Risk & Stochastics and Financial Mathematics Joint Seminar in 2014

Seminars are listed in reverse chronological order, most recent first.

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27 November - Jan-Henrik Steg (Bielefeld)
Symmetric Equilibria in Stochastic Timing Games

We construct subgame-perfect equilibria with mixed strategies for symmetric stochastic timing games with arbitrary strategic incentives. The strategies are qualitatively different for local first- or second-mover advantages, which we analyze in turn. When there is a local second-mover advantage, the players may conduct a war of attrition with stopping rates that we characterize in terms of the Snell envelope from the general theory of optimal stopping, which is very general but provides a clear interpretation. With a local first-mover advantage, stopping typically results from preemption and is abrupt. Equilibria may differ in the degree of preemption, precisely at which points it is triggered. We provide an algorithm to characterize where preemption is inevitable and to establish the existence of corresponding payoff-maximal symmetric equilibria.

13 November - Igor Makarov (LSE)
Marking-to-market and price impact

The paper studies incentives and trading decisions of money managers who trade in markets with price impact. I show that in markets with price impact the practice of marking-to-market funds' assets creates incentives for managers to accumulate excessively large positions. This trading behaviour may force prices away from their fundamental levels for a long time and may result in large losses for investors.

30 October – Samuel Drapeau (Humboldt Universität zu Berlin)
Numerical representation of convex preferences on Anscombe–Aumann acts

We study the preferences of agents for diversification and better outcomes when they are facing both, in Frank Knight's formulation, measurable as well as unmeasurable uncertainty.

Following Anscombe and Aumann, such a situation can be modeled by preferences expressed on stochastic kernels, that is scenario dependent lotteries.
By means of automatic continuity methods based on Banach-Dieudonné's Theorem on Fréchet spaces, we provide a robust representation.

This gives us some insight into the nature of uncertainty aversion these preferences are expressing.

We further investigate under which conditions these two intricate dimensions of uncertainty can be disentangle into a distributional uncertainty, in the direction of von Neumann and Morgenstern's theory, and a probability model uncertainty, in the spirit of risk measures.

These results allow in particular to address both Allais as well as Elsberg's paradox. Joint work with P. Cheridito, F. Delbaen, and M. Kupper.

16 October - Scott Robertson (Carnegie Mellon)
Indifference pricing for contingent claims: large deviations effects

In this talk, we consider utility indifference prices and optimal purchasing quantities for a non-traded contingent claim in an incomplete semi-martingale market with vanishing hedging errors, making connections with the theory of large deviations. This work is motivated by the recent explosive growth in the derivatives market; in particular we seek to explain why such positions are being taken and what the effects are in terms of pricing. To make the analysis tractable, we concentrate on sequences of semi-complete markets where for each n the claim h_n admits the decomposition h_n = D_n+Y_n where D_n is replicable and Y_n is completely unhedgeable in that the indifference price of Y_n for an exponential investor is its certainty equivalent. Under broad conditions, we may assume that Y_n vanishes in accordance with a large deviations principle as n grows. In this setting, we identify limiting indifference prices as the position size becomes large, and show the prices typically are not the unique arbitrage free price in the limiting market. Furthermore, we show that optimal purchase quantities occur at the large deviations scaling, and hence large positions endogenously arise in this setting.

Joint work with Konstantinos Spiliopoulos, Boston University.

19 May - Elena Boguslavskaya (Brunel)
An effective method to solve optimal stopping problems for Lévy processes in infinite horizon or how to avoid differential or integro-differential equations while solving an optimal stopping problem for a Lévy problem

We present a method to solve optimal stopping problems in infinite horizon for a Levy process when the reward function g can be non-monotone.

To solve the problem we introduce two new objects. Firstly, we define a random variable $\eta(x)$ which corresponds to the $\argmax$ of the reward function. Secondly, we propose a certain integral transform which can be built on any suitable random variable. It turns out that this integral transform constructed from

$\eta(x)$ and applied to the reward function produces an easy and straightforward description of the optimal stopping rule. We illustrate our results with several examples.

The method we propose allows to avoid complicated differential or integro-differential equations which arise if the standard methodology is used.

15 May - Michael Schroeder (VU Amsterdam)
Volatility smiles and derivatives: a direct route to new kinds of high-dimensionality?

