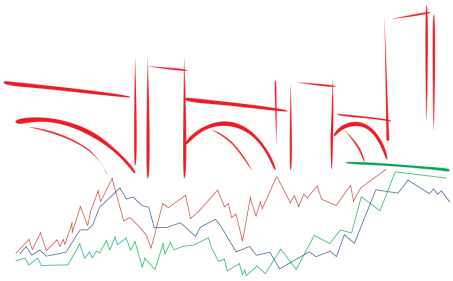
Opening conference of the thematic semester on stochastic modeling



VPSMS 2018

Book of Abstracts

December 18–21, 2017
Verona, Italy

Contents

Monday, December 18th, 2017

Feedback equilibrium solutions to non-cooperative differential games

Monday
Dec 18
09h15-
10h00

Alberto Bressan
Penn State university

The talk will survey some recent work on existence and stability (or instability) for Nash or Stackelberg equilibrium solutions to differential games, where the strategies of both players are given in feedback form. The main focus will be on noncooperative games in infinite time horizon, with exponentially discounted cost.

Dynamic Cournot-Nash equilibrium via causal optimal transport

Monday
Dec 18
10h00-
10h45

Beatrice Acciaio
London School of Economics

I will consider Cournot-Nash equilibrium problems in a dynamic setting, where each agent faces a cost that is composed by an idiosyncratic part depending on its own type and action, and a mean-field term depending on the actions distribution over all agents. The tools used in order to get existence and uniqueness come from dynamic optimal transportation of non-anticipative nature. The talk is based on an ongoing project with Julio Backhoff Veraguas.

Rough volatility from an affine point of view

Monday
Dec 18
11h15-
12h00

Christa Cuchiero
University of Vienna

We represent Hawkes process and their Volterra long term limits, which have recently been used as rough variance processes, as projections of (infinite dimensional) affine Markov processes. The representations lead to several new views on affine Volterra processes introduced by Abi-Jaber, Larsson and Pulido. We also discuss numerical approximation schemes based on these representations. The talk is based on joint work with Josef Teichmann.

A Branching Process Approach to Power Markets

Monday
Dec 18
12h00-
12h45

Carlo Sgarra
Politecnico di Milano

We propose and investigate a market model for power prices, including most basic features exhibited by previous models and taking into account self-exciting properties. The model proposed extends Hawkes-type models by introducing a two-fold integral representation property. A Random Field approach was already exploited by Barndorff-Nielsen et al., who adopted the Ambit Field framework for describing the power price dynamics. The novelty contained in our approach consists in combining the basic features of both Branching Processes and Random Fields in order to get a realistic and parsimonious model setting. We shall provide some closed-form evaluation formulae for forward contracts. We discuss the risk premium behavior, by pointing out that in the present framework, a very realistic description arises. We outline a possible methodology for parameters estimation. We illustrate by graphical representation the main achievements of this approach. Joint work with Ying Jiao, Chunhua Ma and Simone Scotti.

Stochastic modeling and control of power grids under uncertainty

Monday
Dec 18
14h00-
14h45

Alessandro Zocca
California Institute of Technology

Power grids are increasingly affected by uncertainty due to the intermittent nature of renewable generation. In this talk I will present a stylized model for power grids under uncertainty, aiming to get insight in the interplay between renewables penetration and grid reliability.

The physical network is modelled as a weighted graph, where nodes represent buses and edges represent transmission lines. The power injected or consumed in the network nodes is described by a power injections vector, modelled as a random vector or multidimensional stochastic process, that uniquely determines the line power flows in the network edges. This stochastic model is leveraged to analyze two different aspects, namely (i) stochastic optimization of energy storage and (ii) endogenous line failures and cascading failures. The first part of the talk is based on [1,3] and investigate a scenario where energy storage devices ("batteries") that can coordinate their operations are added to the grid. Such batteries can both charge using the power in excess in the network or discharge to meet the network power demand. Either way, the presence of batteries can be leveraged to mitigate the intrinsic uncertainty in the power generation and demand and, hence, transport electricity more efficiently through the network. Using the expected total power loss as metric, we derive analytically the optimal control for these batteries and show how it fundamentally depends on the network structure as well as on the power injections correlation structure. Due to the interplay between network structure, correlations in the power injections, and power flow physics, the stochastic fluctuations of the

power injections may cumulate and cause line failures, possibly triggering cascades. This aspect is highly relevant due to the increasing penetration of renewable energy sources in modern power grids, their geographical correlations, and their susceptibility to weather conditions. In the second part of the talk, based on [2], we explore how these endogenous failures emerge using techniques from large deviations theory and studying statistical properties of the corresponding cascading failures. This work is supported by NWO Rubicon grant No. 680-50-1529.

