS), VaR and CVaR, compared to the corresponding non-robust model.

Thursday, June 13: Numerical and machine learning methods in finance

Conditional Monte Carlo methods under stochastic volatility models

Thursday
June 13
14h00-14h30

Riccardo Brignone

Università degli Studi di Milano-Bicocca

We develop conditional Monte Carlo methods for simulating the Heston, Stochastic Alpha Beta Rho (SABR), and Ornstein-Uhlenbeck stochastic volatility models. Sampling from these models represents a nontrivial longstanding problem with various solution attempts in the literature, which are mainly based on time-discretization (or other) techniques with inherent biases, or some might be exact but with imbalanced runtimes. Our method relies on the integer moments of the conditional integrated variance. Besides the more standard case of path-independent derivatives, we exhibit the range of applicability of our methods to options whose payoff is dependent on the maximum (or minimum) value of some underlying asset, such as barrier, lookback and hindsight options, where alternative valuation approaches might even be unavailable under the asset price dynamics of interest. Numerical experiments highlight the accuracy-runtime benefits of our proposed methodologies.

Stochastic gradient hamiltonian Monte Carlo for non-convex learning in the big data regime

Thursday
June 13
14h30-15h00

Ngoc Huy Chau

Alfréd Rényi Institute of Mathematics

Most of machine learning algorithms train their models and perform inference by solving minimization problems where objective functions are usually non-convex. In this talk, we will discuss the Stochastic Gradient Hamiltonian Monte Carlo (SGHMC) algorithm. Non-asymptotic convergence analysis of SGHMC is given in the context of non-convex optimization, where subsampling techniques are used over an i.i.d dataset for gradient updates. Our results complement and improve those in the literature.

Thursday
June 13
15h00-15h30

On the approximation of Lévy driven Volterra processes and their integrals

Andrea Fiacco
University of Oslo

Volterra processes appear in several applications ranging from turbulence to energy finance where they are used in the modelling of e.g. temperatures and wind, and the related financial derivatives. Volterra processes are in general non-semimartingales, see e.g. [1] and a theory of integration with respect to such processes is in fact not standard. In our work we consider Volterra type processes driven by Lévy noise L_t, $t \geq 0$, of the form:

$$Y_t := \int_0^t g(t-s)dL_s, \qquad t \geq 0,$$

with g a deterministic kernel, and we suggest to approximate them by semimartingales Y^ϵ. This is because semimartingales constitute the largest class of integrators for a stochastic integration theory (Itô type integration), well-suited for applications where the adaptedness or the predictability with respect to a given information flow plays an important role. Also, numerical methods are flourishing in the case of semimartingale models. Thus such approximations open up for the study not only of the integration with respect to Y, but also the study of computation techniques. As illustration, the Lévy driven Gamma-Volterra processes and their integrals are studied in full detail along with their approximations. Specifically, our approximation is based on the perturbation of the kernel:

$$Y_t^\epsilon = \int_0^t g^\epsilon(t-s)dL_s, \qquad t \geq 0, \quad \epsilon > 0.$$

The kernels g^ϵ are given in a such a way that the processes Y^ϵ are semimartingales. Our results provide conditions to guarantee that $\forall\, t \geq 0$

$$Y_t^\epsilon \longrightarrow Y_t, \qquad \epsilon \to 0$$

in L^p-sense for some $p \geq 1$. As for what concerns stochastic integration with respect to Y, we consider a pathwise-type of integration based on fractional calculus, as introduced in [2]. That is, we define the generalized Lebesgue-Stieltjes integral of X with respect to Y by:

$$\int_0^t X_s dY_s := \int_0^t \left(\mathcal{D}_{0+}^{\alpha} X\right)(s) \left(\mathcal{D}_{t-}^{1-\alpha} Y_{t-}\right)(s) ds,$$

when the above integral exists, where $\mathcal{D}_{0+}^{\alpha} X$ and $\mathcal{D}_{t-}^{1-\alpha} Y_{t-}$ are the Riemann-Liouville left and right fractional derivatives. For this we define the two classes of integrands and integrators for which the above integral is well defined. Taking specifically the case of Volterra processes Y into account, we find conditions that ensures that Y is an appropriate integrator for all integrands X. Finally, we exploit the approximations Y^ϵ of Y to study the integrals and their approximations: $\forall\, t \geq 0$

$$\int_0^t X_s dY_s^\epsilon \longrightarrow \int_0^t X_s dY_s, \qquad \epsilon \to 0$$

in the L^1-sense. Finally, we include an algorithm for numerical simulation. We take again as example the case of a Gamma-Volterra process, driven by a symmetric tempered stable Lévy process. As far as it concerns the integrals, we consider two different integrands, using a classical numerical integration with an Euler scheme.

