Department of Mathematics

Joint Risk & Stochastics and Financial Mathematics Seminar in 2019

Seminars are listed in reverse chronological order, most recent first

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Thursday 5 December - Renyuan Xu (University of Oxford)

Learning Mean-Field Game
Motivated by the online Ad auction problem for advertisers, we consider the general problem of simultaneous learning and decision-making in a stochastic game setting with a large population. We formulate this type of games with unknown rewards and dynamics as a generalized mean-field-game (GMFG), with the incorporation of action distributions.

We first analyze the existence and uniqueness of the GMFG solution, and show that naively combining Q-learning with the three-step fixed-point approach in classical MFGs yields unstable reinforcement learning algorithms. We then propose an approximating Q-learning algorithm and establish its convergence and complexity results. The numerical performance shows superior computational efficiency. This is based on joint work with Xin Guo (UC Berkeley), Anran Hu (UC Berkeley) and Junzi Zhang (Stanford).

Tuesday 26 November - Philipp Illeditsch (University of Pennsylvania)

The Effects of Speculation on Constrained Households
We study how financial speculation affects households who do not participate in financial markets. We show that the consumption/wealth shares of households decrease because they forego they equity premium and pay the liquidity premium for cash (a negative inflation risk premium in our model) by putting all their savings in a short term bank account but not because investors are speculating. In an infinite horizon economy, non participation in financial markets would lead to consumption/wealth shares of households that go to zero whereas in our OLG model with finite life expectancy it only leads to a decrease in the households' average consumption share and thus allows us to study the effects of financial speculation on non participating households.

Interestingly, financial speculation in the stock market due to disagreement about expected output growth does not affect households' aver- age consumption share

and even lowers its volatility. In contrast, disagreement about output growth increases the cross-sectional consumption volatility of speculators. Disagreement has no effect on average valuation ratios and lowers their volatility if speculators have the same time preferences. Otherwise valuations are on average lower and more volatile. Precautionary savings increase and thus interest rates decrease when household do not invest in the stock market. Disagreement raises the interest rate volatility and thus the consumption growth volatility of households but has no effect on its mean unless speculators have different time preferences. Stock market volatility tends to decrease with disagreement. While the stock market risk premium increases and is countercyclical due to household non participation in financial markets, disagreement has no effect on the risk premium unless speculators have different time preferences."

Thursday 21 November - Francesco Russo (ENSTA Paris, Institut Polytechnique de Paris)

The title and abstract can be found here.

Thursday 7 November - Stefano Duca and Philip Gradwell (Chainalysis)

Cryptocurrencies: what the data tells us about a new financial market
Cryptocurrencies have generated much hype and controversy, but they have also generated vast amounts of financial data. Not only are they traded on exchanges, via spot and derivatives, but they are also transacted on the blockchain. This potentially allows for detailed analysis of this new financial market. However, interpretation of the data is complex due to the pseudo-anonymity of blockchain transactions and the immaturity of markets. Chainalysis, the leading blockchain analytics company, will describe the state of cryptocurrency data, their latest understanding of the crypto-economy, and frame the open questions for a debate on the frontiers of cryptocurrency research.

Thursday 24 October - Eugene Feinberg (Stony Brooks University)

Solutions for Zero-Sum Two-Player Games with Noncompact Decision Sets
The classic theory of infinite zero-sum two-player games has been developed under the assumptions that either the decision set of at least one of the players is compact or some convexity/concavity conditions hold. In this talk we describe sufficient conditions for the existence of solutions for two-person zero-sum games with possibly noncompact decision sets for both players and the structure of the solution sets under these conditions. Payoff functions may be unbounded, and we do not assume any convexity/concavity-type conditions. For such games expected payoffs may not exist for some pairs of strategies. These results imply several classic facts, and they are illustrated with the number guessing game. We also

describe sufficient conditions for the existence of a value and solutions for each player.

The talk is based on joint papers with Pavlo O. Kasyanov and Michael Z.