FX-rates provide the textbook example for financial instruments that are not just traded in a 24/7 fashion but quoted in real time over the entire year. FX-derivatives are similar in their liquidity, but completely different in character. FX-options, for example, are famously liquidly traded at at most 5 strikes and 10 maturities; their design is subordinated to the daily 4pm-GMT-fixings. We will outline methods to handle such institutional discetenesses in model-based approaches to derivatives. Highlighting recent stochastic volatility models of Ornstein-Uhlenbeck type, this will include methods for model calibration based on discretely-sampled generalized BS-formulas. We will also report on exact valuation methods for discretely-sampled Asian options (as part of an LSE-project with M.Frentz (Bank of Sweden)).

17 March - Sergio Pulido (EPFL)
Markovian cubature rules for polynomial preserving processes

Polynomial preserving processes are defined as time-homogeneous Markov jump-diffusions whose generator leaves the space of polynomials of any fixed degree invariant. Polynomial preserving processes include affine processes, whose transition functions admit an exponential-affine characteristic function. These processes are attractive for financial modeling because of their tractability and robustness. In this work we study Markovian cubature rules for polynomial preserving processes. These rules aim to exploit the defining property of polynomial preserving processes in order to reduce the complexity of the implementation of such models. More precisely, we study conditions guaranteeing the existence of finite-state Markov processes that match the moments of a given polynomial preserving process. The states of these processes together with their transition probabilities can be interpreted as Markovian cubature rules. We first give a characterization theorem for the existence of Markovian cubature rules in continuous time. This theorem illustrates the complexity of the problem by combining algebraic and geometric considerations. We show that for polynomial preserving diffusions, there are no continuous-time Markovian cubature rules for high order moments. We provide a positive result by showing that the construction is possible when one considers finite-state Markov chains on lifted versions of the state space. Additionally, by relaxing the continuous-time cubature problem, we can

construct discrete time finite-state Markov processes that match moments of arbitrary order. This discrete time construction relies on the existence of long-run moments for the polynomial process and cubature rules over these moments.

This is joint work with Damir Filipovic and Martin Larsson.

10 March - Giorgio Ferrari (Bielefeld)
A Stochastic Partially Reversible Investment Problem on a Finite Time-Horizon: Free-Boundary Analysis

We study a continuous-time, finite horizon, stochastic partially reversible investment problem for a firm producing a single good in a market with frictions. The production capacity is modelled as a one-dimensional, time-homogeneous, linear diffusion controlled by a bounded variation process which represents the cumulative investment-disinvestment strategy. We associate to the investment-disinvestment problem a zero-sum optimal stopping game and characterize its value function through a free-boundary problem with two moving boundaries. These are continuous, bounded and monotone curves that solve a system of non-linear integral equations of Volterra type. The optimal investment-disinvestment strategy is then shown to be a diffusion reflected at the two boundaries.

This is joint work with Tiziano De Angelis (University of Manchester)

3 March - Yu-Jui Huang (Dublin City)
Model-independent Superhedging under Portfolio Constraints

In a discrete-time market, we study the problem of model-independent superhedging of exotic options under portfolio constraints. The superhedging portfolio consists of static positions in liquidly traded vanilla options, and a dynamic trading strategy, subject to certain constraints, on the risky asset. By the theory of Monge-Kantorovich optimal transport, we establish a superhedging duality, which admits a natural connection to convex risk measures. With the aid of this duality, we derive a model-independent version of the fundamental theorem of asset pricing under portfolio constraints. It is worth noting that our method covers a large class of Delta constraints as well as Gamma constraint.

17 February - Antoine Jacquier (Imperial)
Asymptotics of forward implied volatility

We study the asymptotic behaviour of the forward implied volatility (namely the implied volatility corresponding to forward-start European options). Our tools rely on (finite-dimensional) large deviations and saddlepoint analysis, albeit not necessarily relying on standard convexity arguments. We shall also relate this to the Freidlin-Wentzell approach for sample paths. From a practical point of view, this

sheds light on the dynamics of forward implied volatilities, which we highlight numerically in the Heston model.