Randomized dimension reduction for Monte Carlo simulations

Thursday
June 13
15h30-16h00

Nabil Kahale
ESCP-EAP École Supérieure de Commerce de Paris

We present a new unbiased algorithm that estimates the expected value of $f(U)$ via Monte Carlo simulation, where U is a vector of d independent random variables, and f is a function of d variables. We assume that f does not depend equally on all its arguments. Under certain conditions we prove that, for the same computational cost, the variance of our estimator is lower than the variance of the standard Monte Carlo estimator by a factor of order d. Our method can be used to obtain a low-variance unbiased estimator for the expectation of a function of the state of a Markov chain at a given time-step. We study applications to volatility forecasting and time-varying queues. Numerical experiments show that our algorithm dramatically improves upon the standard Monte Carlo method for large values of d, and is highly resilient to discontinuities.

Thursday, June 13: Risk measures

Risk measures based on benchmark loss distributions

Thursday
June 13
14h00-14h30

Valeria Bignozzi
University of Milano-Bicocca

We introduce a class of quantile-based risk measures that generalize Value at Risk (VaR) and, likewise Expected Shortfall (ES), take into account both the frequency and the severity of losses. Under VaR a single confidence level is assigned regardless of the size of potential losses. We allow for a range of confidence levels that depend on the loss magnitude. The key ingredient is a benchmark loss distribution (BLD), i.e. a function that associates to each potential loss a maximal acceptable probability of occurrence. The corresponding risk measure, called Loss VaR (LVaR), determines the minimal capital injection that is required to align the loss distribution of a risky position to the target BLD. By design, one has full flexibility in the choice of the BLD profile and, therefore, in the range of relevant quantiles. Special attention is given to piecewise constant functions and to tail distributions of benchmark random losses, in which case the acceptability condition imposed by the BLD boils down to first-order stochastic dominance. We investigate the main theoretical properties of LVaR with a focus on their comparison with VaR and ES and discuss applications to capital adequacy, portfolio risk management, and catastrophic risk.

Thursday
June 13
14h30-15h00

Risk measures and progressive enlargement of filtrations: a BSDE approach

Alessandro Calvia

University of Milano-Bicocca

From the beginning of the 21st century, connections between dynamic risk measures and Backward Stochastic Differential Equations (or BSDEs, for short) have been studied in the literature. BSDEs are well established tools in mathematical finance (see, e.g., [2]) and, as is known, one can induce dynamic risk measures from their solutions. The theory of g-expectations, developed by S. Peng (see, e.g., [4]), paved the way for this connection, that has been thoroughly studied when the noise driving BSDEs is either a brownian motion (see, e.g., [1,6]) or a brownian motion and an independent Poisson random measure (as in [5]).

Here we consider a class of BSDEs with jumps (BSDEJ) introduced by I. Kharroubi and T. Lim, whose driving noise is given by a brownian motion and a marked point process. Starting from the existence and uniqueness results of the solution (Y, Z, U) of the BSDEJ with fixed terminal time $T > 0$ provided in [3], we define the induced dynamic risk measure as the functional mapping any essentially bounded terminal condition of the BSDEJ into the first component Y of its solution.

From a financial perspective, such BSDEJs and, consequently, the induced dynamic risk measures, can be adopted to evaluate the riskiness of a future financial position (modelled by the terminal condition) when there are possible default events, described by the marked point process driving the BSDEJ. Another important feature is that the information available to financial agents is progressively updated as these random events occur. This feature is mathematically encoded in the progressive enlargement of a brownian reference filtration. It is proved in [3] that under such a framework it is possible to provide a decomposition of the solution (Y, Z, U) into processes that are solution, between each pair of consecutive random times, of BSDEs driven only by the brownian motion.