Thursday 10 October - Simone Scotti (Université Paris Diderot)

Alpha-Heston stochastic volatility model
We introduce an affine extension of the Heston model where the instantaneous variance process contains a jump part driven by α-stable processes with $\alpha\in(1,2]$. In this framework, we examine the implied volatility and its asymptotic behaviors for both asset and variance options. In particular, we show that the behavior of stock implied volatility is the sharpest coherent with theoretical bounds at extreme strikes independently of the value of $\alpha\in(1,2)$. As far as volatility options are concerned, VIX-implied volatility is characterized by an upward-sloping behavior and the slope is growing when α decreases. Furthermore, we examine the jump clustering phenomenon observed on the variance marketand provide a jump cluster decompositionwhich allows to analyse the cluster processes. The variance process could be split into a basis process, without large jumps, and a sum of jump cluster processes, giving explicit equations for both terms. We show that each cluster process is induced by a first ``mother'' jump giving birth to a sequence of ``child jumps''. We first obtain a closed form for the total number of clusters in a given period.
Moreovereach cluster process satisfies the same α-CIR evolution of the variance process excluding the long term mean coefficient that takes the value 0.We show that each cluster process reaches 0 in finite time and we exhibit a closed form for its expected life time.We study the dependence of the number and the duration of clusters as function of the parameter α and the threshold used to split large and small jumps.

Joint work with Ying Jiao, Chunhua Ma and Chao Zhou

Wednesday 8 May - Guy Flint

A primer on rough path theory
Stochastic differential equations provide a way to describe the evolution of a multidimensional system affected by some stochastic input signal:

\[

dy_t = V(y_t)\, dx_t, \, \, \, y_0 = \xi \in \mathbb{R}^q.

\]

As it is random, $x = (x_t) \subset\mathbb{R}^d$ is typically highly oscillatory and thus far from differentiable. Traditionally we can use It\^{o} calculus to define a solution to the differential equation but the It\^{o} mapping, $\pi = (\pi_t) : x \mapsto y$, is not continuous in the uniform topology unless $d=1$ or we impose very restrictive conditions on the vector field V. For example, given two correlated Brownian motions W_1,W_2, stochastic calculus cannot be used to make useful quantitative statements about the difference in their outputs:

\[

\sup_{t\in [0,1]} \| \pi_t(W_1) - \pi_t(W_2) \|.

\]

Rough path theory solves this predicament by lifting the original input x into a path in a higher-dimensional Lie group. This so-called rough path encodes enough extra information to make such continuity statements precise. In fact, the estimates can be factored into deterministic and stochastic parts which has enabled simple proofs of fundamental results in stochastic analysis as well as providing the motivating example for the theory of regularity structures, (the latter was used in Martin Hairer's Fields medal-winning work on the KPZ equation).
This talk aims to provide a primer on the main ideas of rough path theory. With a minimum of Lie group theory, we hope to show some examples on how rough paths can be used by the non-specialist.

Thursday 4 April - Michael Kupper (University of Konstanz)

Computation of model-free hedging problems via penalization and neural networks
We present a widely applicable approach to solving model-free hedging 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. As an application we discuss a version of the martingale transport problem with homogeneous stock movements and illustrate the approach with several numerical examples. The talk is based on joint work with Stephan Eckstein.

Lent Term 2019

Thursday 28 March - Flavia Barsotti

Behavioural modeling: contagion effects among customers' decisions and macroeconomic drivers

The aim of the talk is to present a methodological approach suitable to model customers' behaviours by embedding i) correlation and contagion effects among their decisions and ii) the role of macroeconomic factors. The proposed approach is suitable to model both stable economic regimes and stress scenarios. As an example, the problem of lapse risk will be discussed. The mathematical setting assumes the lapse intensity following a dynamic contagion process with both endogenous and exogenous jump components. This allows to capture both correlation and contagion potentially arising among customers' behaviours and the macroeconomic driver. The shot-noise intensity is then not constant and the resulting intensity process is not Markovian. Closed-form expressions and analytic sensitivities for the moments of the lapse intensity are provided, showing how lapses can be affected by massive copycat behaviours. Further analyses are then conducted to illustrate how the mean risk varies depending on the model's parameters.