References

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2. T. Nesti, A. Zocca, and B. Zwart. (2017). "Emergent failures and cascades in power grids: a statistical physics perspective". Submitted. Preprint at arXiv:1709.10166.

3. A. Zocca, and B. Zwart. (2017). "Optimization of stochastic lossy transport networks and appli- cations to power grids". In preparation.

Reflected Second order BSDEs with measurable coefficients

Monday
Dec 18
14h45-
15h30

Anis Matoussi
Le Mans Université

We present existence and uniqueness results for Reflected second order BSDEs (2RBSDEs) with measurable coefficients in the context of general filtration. The dynamic programming principle plays a key role for the existence proof, we construct a value function that is measurable with respect to time, space and probability measure. Therefore, we use the measurable selection theorem to prove dynamic programming principle. The non-symmetry between the lower obstacle and the upper obstacle in the second-order framework is also highlighted. Then we consider the problem of approximation of the initial value of the solution of a 2RBSDEs . This can be interpreted as an approximation of a control problem of the standard reflected backward stochastic differentials equations solutions with uncertainty on the model. These works were motivated by applications on hedging American option and Dynkin game under uncertainty. This talk is based on several works with L. Denis, F. Noubiagain (Le Mans Université).

Multi-dimensional BSDEs whose terminal values are bounded and have bounded Malliavin derivatives

Monday
Dec 18
16h00-
16h45

Shiqi Song
Université d'Evry

We consider a class of multi-dimensional BSDEs on a finite time horizon (containing the Lipschitzian-quadratic BSDEs), whose terminal values are bounded as well as their corresponding Malliavin derivatives. We prove two results. The first one is an exponential integrability condition which determines when a BSDE in this class has a bounded solution up to the given time horizon. In the second result, via a (deterministic) differential equation, we compute a minimum horizon up to which a bounded solution for any BSDE in this class exists.

When Capital is a Funding Source: The XVA Anticipated BSDEs

Monday
Dec 18
16h45-
17h30

Wissal Sabbagh
Université d'Evry

Economic capital (EC) can be used as a funding source by banks, at a risk-free cost instead of the additional credit spread of the bank in the case of unsecured borrowing. This results in a significant reduction of funding costs and an FVA (funding valuation adjustment) ignoring it would be grossly overestimated. Mathematically the intertwining of EC and FVA leads to an anticipated BSDE (ABSDE) for the FVA, with coefficient entailing a conditional risk measure of the one-year-ahead increment of the martingale part of the FVA itself. Accounting further for the KVA (capital valuation adjustment) component of economic capital, with the ensuing feedback condition that EC must be greater than KVA, yields a system of ABSDEs for the FVA and the KVA processes considered simultaneously.

In this talk we show that the ensuing (FVA, KVA) system of ABSDEs is well-posed and we establish the convergence of a Picard approximation scheme. This is first done for a bank without debt. In the realistic case of a defaultable bank, the resulting ABSDEs, which are stopped before the default of the bank, are solved by reduction to a reference filtration.

Tuesday, December 19th, 2017

Replicating portfolio approach to capital calculation

Tuesday Dec 19 09h00-09h45

Damir Filipovic
EPFL and Swiss Finance Institute

The replicating portfolio (RP) approach to the calculation of capital for life insurance portfolios is an industry standard. The RP is obtained from projecting the terminal loss of discounted asset-liability cash flows on a set of factors generated by a family of financial instruments that can be efficiently simulated. We provide the mathematical foundations and a novel dynamic and path-dependent RP approach for real-world and risk-neutral sampling. We show that our RP approach yields asymptotically consistent capital estimators if the chaotic representation property holds. We illustrate the tractability of the RP approach by three numerical examples. This is a joint work with Mathieu Cambou.