The aim of this paper is to show, in the single jump case to ease the notation, that a similar decomposition holds also for the dynamic risk measure induced by the BSDEJ: we obtain two risk measures, acting respectively before and after the default time. Furthermore, we prove that properties of the driver of the BSDEJ are reflected into desirable properties of the dynamic risk measure, such as monotonicity, convexity, homogeneity, etc... Finally, we show that the dynamic risk measure is time consistent, focus on its dual representation and provide some examples.

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Intra-horizon expected shortfall and risk structure in models of jumps

Thursday
June 13
15h00-15h30

Ludovic Mathys

University of Zürich

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 in [BP10]. 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 [CD04]. 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.

Thursday
June 13
15h30-16h00

On the properties of Λ-quantiles

Ilaria Peri

Department of Economics, Mathematics and Statistics, Birkbeck, University of London

The aim of this work is to study the properties of a family of risk measures recently introduced in [5] and [1] under the name of Λ-Value at Risk. Our main theoretical result is an axiomatization of the corresponding Λ-quantiles, that is similar in spirit to the one provided in [2] for the usual quantiles. We then introduce Λ-quantile regression as an extension of the usual quantile regression of [6]. As a financial application, we compare the forecasts of Λ-quantiles obtained by a standard Garch(1,1) model with innovations with the ones obtained by a Λ-quantile regression that uses among the covariates also the VIX Index. Backtesting is performed by means of the techniques developed in [3] and [4].

References:

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Thursday, June 13: Equilibrium models

Pathwise Kyle equilibrium model

Thursday
June 13
14h00-14h30

Jose Corcuera
Departament de Matematiques i Informatica, Universitat de Barcelona

We study the equilibrium in the model proposed by Kyle in 1985 and extended to the continuous time setting by Back in 1992. The novelty of this work is that we consider a general price functional of the path of the aggregate demand and by using the functional Itô caculus we give necessary and sufficient conditions for the existence of an equilibrium. We also study the equilibrium when the insider is risk averse.

Key words: Kyle model, market microstructure, equilibrium, insider trading, stochastic control, semimartingales

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Equilibrium asset pricing with transaction costs

Thursday
June 13
14h30-15h00

Martin Herdegen
University of Warwick

We study a risk-sharing equilibrium where heterogenous agents trade subject to quadratic transaction costs. The corresponding equilibrium asset prices and trading strategies are characterised by a system of nonlinear, fully-coupled forward-backward stochastic differential equations. We show that a unique solution generally exists provided that the agents' preferences are sufficiently similar. In a benchmark specification, the illiquidity discounts and liquidity premia observed empirically correspond to a positive relationship between transaction costs and volatility.

Aggregation of heterogeneous consistent progressive utilities

Thursday
June 13
15h00-15h30

Caroline Hillairet
École Nationale de la Statistique et de lÁdministration Économique

We aim to describe globally the behavior and preferences of heterogeneous agents. Our starting point is the aggregate wealth of a given economy, with a given repartition of the wealth among investors, which is not necessarily Pareto optimal. We propose a construction of an aggregate forward utility, market consistent, that aggregates the marginal utility of the heterogeneous agents. This construction is based on the aggregation of the pricing kernels of each investor. As an application we analyze the impact of the heterogeneity and of the wealth market on the yield curve.

Joint work with Nicole El Karoui et Mohamed Mrad.

Thursday
June 13
15h30-16h00

Costly short sales and nonlinear asset pricing

Rodolfo Prieto

INSEAD Institut Européen dádministration des Affaires

We study a dynamic general equilibrium model with costly-to-short stocks and heterogeneous beliefs. The model is solved in closed-form and shows that costly short sales drive a wedge between the valuation of assets that promise identical cash flows but are subject to different lending fees. The price of an asset is given by the risk-adjusted present value of its future cash flows, which include both dividends and an endogenous yield derived from lending fees. This pricing formula implies that asset returns satisfy a modified capital asset pricing model which includes a negative adjustment for lending fees and, thus, provides a theoretical foundation for the recent findings on the role of lending fees as an explanatory variable of stock returns. Empirical results are consistent with the theory proposed.

