Joint Risk & Stochastics and Financial Mathematics Seminar

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

Thursday 23 March 2023 - Sara Svaluto-Ferro (University of Verona)
Hybrid and KSW.G.01

Signature-based models: theory and calibration

Universal classes of dynamic processes based on neural networks and signature methods have recently entered the area of stochastic modeling and Mathematical Finance. This has opened the door to robust and more data-driven model selection mechanisms, while first principles like no arbitrage still apply.
In the first part of the talk we focus on signature SDEs whose characteristics are linear functions of a primary underlying process, which can range from a (market-inferred) Brownian motion to a general multidimensional tractable stochastic process. The framework is universal in the sense that any classical model can be approximated arbitrarily well and that the model characteristics can be learned from all sources of available data by simple methods. Indeed, we derive formulas for the expected signature in terms of the expected signature of the primary underlying process.
In the second part we focus on a stochastic volatility model where the dynamics of the volatility are described by linear functions of the (time extended) signature of a primary underlying process. Under the additional assumption that this primary process is of polynomial type, we obtain closed form expressions for the squared VIX by exploiting the fact that the truncated signature of a polynomial process is again a polynomial process. Adding to such a primary process the Brownian motion driving the stock price, allows then to express both the log-price and the squared VIX as linear functions of the signature of the corresponding augmented process. For both SPX and VIX options we obtain highly accurate calibration results.

The talk is based on joint works with Christa Cuchiero, Guido Gazzani, and Janka Möller.

Thursday 9 February 2023 - Ryan Donnelly (KCL)

Dynamic Inventory Management with Mean-Field Competition
Agents attempt to maximize expected profits earned by selling multiple units of a perishable product where their revenue streams are affected by the prices they quote as well as the distribution of other prices quoted in the market by other agents. We propose a model which captures this competitive effect and directly analyze the model in the mean-field limit as the number of agents is very large. We classify mean-field Nash equilibrium in terms of the solution to a Hamilton-Jacobi-Bellman equation and a consistency condition and use this to motivate an iterative numerical algorithm to compute equilibrium. Properties of the equilibrium pricing strategies and overall market dynamics are then investigated, in particular how they depend on the strength of the competitive interaction and the ability to oversell the product.

Thursday 26 Janauary 2023 - Miryana Grigorova (University of Warwick)

Optimal stopping: Bermudan strategies meet non-linear evaluations
We address an optimal stopping problem over the set of Bermudan-type strategies (which we understand in a more general sense than the stopping strategies for Bermudan options in finance) and with non-linear operators (non-linear evaluations) assessing the rewards, under general assumptions on the non-linear operators. We provide a characterization of the value family V in terms of a suitably defined non-linear Snell envelope of the the pay-off family. We establish a Dynamic Programming Principle. We provide an optimality criterion in terms of a non-linear martingale property of V on a stochastic interval. We investigate the non-linear martingale structure and we show that, under suitable conditions, the first time when the value family coincides with the pay-off family is optimal. The reasoning simplifies in the case where there is a finite number, say n, of pre-described stopping times, where n does not depend on the scenario/state of nature. We provide examples of non-linear operators from the stochatsic control and mathematical finance literature, which enter our framework.

Based on an ongoing joint work with Marie-Claire Quenez (Paris) and Peng Yuan (Warwick).

Thursday 1 December 2022 - Linus Wunderlich (QMUL)

Neural networks for high-dimensional parametric option pricing using PDEs
In this talk we will discuss the deep parametric PDE method for parametric option pricing in high dimensions, underlying theoretical results for neural networks and an

application in risk management.
The deep parametric PDE method uses deep neural networks to solve parametric partial differential equations, such as those arising in option pricing. Especially for a large number of risk factors, the efficiency of neural networks for high dimensional problems is beneficial. We investigate this efficiency theoretically by presenting approximation rates for networks with smooth activation functions.

Thursday 3 November 2022 - Alexandre Pannier (Imperial College London)

On the ergodic behaviour of affine Volterra processes
We show the existence of a stationary measure for a class of multidimensional stochastic Volterra systems of affine type. These processes are in general not Markovian, a shortcoming which hinders their large-time analysis. We circumvent this issue by lifting the system to a measure-valued stochastic PDE introduced by Cuchiero and Teichmann, whence we retrieve the Markov property. Leveraging on the associated generalised Feller property, we extend the Krylov-Bogoliubov theorem to this infinite-dimensional setting and thus establish an approach to the existence of invariant measures. We present concrete examples, including the rough Heston model from Mathematical Finance.

Thursday 20 October 2022 - David Itkin (Imperial College London)

Open Markets in Stochastic Portfolio Theory and Rank Jacobi Processes
Stochastic portfolio theory is a framework to study large equity markets over long time horizons. In such settings investors are often confined to trading in an “open market” setup consisting of only assets with high capitalizations. In this work we relax previously studied notions of open markets and develop a tractable framework for them under mild structural conditions on the market.
Within this framework we also introduce a large parametric class of processes, which we call rank Jacobi processes. They produce a stable capital distribution curve consistent with empirical observations. Moreover, there are explicit expressions for the growth-optimal portfolio, and they are also shown to serve as worst-case models for a robust asymptotic growth problem under model ambiguity.
Lastly, the rank Jacobi models are shown to be stable with respect to the total number of stocks in the market. Time permitting, we will show that, under suitable assumptions on the parameters, the capital distribution curves converge to a limiting quantity as the size of the market tends to infinity. This convergence result provides a theoretical explanation for an important empirically observed phenomenon.

This talk is based on joint work with Martin Larsson.

Thursday 6 October 2022 - Joe Jackson (University of Texas)

Well-posedness for non-Markovian quadratic BSDE systems with special structure

In this talk I will discuss some recent existence and uniqueness results for non-Markovian quadratic BSDE systems. Much of the talk will actually be about *linear* BSDEs, because it turns out that estimates for an appropriate class of linear BSDEs can be used to obtain existence results for quadratic systems. Indeed, the Malliavin derivative of a BSDE satisfies a linear BSDE, and strong enough estimates on the Malliavin derivative can be used to obtain existence. The difficulty in executing this strategy in the quadratic case is that the relevant linear BSDEs have *unbounded* coefficients, which a-priori can only be estimated in a space we call *bmo*. In a series of recent works with Gordan Žitković, I studied linear BSDEs with bmo coefficients systematically, and the following picture has emerged: both existence and uniqueness may fail for such equations, but can be recovered under various structural conditions.