State constrained optimal control problems via reachability approach

Tuesday Dec 19 09h45-10h30

Athena Picarelli
Imperial College

This work deals with a class of stochastic optimal control problems in the presence of state constraints. It is well known that for such problems the value function is, in general, discontinuous, and its characterisation by a Hamilton-Jacobi equation requires additional assumptions involving an interplay between the boundary of the set of constraints and the dynamics of the controlled system. Here, we give a characterization of the epigraph of the value function without assuming the usual controllability assumptions. To this end, the stochastic optimal control problem is first translated into a state-constrained stochastic target problem. Then a level-set approach is used to describe the backward reachable sets of the new target problem. It turns out that these backward reachable sets describe the value function. The main advantage of our approach is that it allows us to easily handle the state constraints by an exact penalisation. However, the target problem involves a new state variable and a new control variable that is unbounded.

Volatility and arbitrage

Tuesday
Dec 19
11h00-
11h45

Johannes Ruf
London School of Economics

The capitalization-weighted cumulative variation $\sum_{i=1}^{d} \int_0^{\cdot} \mu_i(t) \mathrm{d}\langle \log \mu_i \rangle(t)$ in an equity market consisting of a fixed number d of assets with capitalization weights $\mu_i(\cdot)$, is an observable and a nondecreasing function of time. If this observable of the market is not just nondecreasing but actually grows at a rate bounded away from zero, then strong arbitrage can be constructed relative to the market over sufficiently long time horizons. It has been an open issue for more than ten years, whether such strong outperformance of the market is possible also over arbitrary time horizons under the stated condition. We show that this is not possible in general, thus settling this long-open question. We also show that, under appropriate additional conditions, outperformance over any time horizon indeed becomes possible, and exhibit investment strategies that effect it. Joint work with Bob Fernholz and Ioannis Karatzas.

Rough volatility, market impact and no-arbitrage

Tuesday
Dec 19
11h45-
12h30

Mathieu Rosenbaum
Ecole Polytechnique

It has been recently established that a quasi-universal law of financial markets is that volatility is rough. In this talk, we wish to understand how this stylized fact can be related to the notions of market impact and no-arbitrage. More precisely, we show that rough volatility naturally emerges as a consequence of a no-statistical arbitrage principle.

Wednesday, December 20th, 2017

Deterministic and stochastic 2D Euler equations with random initial conditions

Wednesday Dec 20 09h00-09h45

Franco Flandoli
Università di Pisa

Starting from a classical work of S. Albeverio and A.B. Cruzeiro, the 2D Euler equations are considered in spaces of distributional vorticity, with random initial conditions related to the enstrophy measure. Solutions are constructed as limit of random point vortices. Under suitable assumptions on the noise, we investigate uniqueness of solutions.

Stochastic diffusion equations on networks with non-local boundary condition and applications to finance

Wednesday Dec 20 09h45-10h30

Francesco Cordoni
HPA-High Performance Analytics

In the talk, we will consider a class of reaction-diffusion SPDE, subject to non-local stochastic boundary conditions. Existence and uniqueness for the aforementioned SPDE with non-local in space or non-local in time, namely with time delay, boundary conditions are established via semigroup techniques. Also, general applications to stochastic optimal control are considered. Finally, it is shown how the introduced setting can be exploited to consider financial applications related to systems of interconnected banks.

Common Agency Dilemma with information asymmetry

Wednesday Dec 20 11h15-12h00

Thibaut Mastrolia
Ecole Polytechnique

We consider a problem of contract theory in which several Principals hire a common Agent and we study the model in the continuous time setting. We show that optimal contracts should satisfy some equilibrium conditions and we reduce the optimisation problem of the Principals to a system of coupled Hamilton-Jacobi-Bellman (HJB) equations. Further, in a more specific linear-quadratic model where two interacting Principals hire one common Agent, we are able to calculate the optimal effort by the Agent for both Principals. In this continuous time model, we extend the result of Bernheim and Whinston 86' in which the authors compare the optimal effort of the Agent in a non-cooperative Principals model and that in the aggregate model, and give the condition under which these two optimisations coincide.