Friday, June 14: Stochastic control in finance

Friday
June 14
10h15-10h45

Maximum principles for Volterra time change processes

Michele Giordano

University of Oslo

We establish a framework for the study of backward stochastic Volterra integral equations (BSVIE) driven by time-changed Lévy noises. In fact we shall consider the random measure μ:

$$\mu(\Delta) = B(\Delta \cap [0,T] \times \{0\}) + \widetilde{H}(\Delta \cap [0,T] \times \mathbb{R}_0),\ \Delta \in \mathcal{B}([0,T] \times \mathbb{R})$$

where B is a conditional Gaussian measure on $[0,T] \times \{0\}$, and $\widetilde{H}$ is a conditional centered Poisson measure on $[0,T] \times \mathbb{R}_0 := [0,T] \times \mathbb{R} \backslash \{0\}$.

In this paper we deal with two information flows

- $\mathbb{F} := \{\mathcal{F}_t,\ t \in [0,T]\}$, namely the smallest right continuous filtration to which μ is adapted,
- $\mathbb{G} := \{\mathcal{G}_t,\ t \in [0,T]\}$, generated by μ and the entire history of the time change processes,

and we shall consider the information $\mathbb{F}$ as partial with respect to $\mathbb{G}$.

Given a controlled dynamic:

$$X^u(t) = X_0 + \int_0^t b(t,s,\lambda,u,X)ds + \int_0^t \int_{\mathbb{R}} \kappa(t,s,z,\lambda,u,X)\mu(ds,dz),$$

we consider the optimization problem of finding

$$\sup_{u\in\mathcal{A}} J(u) = \sup_{u\in\mathcal{A}} \mathbb{E}\left[\int_0^T F(t, X^u(t), u(t))dt + G(X^u(T))\right]$$

for a suitable control set $\mathcal{A}$ which we consider to be either $\mathbb{F}$ or $\mathbb{G}$ predictable.

We prove both a sufficient and a necessary maximum principle for such performance functional, showing that in the $\mathbb{F}$-predictable case we can find a solution by projecting the results obtained for the $\mathbb{G}$-predictable case onto the $\mathbb{F}$-predictable one.

We shall make use of stochastic derivatives. We stress that we cannot use the classical Malliavin calculus as our integrators are not the Brownian motion nor the centered Poisson random measure. Indeed we could use a conditional form of such calculus as introduced by Yablonsky (2005). However we resolve by using the *non-anticipating derivative* introduced in Di Nunno (2002) and for martingale random fields as integrators in Di Nunno and Eide (2009). The use of the non-anticipating derivative has also the advantage that we do not require more restrictive conditions on domains, since it is already well defined for all $L^2(P)$ random variables.

When studying such problems, we come across a BSVIE of the form

$$\begin{aligned} Y_t &= \xi(t) + \int_t^T g(t, s, \lambda, Y, \phi)ds - \int_t^T \int_{\mathbb{R}} \phi(t, s, z)\mu(ds, dz) \\ Y_T &= \xi(T) \end{aligned}$$

where μ is as above.

We prove existence and uniqueness results for such BSVIE and we compute an explicit solution in the linear case.

Examples and applications will be presented.

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Friday
June 14
10h45-11h15

Risk sensitive dyadic impulse control for unbounded processes

Marcin Pitera

Faculty of Mathematics and Computer Science of the Jagiellonian University

Dyadic impulse control of continuous time Feller-Markov processes with risk-sensitive long-run average cost is considered. The uncontrolled process is assumed to be bounded in the weighted norm and to be ergodic; the process could be unbounded in the supremum norm and do not necessarily satisfy uniform ergodicity property. The existence of solution to suitable Bellman equation using local span contraction method is shown, and link to optimal problem solution is established with the help of Hölder's (entropic) inequalities. The talk is based on a joint work with L. Stettner (IMPAN).

Friday
June 14
11h15-11h45

Existence of stochastic optimal control in the G-framework

Amel Redjil

UBM University and LaPS laboratory

The purpose of this work is to study stochastic optimal control of systems subject to model uncertainty or ambiguity due to incomplete or inaccurate information, or vague concepts and principles. Climate or weather and financial markets are typical fields where information is subject to uncertainty.