10 February - Anna Aksamit (Université d'Evry Val d'Essonne)
Optional semimartingale decomposition and non-arbitrage condition in enlarged filtration

Our study addresses the question of how an arbitrage-free semimartingale model is affected when stopped at a random horizon or when a random variable satisfying Jacod's hypothesis is incorporated. Precisely, we focus on the No-Unbounded-Profit-with-Bounded-Risk condition, which is also known in the literature as the first kind of non-arbitrage. In the general semimartingale setting, we provide a necessary and sufficient condition on the random time for which the non-arbitrage is preserved for any process. Analogous result is formulated for initial enlargement with random variable satisfying Jacod's hypothesis. Moreover we give an answer to a stability of non-arbitrage question for fixed process. The crucial intermediate results in enlargement of filtration theory are obtained. For local martingales from the reference filtration we provide special optional semimartingale decomposition up to random time and in initially enlarged filtration under Jacod's hypothesis. An interesting link to absolutlety continuous change of measure problem is observed.

5 February - Walter Schachermayer (Vienna)
Duality Theory for Portfolio Optimisation under Transaction Costs

In this talk, we develop a dynamic duality theory for portfolio optimisation under proportional transaction costs with cadlag price processes. In particular, we provide examples that illustrate the new effects arising from the combination of the transaction costs and jumps of the underlying price process.

The talk is based on joint work with Christoph Czichowsky.

3 February - Claude Martini (Zeliade Systems)
Calibration of the SSVI model and applications to model free option pricing bounds

Gatheral and Jacquier achieved in 2012 a consistent (arbitrage-free) extension of the parametric SVI model in the maturity dimension. This Surface SVI (SSVI) model is parameterized by a correlation coefficient and a function which corresponds to the curvature of the smile at each maturity. We go through a re-parameterization of the SSVI model that lends itself to a nice 2-stages calibration procedure. Calibration examples on CBOE SPX delayed quotes are provided. Since the SSVI model does calibrate very well, we eventually get an explicit arbitrage-free parameterization of the market implied volatility surface. We compute the model-free Beiglböck-Juillet-Touzi-Henry Labordère optimal transport bounds of an exotic option in this setting. An executable version of this work is available on the Zanadu platform (joint work

with I.Laachir, ENSTA and Zeliade Systems). (Keywords: implied volatility, SVI, calibration, Optimal Transport option bounds).

27 January - René Aid (EDF)
A high-dimensional investment model in electricity generation

In this talk, we will show how the progresses made in the recent decade in numerical methods for optimal stopping time problems and optimal switching problems allow to design efficient and yet realistic models to study the dynamic of investment in electricity generation. We will give the example of a high-dimensional electricity generation investment model. This model takes into account electricity demand, cointegrated fuel prices, carbon price and random outages of power plants. The evolution of the optimal generation mix is illustrated on a realistic numerical problem in dimension 8, i.e. with 2 different technologies and 6 random processes.

This talk is based on a joint work with Luciano Campi, Nicolas Langrene and Huyen Pham.

20 January - Hansjoerg Albrecher (HEC Lausanne)
On theoretical and practical aspects of catastrophe insurance

In this talk we give an overview of some recent results and developments in the modelling of insurance risk related to natural catastrophes. In addition to some theoretical results on the statistics of such extremal events, we present a study of flood and storm risk in Austria. The feasibility of the general principle of time diversification in this context is also discussed.

13 January - Agostino Capponi (John Hopkins)
Optimal Investment in Credit Derivatives Portfolio under Contagion Risk

We consider the optimal portfolio problem of a power investor who wishes to allocate her wealth between several credit default swaps (CDSs) and a money market account. We model contagion risk among the reference entities in the portfolio using a reduced form Markovian model with interacting default intensities. Using the dynamic programming principle, we establish a lattice dependence structure between the Hamiltonian-Jacobi-Bellman equations associated with the default states of the portfolio.

We show existence and uniqueness of a classical solution to each equation and characterize them in terms of solutions to inhomogeneous Bernoulli's type ODEs. We provide a precise characterization for the directionality of the CDS investment strategy and perform a numerical analysis to assess the impact of default contagion. We find that the increased intensity triggered by default of a very risky

entity strongly impacts size and directionality of the investor strategy. Such findings outline the key role played by default contagion when investing in portfolios subject to multiple sources of default risk