Consistent Utility of Investment and Consumption: a Forward/Backward SPDE viewpoint

Wednesday Dec 20 12h00-12h45

Caroline Hillairet
Ensae, CREST

This work provides an extension of the notion of consistent progressive utilities U to consistent progressive utilities of investment and consumption (U;V). It discusses the notion of market consistency in this forward framework, compared to the classic backward setting with a given terminal utility, and whose value function is an example of such consistent forward utility. To ensure the consistency with the market model on a given set of test processes, we establish a stochastic partial differential equation (SPDE) of Hamilton- Jacobi-Bellman (HJB)-type to be satisfied by U. This SPDE highlights the link between the utility of wealth U and the utility of consumption V, and between the drift and the volatility characteristics of the utility U. By associating two SDEs with the HJB-SPDE, we discuss the existence and the uniqueness of a concave solution. Finally, we provide explicit regularity conditions and characterize the consistent pairs of consistent utilities of investment and consumption. Some examples, such as power utilities, illustrate the theory.
Joint work with Nicole El Karoui and Mohamed Mrad.

Partial observation optimal control and BSDEs

Wednesday
Dec 20
14h00-
14h45

Marco Fuhrman
Università degli Studi di Milano

We address a classical stochastic optimal control problem with partial observation, where the observation process is corrupted by a nondegenerate Gaussian noise. We introduce a suitable Backward Stochastic Differential Equation (BSDE) to represent the value function of this problem. This is connected to optimal control (with full observation) of the associated Zakai equation for filtering. We use a randomization method that consists in introducing an exogenous pure jump process to replace the control, and then in formulating an auxiliary control problem in the form of control of the stochastic intensity, which turns out to be equivalent with the original one. This is joint work with E. Bandini, A. Cosso and H. Pham.

On Wong-Zakai approximations for a family of SDEs interpolating between the Ito and Stratonovich interpretations

Wednesday
Dec 20
14h45-
15h30

Alberto Lanconelli
University of Bari

From a modeling point of view the celebrated Wong-Zakai theorem provides a crucial insight in the theory of stochastic differential equations. It asserts that the solution to certain random differential equations, which can be considered as natural approximations to stochastic differential equations, converges to the solution of the Stratonovich interpretation of the SDE, instead of the more popular Ito's one. The reason for that has to be found in the type of product utilized in the random differential equation to multiply the diffusion coefficient with the smooothed white noise. In this talk we will introduce a family of products for random variables which interpolates between the pointwise and Wick products. Then, for each product in that family we will define a suitable random differential equation and prove Wong-Zakai type results where in the limiting SDE the stochastic integral is interpreted accordingly to the select product.

Nonzero-sum stochastic differential games with impulse controls: a verification theorem with examples

Wednesday Dec 20 16h00-16h45

Tiziano Vargiolu
Università degli Studi di Padova

We consider a general nonzero-sum impulse game with two players. The main mathematical contribution of the paper is a verification theorem which provides, under some regularity conditions, a suitable system of quasi-variational inequalities for the value functions and the optimal strategies of the two players. As an example, we study an impulse game with a one-dimensional state variable, following a real-valued scaled Brownian motion, and two players with linear and symmetric running payoffs. Thanks to the verification theorem, we find and fully characterize a Nash equilibrium by providing explicit expressions for the value functions and the optimal strategies of the players. Finally, we prove some asymptotic results with respect to the intervention costs for the one-dimensional symmetric game.

Structure of martingale transports in finite dimensions

Wednesday Dec 20 16h45-17h30

Pietro Siorpaes
Imperial College London

Martingale optimal transport, a variant of the classical optimal transport problem where a martingale constraint is imposed on the coupling, was born to study model-independent pricing. In a recent paper, Beiglbck, Nutz and Touzi show that in dimension one there is no duality gap and that the dual problem admits an optimizer. A key step towards this achievement is the characterization of the polar sets of the family of all martingale couplings. Here we aim to extend this characterization to arbitrary finite dimension through a deeper study of the convex order.