Aspects of model ambiguity such as volatility uncertainty have been studied by Peng (2007, 2008, 2010) who introduced an abstract sublinear or G-expectation space with a process called G- Brownian motion, and by Denis and Martini (2006) who suggested a structure based on quasi-sure analysis from abstract potential theory to construct a similar structure using a tight family P of possibly mutually singular probability measures.

Friday, June 14: Arbitrage and statistical arbitrage

Expected shortfall is ineffective against tail-risk seekers

Friday
June 14
10h15-10h45

John Armstrong

King's College London

We show that, in typical complete market models, expected shortfall limits do not affect the sup of the utility attainable by a trader who has an S-shaped utility function. As a result, expected shortfall limits alone are ineffective in curbing the excessive risk-taking behaviour of such traders. We will generalize to incomplete markets, and will show that the failure of expected shortfall constraints in complete markets can be traced to the existence of statistical arbitrage opportunities. We will show how one can determine numerically when such statistical arbitrage opportunities arise in an incomplete markets,and hence when expected shortfall constraints will be effective. We will illustrate the theory with examples of statistical arbitrage opportunities in index option markets.

A dual characterisation of regulatory arbitrage for expected shortfall

Friday
June 14
10h45-11h15

Nazem Khan

Department of Statistics, Warwick

We study portfolio selection in a one-period financial market with an Expected Shortfall (ES) constraint. Unlike in classical mean-variance portfolio selection, it can happen that no efficient portfolios exist. We call this situation regulatory arbitrage and show that the presence or absence of regulatory arbitrage for ES is intimately linked to the fine structure of equivalent martingale measures (EMMs) for the discounted risky assets. More precisely, we prove that the market does not admit regulatory arbitrage for ES at confidence level a if and only if there exists an EMM Q such that $||dQ/dP|| < 1/a$.

Friday
June 14
11h15-11h45

Static and semi-static hedging as contrarian or conformist bets

Sergei Levendorskii
Calico Science Consulting

In this paper, we argue that, once the costs of maintaining the hedging portfolio are properly taken into account, semi-static portfolios should more properly be thought of as separate classes of derivatives, with non-trivial,model-dependent payoff structures. We derive new integral representations for payoffs of exotic European options in terms of payoffs of vanillas, different from Carr-Madan representation, and suggest approximations of the idealized static hedging/replicating portfolio using vanillas available in the market. We study the dependence of the hedging error on a model used for pricing and show that the variance of the hedging errors of static hedging portfolios can be sizably larger than the errors of variance-minimizing portfolios. We explain why the exact semi-static hedging of barrier options is impossible for processes with jumps, and derive general formulas for variance-minimizing semi-static portfolio. We show that hedging using vanillas only leads to larger errors than hedging using vanillas and first touch digitals. In all cases, efficient calculations of the weights of the hedging portfolios are in the dual space using new efficient numerical methods for calculation of the Wiener-Hopf factors and Laplace-Fourier inversion.

Keywords: static hedging, semi-static hedging, Lévy processes, exotic European options, barrier options, Wiener-Hopf factorization, Fourier-Laplace inversion, sinh-acceleration

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Poster sessions

Wednesday, June 12: Poster session I

The reparametrization trick for State-space Bayesian inference in high dimensions. A Python package.

Wednesday
June 12
12h15-14h00

Mattia Bolzoni

Università degli Studi di Milano-Bicocca

High-dimensional econometrics problems are receiving considerable attention recently, and State-space models represent a common modeling choice. However, the inference can be problematic.

In this context, maximum likelihood often shows poor results, and adding a penalty term to shrinks parameters is a popular solution. This last method could be related to a simplified version of Bayesian inference (maximum a posteriori estimate) linking the penalty to prior knowledge. On the other hand, full Bayesian estimation in closed-form is rarely feasible for practical models, while MCMC are usually too slow and could require substantial changes at every slight modification in the model or the prior.

The reparametrization trick, from the field of approximate Bayes, has proven successful in many Machine learning tasks with highly over-parametrized methods like Variational autoencoders or, in general, Bayesian neural networks.