Friday 22 March - Oleksii Mostovyi (University of Connecticut)

Optimal consumption from investment and labor income in a unifying framework of admissibility

We consider a problem of optimal consumption from investment and labor income in an incomplete semimartingale market. We introduce a set of constraint times, i.e., a set of stopping times, at which the wealth process must stay positive, in a unifying way such that borrowing against the future income might be allowed or prohibited. Upon this, we increase dimensionality and treat as arguments of the value function not only the initial wealth but also a function that specifies the amount of labor income. Assuming finiteness of the primal and dual value functions and that the labor income is superreplicable (these are essentially the minimal model assumptions), we establish the existence and uniqueness of a solution to the underlying problem and provide several characterizations of the optimizer and the value functions. This talk is based on the joint work with Mihai Sirbu.

Thursday 21 March - Hyeng Keun Koo (Ajou University)

Duesenberry, Long-term Wealth Management, and Asset Pricing
I will talk about Duesenberry's theory of consumption and propose a formal model of the theory. I will show how the model can be used for long-term investors' risk management. I will also discuss asset pricing implications of the model.

Thursday 14 March - Lukas Gonon (University of St.Gallen)

Reservoir Computing with Stochastic Inputs: Universality, Error Bounds and Financial Applications
We study dynamic machine learning for discrete-time stochastic processes based on reservoir computing. Putting particular emphasis on echo state networks, we present results on universal approximation properties as well as error bounds for learning tasks based on these systems. Finally, we apply them to the problem of predicting realized covariances of financial time series.

The talk is based on joint works with Juan-Pablo Ortega and Lyudmila Grigoryeva.

Thursday 28 February - Pierre-Olivier Goffard (ISFA)

Fraud risk assessment within blockchain transactions
The probability of successfully spending twice the same bitcoins is considered. A double-spending attack consists in issuing two transactions transferring the same bitcoins. The first transaction, from the fraudster to a merchant, is included in a block of the public chain. The second transaction, from the fraudster to himself, is recorded in a block that integrates a private chain, exact copy of the public chain up to substituting the fraudster-to-merchant transaction by the fraudster-to-fraudster transaction. The double-spending hack is completed once the private chain reaches the length of the public chain, in which case it replaces it. The growth of both chains are modeled by two independent counting processes. The probability distribution of the time at which the malicious chain catches up with the honest chain, or equivalently the time at which the two counting processes meet each other, is studied. The merchant is supposed to await the discovery of a given number of blocks after the one containing the transaction before delivering the goods. This grants a head start to the honest chain in the race against the dishonest chain.

A preprint is available on my website.

Thursday 14 February - Sara Svaluto-Ferro (University of Vienna)

Infinite dimensional polynomial jump-diffusions
We introduce polynomial jump-diffusions taking values in an arbitrary Banach space B via their infinitesimal generator. We obtain two representations of the (conditional) moments in terms of solution of a systems of ODEs on $(R, B^*, \dots, (B \otimes k)^*)$ and $(R, B^{**}, \dots, (B \otimes k)^{**})$, respectively. We illustrate how the well known moment formulas for finite dimensional polynomial jump diffusions can be deduced in this general framework. As an application, we consider probability measure-valued polynomial diffusions and polynomial forward variance curve models.

Thursday 31 January - Hyejin Cho (Université de Paris)

The Order-theoretic Single Crossing Property in a One-Dimensional Screening Model:
We consider a finite one-dimensional screening of choices in monotone comparative statics (MCS). Before revealing the true state of the world, a principal sorts on actions of the agent to cause the social value of production as an informed principal. The model produces a rich order-theoretic single-crossing property according to Pick's theorem pursuing no distortion at the top.

Thursday 17 January - Mykhaylo Shkolnikov (Princeton University)

Particles interacting through the hitting times: an application to systemic risk
I will discuss a class of particle systems that form a natural framework for the study of systemic risk. The interaction between the particles falls into the mean field framework pioneered by McKean and Vlasov in the late 1960s, but many new phenomena arise due to the singularity of the interaction. The most striking of them is the loss of regularity of the particle density caused by the self-excitation of the system, which triggers systemic crises. Mathematically, the evolution of the system can be captured initially by a suitable Stefan problem, while the following irregular behavior necessitates a more robust probabilistic approach. Extensions to the setting where the interaction takes place on networks will be also discussed. Based on joint works with Sergey Nadtochiy.

Thursday 17 January - Adam Iqbal (Goldman Sachs)

Book presentation

Volatility - Practical Options Theory