Thursday, December 21st, 2017

Model Uncertainty Stochastic Mean-Field Control

Thursday
Dec 21
09h00-
09h45

Nacira Agram
University of Oslo

We consider the problem of optimal control of a mean-field stochastic differential equation (SDE) under model uncertainty. The model uncertainty is represented by ambiguity about the law $\mathcal{L}(X(t))$ of the state $X(t)$ at time t. For example, it could be the law $\mathcal{L}_{\mathbb{P}}(X(t))$ of $X(t)$ with respect to the given, underlying probability measure $\mathbb{P}$. This is the classical case when there is no model uncertainty. But it could also be the law $\mathcal{L}_{\mathbb{Q}}(X(t))$ with respect to some other probability measure $\mathbb{Q}$ or, more generally, any random measure $\mu(t)$ on $\mathbb{R}$ with total mass 1.
We represent this model uncertainty control problem as a *stochastic differential game* of a mean-field related type SDE with two players. The control of one of the players, representing the uncertainty of the law of the state, is a measure-valued stochastic process $\mu(t)$ and the control of the other player is a classical real-valued stochastic process $u(t)$. This optimal control problem with respect to random probability processes $\mu(t)$ in a non-Markovian setting is a new type of stochastic control problems that has not been studied before. By constructing a new Hilbert space $\mathcal{M}$ of measures, a new type of adjoint, operator-valued BSDEs involving Frechet derivatives with respect to the measure is introduced. We obtain a sufficient and a necessary maximum principle for Nash equilibria for such games in the general nonzero-sum case, and for saddle points in zero-sum games.
As an application we find an explicit solution of the problem of optimal consumption under model uncertainty of a cash flow described by a mean-field related type SDE. Joint with Bernt Øksendal from Oslo University.

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1. Agram, N., & Øksendal, B. (2016). Model uncertainty stochastic mean-field control. arXiv preprint arXiv:1611.01385.

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A Stochastic Approach to Bose-Einstein Condensation

Thursday Dec 21 09h45-10h30

Stefania Ugolini
Università degli Studi di Milano

A well-posed probabilistic way of looking at the Bose-Einstein condensation consists in rigorously associating a N-dimensional diffusion process to the ground state eigenfunction of the N-body Hamiltonian through Nelson?s map. We describe some probability measures convergence problems related to the Gross- Pitaevskii scaling limit when N goes to infinity together with a well-defined rescaling of the interaction potential. In particular we discuss the entropy chaos for the symmetric probability law of the N interacting diffusion system, which is a stronger chaotic property than Kac?s chaos property, and the weak convergence on the path space of the one-particle probability law to the probability measure uniquely associated with the minimizer of the non linear Gross-Pitaevskii functional. The talk is based on the following paper: Albeverio, S.,De Vecchi, F.C., Ugolini, S.:Entropy Chaos and Bose-Einstein Condensation. Journal of Statistical Physics 2017 DOI 10.1007/s10955-017-1820-0.

The VaR estimation in the new PRIIPS regulation. The Cornish Fischer expansion and its dependence from the actual price process model. Theoretical issues and application to real cases

Thursday Dec 21 11h00-11h45

Michele Bonollo
Numerix

The forthcoming PRIIPs regulation, see (4), will come in force from 2018. It asks to all the producers (manufactures) of prepacked financial products for the retail customers (PRIIPs) to publish a key investment document (KID), according to a standardized template. In this document the disclosure about risk is given by a synthetic risk indicator (SRI), where the market risk measure (MRM) is the most relevant component. Differently from other regulations, where only the risk measure (e.g. the value at risk, VaR) and the related parameters (e.g, the confidence level and the horizon) are prescribed, in this case also the estimation technique is strictly stated by the regulation. The products are categorized depending on the payoff (linear vs non linear) and data availability. For the most relevant category, the category 2 of linear products (funds, funds of funds, unit linked, etc), the VaR, i.e. the quantile, must be estimated by the Cornish Fisher expansion, a well known statistical tool, see (2). We recall that this technique is a sort of series expansion that tries calculate the quantile having the Gaussian distribution as the center, adding some terms as the data deviate from the gaussian distribution in the first moments. The quantile estimation is a very challenging technique in the inferential statistics field. One can set some different approaches. For example, given the model family (Gaussian, EVT, ...) one looks for the best estimator according to some optimization criteria (L1, L2, ..). Alternatively one can reject any parametric assumption and to estimate the quantile in a data drive framework, with the empirical quantile, the

L-estimator, the Harrel-Davis estimator and so on, see (3) and (5). What is very hard to detect is the combined effect of the data generating model and the sample variance. In other words, if we trust the model, we are attributing the data empirical deviations to the usual sample randomness, while if we do not trust any model, the quantile estimation will be driven only by the data, as in the very popular historical simulation approach to market risk. In our work, based on both real and simulated time series, we review some theoretical features of the Cornish Fisher and we try to investigate separately how the real data generator model and the sample variance can affect the performances of the estimator chosen by the regulator. Joint work with Davide Chinzi.