Here is presented a python package implementing this inference technique for various state-space models commonly used in econometrics. The algorithm is fast (runtime comparable to max-likelihood estimation) and scalable. The trick can also reuse the information collected by the user during data exploration to speed up the estimate process. Moreover, changing the prior requires typically minimum coding, and it is commonly straightforward for the practitioner to adapt the technique to custom models.

To conclude, an example of volatility forecasting will be used to show that this method systematically beats DCC, for various choices of the model. These results also seem to confirm the better properties of Bayesian modeling in high dimensions.

Inhomogeneous change of time for Markov chains and its properties

Wednesday
June 12
12h15-14h00

Zofia Michalik

University of Warsaw

Change of time is a very powerful tool in mathematical finance, for example to introduce jumps or stochastic volatility to the asset price models. In the talk we consider a change of time given as a solution to the inhomogeneous time change equation of the form $\tau_t = \int_0^t g(s, X_{\tau_s})ds$, where X is a finite-state Markov chain and g is a nonnegative Borel function. Such a change of time is a generalisation of changes of time studied e.g. by Ethier and Kurtz in [1] and Krühner and Schnurr in [2]. The question of existence and uniqueness of solution to the time change equation demands different approach than in the homogeneous case and for Markov chains it can be solved via explicit construction. We will show some properties and applications of such a change of time, especially those connected to Markov consistency of a time-changed process.

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A refined measure of conditional maximum drawdown

Wednesday
June 12
12h15-14h00

Damiano Rossello

Department of Economics and Business, University of Catania

Risks associated to maximum drawdown have been recently formalized as the tail mean of maximum drawdown distributions, called Conditional Expected Drawdown (CED). In fact, the special case of average maximum drawdown is widely used in the fund management industry also in association to performance management. As a path-dependent deviation measure, it lacks relevant information on worst case scenarios over a fixed horizon, mostly represented by the all time minimum of cumulative returns. Formulating a refined version of CED, we are able to add this piece of information to the risk measurement of drawdown, and then we get a new path-dependent risk measure that preserves all the good properties of the CED but following more prudential regulatory and management assessments,also in term of marginal risk contribution attributed to factors.

Super-replication in illiquid markets – semi-static approach

Wednesday
June 12
12h15-14h00

Agnieszka Rygiel

Cracow University of Economics

We study super-replication of contingent claims in a discrete-time financial market model where trading costs are given by convex cost functions. This model covers the classical case of proportional transaction costs and markets with nonlinear illiquidity effects. We give dual representations of the super-hedging costs of path dependent European options with continuous payoff. This is obtained without making any probabilistic assumptions on the behaviour of the risky asset. As in [1], we only assume that stock price returns are in the range specified by fixed volatility bounds. Instead, we assume that in addition to trading a stock, the investor is allowed to take static positions in a finite number of options – written on this risky asset – with initially known prices. In this setting we may reduce the super-hedging cost by including (liquid) derivatives in the super-replicating portfolio.

References:

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CDS central counterparty clearing liquidation: road to recovery or invitation to predation?

Wednesday
June 12
12h15-14h00

Magdalena Tywoniuk

University of Geneva and Swiss Finance Institute

Recent regulation, mandating the clearing of credit default swaps (CDS) by a Central Clearing Counterparties (CCP), has rendered it's possible failure a serious threat to global financial stability. This work investigates the potential failure of a CCP initiated by the default of a large dealer bank and the unwinding of its positions. The theoretical model examines variation margin exchange be- tween dealer banks and the price impact of liquidation and predatory selling. It provides a measure of covariance between assets in banks' portfolios; price impact affects assets to varying degrees, based on their relative distance to defaulted assets. Key results show that liquidation lowers CCP profits, and how predation decreases the profits of all members, pushing banks to default. Furthermore, a hybrid CCP (vs. current) structure provides a natural disciplinary mechanism for predation. Also, it is more incentive compatible for the CCP, in expectation of a large loss. A multi-period, dynamic simulation, calibrated to OTC market data, provides parameter sensitivities concerning the magnitude of CCP and predatory bank gains/losses, specifically, the minimisation of those losses with a hybrid fund structure. Furthermore, regulatory implications concerning the timing of liquidity injection for a Lender of Last Resort (LoL) are determined for various liquidity scenarios; stable and decreasing market

liquidity, as well as, a liquidity dry-up at the bottom of a financial crisis.

Keywords: Systemic Risk, CCP Recovery, CDS, CDS Spread Fire Sales, Liquidation, Predation, Price Impact, Contagion, Financial Network, Over the Counter Markets.

JEL Classification: G00, G01, G02, G14, G10, G18, G20, G23, G33

Wednesday
June 12
12h15-14h00

Performance-based estimation of issuer margins priced in structured financial products

Sebastian Wessels

University of Hagen

We propose a novel approach to estimate issuer margins priced in structured financial products (certificates). In particular, we supply a one-fits-all approach that can be applied to diverse product types without valuing the products' components. The main benefits are that the procedure is simple to implement and that knowledge about the certificates' structure is not necessarily required. We follow the idea of measuring the (risk-adjusted) performance of the structured product with respect to a fair value benchmark; underperformance compared to the benchmark is interpreted as decomposed margin. The crucial part of determining an appropriate performance measure for products with option components - such as structured financial products - is that options are subject to time decay. Hence, running regressions of the certificates' returns on the standard risk factors - we account for market and volatility risk - leads to a biased performance measure. Thus, we adjust the performance measure by the size of the relative certificates' thetas. Estimators for the thetas are obtained from the Black-Scholes PDE; deltas and gammas entering the PDE are estimated from a time series regression of the certificates' market prices. A theoretical derivation of the approach is complemented by a simulation study: In a framework with stochastic volatility, we demonstrate that our approach yields a virtually unbiased measure of mean decomposed margins priced in synthetic certificates. Empirically, we apply our approach to a comprehensive data set of discount and bonus certificates on the German market index DAX, as well as express certificates on the European index EURO STOXX 50.

Thursday, June 13: Poster session II

Optimal stopping in a simple model of unemployment insurance

Thursday
June 13
12h30-14h00

Jason Anquandah

University of Leeds

Managing unemployment is one of the key issues in social policies. Unemployment insurance schemes are designed to cushion the financial and morale blow of loss of job but also to encourage the unemployed to seek new jobs more pro-actively due to the continuous reduction of benefit payments. A simple model of unemployment insurance is proposed with a focus on optimality of the individual's entry to the scheme. The corresponding optimal stopping problem is solved and some examples in this direction are worked out.

On modified copula expected shortfall for sum of dependent random losses

Thursday
June 13
12h30-14h00

Bony Josaphat

Faculty of Mathematics and Natural Sciences, Institut Teknologi Bandung

Our goal in this paper is to propose an alternative risk measure toward the classical Expected Shortfall (ES), Modified Expected Shortfall (MES), and Copula Expected Shortfall (CES). Similar to CES, this new risk measure takes into account fluctuations in losses and possible correlations between random variables but at the same time reduces potentially large values of CES due to extreme values of the risk. This new notion of risk measure, that we call Modified Copula Expected Shortfall (MCES) describes the expected amount of risk that can be experienced given that a potential bivariate risk lies in bivariate lower and upper bounds, while CES describes the similar expected amount amount in term of just exceeding a bivariate threshold value. On the other hand, risk model may be constructed through collection of, either independent or dependent, random losses. In this paper, we propose an actuarial model of sum of dependent random losses. Specifically, we consider normal and heavy-tailed distributions. Furthermore, we do forecasting MES for such models by using the formula of MCES. Numerical analysis is carried out to illustrate this forecast in particular whether or not property of subadditivity is captured by risk measure.

Thursday
June 13
12h30-14h00

Near-optimal investment strategies in incomplete markets

Thijs Kamma

Department of Quantitative Economics, Maastricht University

We develop a dual control method for approximating investment strategies in incomplete environments that emerge from the presence of non-traded risk. Convex duality enables the approximate technology to generate lower and upper bounds on the optimal value function. The mechanism rests on closed-form expressions pertaining to the portfolio composition, whence we are able to procure the near-optimal asset allocation explicitly. In a real financial market, we illustrate the accuracy of our approximate method on a dual CRRA utility function that characterizes the preferences of some finite-horizon investor. Negligible duality gaps and insignificant annual welfare losses substantiate veracity of the technique.