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Alpha-CIR model with branching processes in sovereign interest rate modelling

Thursday
Dec 21
11h45-
12h30

Simone Scotti

Paris Diderot, LPMA

We introduce a class of interest rate model, called the α-CIR model, which is a natural extension of the standard CIR model by adding a jump part driven by a α-stable Levy processes with index $\alpha \in (1; 2]$. We deduce an explicit expression of the bond price by using the fact that the model belongs to the family of CBI and affine processes, and analyze the bond price and bond yield behaviors. The α-CIR model allows to describe in a unified and parsimonious way several recent observations on the sovereign bond market such as the persistency of low interest rates together with the presence of large jumps. Finally we provide a thorough analysis of the jumps and in particular the large jumps.

Poster presentations

Filtering and optimal control of time-homogeneous pure jump Markov processes with noise-free partial observation

Alessandro Calvia

Università degli Studi di Milano-Bicocca

I am going to address a stochastic filtering and optimal control problem with partial observation, mainly characterized by observations not corrupted by noise. Let X and Y be a given couple of stochastic processes, with values in complete and separable metric spaces I and O respectively. The unobserved (or signal) process X is a time-homogeneous pure jump Markov process, whose rate transition measure is known. The observed process Y is defined as $Y_t = h(X_t)$, $t \geq 0$, where $h\colon I \to O$ is a known surjective and measurable function.

The first aim is to provide an explicit SDE for the filtering process $(\pi_t)_{t\geq 0}$, satisfying

$$\pi_t(\varphi) = \mathbb{E}\big[\varphi(X_t) \mid \mathcal{Y}_t\big]$$

for all $t \geq 0$ and all $\varphi\colon I \to \mathbb{R}$ bounded and measurable functions; here $(\mathcal{Y}_t)_{t\geq 0}$ denotes the natural filtration of Y, i.e. $\mathcal{Y}_t = \sigma(Y_s\colon 0 \leq s \leq t)$, for all $t \geq 0$. The problem is tackled with the aid of known results from marked point processes theory and a martingale approach. The filtering process is also characterized as a *Piecewise Deterministic Markov Process*, in the sense of Davis.

The second goal is to solve an infinite-horizon optimal control problem. The aim is to minimize a discounted cost functional by controlling the rate transition measure of the unobserved process via the information provided by the observed process. The problem is reformulated into a discrete-time optimal control problem for the filtering process. In the case of a finite-state controlled Markov chain (i.e. when the space I is of finite cardinality), the value function can be characterized as the unique fixed point of a suitably defined operator. In addition, a HJB equation can be explicitly written and the value function is proved to be its unique constrained viscosity solution, in the sense of Soner. Finally, the existence of an optimal control for the discrete-time optimal control problem is shown. In our setting such an optimal control coincides with a *piecewise open-loop* control in the sense of Vermes.

Convergence, Fluctuations and Large Deviations for Finite State Mean Field Games via the Master Equation

Alekos Cecchin

Università degli Studi di Padova

We show the convergence of finite state symmetric N–player differential games, where players control their transition rates from state to state, to a limiting dynamics given by a finite state Mean Field Game system made of two coupled forward-backward ODEs. We exploit the so-called Master Equation, which in this finite-dimensional framework is a first order PDE in the simplex of probability measures, obtaining the convergence of the feedback Nash equilibria, the value functions and the optimal trajectories. The convergence argument requires only the regularity of a solution to the Master equation. Moreover, we employ the convergence method to prove a Central Limit Theorem and a Large Deviation Principle for the evolution of the N–player empirical measures. The well-posedness and regularity of solution to the Master Equation are also studied.

Gauge symmetries of semimartingales with applications

Francesco De Vecchi

Università degli Studi di Milano

We introduce the concept of gauge symmetry group of a general semimartingale with jumps. This concept is originally introduced for explaining the concept of weak symmetries of Brownian-motion-driven SDEs, indeed the group of random rotations of a Brownian motion can be considered a first example of gauge symmetry group. After introducing the concept we propose some practical methods, exploiting the characteristic triplet of a semimartingale, for verifying the presence of gauge symmetries for specific semimartingales. Finally we use this notion to propose a definition of weak symmetry for SDEs driven by general semimartingales with jumps and we show some concrete examples of weak symmetric SDEs. Based on the paper *Symmetries and invariance properties of stochastic differential equations driven by semimartingales with jumps* (arXiv:1708.01764) written in collaboration with Sergio Albeverio, Paola Morando and Stefania Ugolini.

Stochastic models for wind energy markets

Silvia Lavagnini
University of Oslo

During recent years wind energy has become an increasingly important renewable source. Unfortunately, such type of energy has the limit that it can only be generated in the presence of the suitable amount of wind, also to avoid possible damages for the power plant. In this study, we analysed a wind power plant from the stochastic point of view. By employing different stochastic models, we provided an analytical formula for the income from the wind mill as the product of the electricity spot price and the amount of energy produced, two variables that are negatively correlated. Considering relevant data sets, we then outlined at least one possible approach for calibrating each model. Finally, we defined the basis to rigorously study quanto options in wind energy markets. In particular, we defined a European-put type quanto option based on two indices. The first one concerns the spot price, while the second one takes into account the degrading of the power plant over time. Joint work with Fred Espen Benth and Luca Di Persio.

Additive energy forward curves in a Heath-Jarrow-Morton framework

Marco Piccirilli
Università degli Studi di Padova

One of the peculiarities of power and gas markets is the delivery mechanism of forward contracts. The seller of a futures contract commits to deliver, say, power, over a certain period, while the classical forward is a financial agreement settled on a maturity date. Our purpose is to design a Heath-Jarrow-Morton framework for an additive, mean-reverting, multicommodity market consisting of forward contracts of any delivery period. The main assumption is that forward prices can be represented as affine functions of a universal source of randomness. This allows us to completely characterize the models which prevent arbitrage opportunities. In this respect, we prove two results on the martingale property of stochastic exponentials. The first allows to validate measure changes made of two components: an Esscher-type density and a Girsanov transform with stochastic and unbounded kernel. The second uses a different approach and works for the case of continuous density. Within this framework, we introduce two models: a generalized Lucia-Schwartz model and a cross-commodity cointegrated market. Joint work with Fred Espen Benth and Tiziano Vargiolu.

An SDP approach for bounding option prices in polynomial models

Francesco Statti
EPFL

We propose a new methodology for bounding European and American option prices in polynomial models [1]. The starting point of our approach is to consider two optimization problems whose solutions provide upper and lower bounds for the option price. For example, the price at time $t = 0$ of a European call option maturing at time T with strike K and underlying $(X_t)_{0\leq t\leq T} \in \mathbb{R}^+$ can be bounded from above and below by solving

$$\min\{\mathbb{E}[p(X_T)] \mid p \in \mathrm{Pol}_n(\mathbb{R}^+) \text{ so that } p(x) \geq (x-K)^+, \forall x \in \mathbb{R}^+\}, \tag{1}$$
$$\max\{\mathbb{E}[p(X_T)] \mid p \in \mathrm{Pol}_n(\mathbb{R}^+) \text{ so that } p(x) \leq (x-K)^+, \forall x \in \mathbb{R}^+\}, \tag{2}$$

where $\mathrm{Pol}_n(\mathbb{R}^+)$ denotes the set of polynomials on $\mathbb{R}^+$ of maximal degree $n \in \mathbb{N}$. The second step of the methodology consists of rewriting (1) and (2) in order to make them numerically solvable. To this aim, we translate them into two semidefinite programming (SDP) problems by imposing s.o.s. (sum of squares) conditions on the involved non-negative polynomials and by exploiting the moment formula for jump-diffusions which allows us to obtain a linear objective function. Finally, solving the resulting SDPs gives us the desired upper and lower bounds. In our numerical experiments, we were able to apply this technique to single-asset options as well as to multidimensional pricing problems. Furthermore, a time-discretization approach allows us to extend it to the problem of American option pricing. Joint work with Damir Filipovic and Daniel Kressner.

References

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