Thursday
June 13
12h30-14h00

An insider information optimal stopping game

Nikita Merkulov

University of Leeds

We study an optimal stopping game of two players. A scenario - a "state of the world" in which the game is played - is chosen according to a probability distribution known to both players. Immediately after the game starts, one of the players receives the information about the scenario, therefore knowing exactly the structure of the game. They then need to use a randomized stopping strategy in order to hide the information from the other player and use their informational advantage.

We restrict ourselves to a special case when only the terminal time payoff depends on the random scenario. We discuss alternative representations of the game: in particular, usage of randomized strategies gives rise to an equivalent game of optimal controls. Ultimately, we provide the conditions necessary for the game to have a value and an epsilon-Nash equilibrium.

Thursday
June 13
12h30-14h00

Does superior forecast accuracy translate to trading profitability? A study of nonparametric volatility estimators.

Arpita Mukherjee

Department of Economics, Rutgers University (New Brunswick, New Jersey)

The recent insurgence of nonparametric estimators of stochastic (integrated) volatility can be attributed to the numerous volatility based derivative products being traded in the financial markets. In the light of this fact, I evaluate the predictive performance of several competing volatility estimators to analyze the following question: Is "statistical forecast accuracy" a good indicator of "economic profitability of forecasts" ? I use a density-forecast based methodology, "conditional confidence interval", that predicts the probability with which one-period ahead volatility lies

within a given interval. In essence, it can predict the directional movement of future volatility. Since volatility is latent in nature, statistical forecast accuracy assessment of volatility estimators is carried out in a simulated environment with respect to multiple data-generating processes designed to mimic real world scenarios. On the other hand, I design empirical trading strategies using high frequency asset price data, to measure the economic significance of forecasts. Trading rules are based on the empirical evidence I find, in terms of a strong negative causal relationship between contemporaneous daily volatility and excess return. I find that, although ranking of the volatility estimators generated via tests of forecast accuracy are not identical to the tests of trading profitability, the estimator with the highest statistical forecast accuracy is also the one that is economically the most profitable. In particular, the overall "winning" estimator, Truncated Realized Volatility (Ait-Sahalia and Jacod, 2009), is one that is robust to price jumps but not robust to microstructure noise. This analysis, thus suggests that forecast accuracy can have a direct mapping onto trading profitability. As a robustness check, I use two additional (more popular) pointwise-forecasting techniques to develop the empirical investment strategies. One belongs to the class of parametric heterogeneous autoregressive models (HAR) and the other belongs to class of recurrent neural network models (RNN). I find that the type of forecasting methodology used does not have any bearing on the performance of Truncated Realized Volatility, i.e. it prevails as the "winning" estimator.

Dynamic pricing in insurance

Thursday
June 13
12h30-14h00

Yuqing Zhang
University of Manchester

We study the application of dynamic pricing in insurance from the perspective of an insurance company. We consider the problem of online revenue management for an insurance company that wishes to sell a new product. We do not consider effects of competition and demand constraint in the market. The insurance company can only observe realised demand and incurred claims but does not know the underlying functions for the insurance product. This is particular relevant for the release of new insurance products. We develop two pricing models: parametric and non-parametric models to balance between exploration (demand/claims learning) and exploitation (pricing) trade-off. We aim to find the relationship between price and demand/total claims, and simultaneously maximises revenues. The performance oft he pricing policies is measured in terms of the cumulativeRegret: the expected revenue loss caused by not using the optimal price. In the parametric model, we use the maximum quasi-likelihood estimation (MQLE) is used to estimate the unknown parameters in the model. MQLE parameter estimates eventually exist and converge to the correct values, which implies that the sequence of chosen prices also converge to the optimal price. In the non-parametric model, we sample demand and total claims from Gaussian Processes (GP). We then analyse Gaussian process upper confidence bound (GP-UCB) algorithm on insurance pricing. Although similar results exist in other domains, this is among the first to consider dynamic pricing problems in the field of insurance.

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