12th International Workshop

Stochastic Models and Control

Cottbus, Germany
March 19 – 22, 2019
Invited Speakers
Hansjörg Albrecher (Université de Lausanne)
Luis Alvarez Esteban (University of Turku)
Rüdiger Frey (Vienna University of Economics and Business)
Anna Jaśkiewicz (Wroclaw University of Technology)
Rodwell Kufakunesu (University of Pretoria)
Hannelore Lisei (Babes-Bolyai University, Cluj-Napoca)
Michela Ottobre (Heriot Watt University, Edinburgh)
Huyên Pham (Université Paris Diderot (Paris 7))
Łukasz Stettner (Polish Academy of Sciences, Warsaw)
Michaela Szölgyényi (University of Klagenfurt)
Nizar Touzi (École Polytechnique, Palaiseau)

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Sören Christensen (Hamburg)
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Welcome

Dear Participants,

We warmly welcome you to the 12th International Workshop on Stochastic Models and Control in Cottbus, Germany. This workshop continues a series of biannual workshops, the latest of which were held in Trier (2017), Kaiserslautern (2015) and Berlin (2013). After 25 years the workshop comes back to the place where it all began in March 1994.

We are very happy to welcome about 60 participants coming from 15 countries. The scientific program comprises 37 paper presentations, among them 11 invited lectures. The social programme with an excursion to the Branitz Park and a conference dinner will provide additional opportunities for scientific exchange and discussion.

We would like to thank the authors who submitted their work, the members of the program committee, as well as our partners and sponsors. We wish you all four wonderful days and we hope that this event will help you to find new ideas for your research.

Welcome to Cottbus and SMC2019,
the local organizers

Venue

The workshop will be held at
Brandenburg University of Technology Cottbus-Senftenberg
Platz der Deutschen Einheit 1
03046 Cottbus
Zentrales Hörsaalgebäude (ZHG)
Lecture Room (Hörsaal) C

For directions, please consult the workshop website at [www.smc2019.b-tu.de](http://www.smc2019.b-tu.de)

Internet Access

For all participants with access to [eduroam](https://www.smc2019.b-tu.de) service we recommend to use this network. All other participants are kindly asked to come to the reception desk where we provide access data for guest accounts to our university network.
## Tuesday, March 19

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TUESDAY 9:30–10:15
On optimal dividend problems in risk theory

Hansjörg Albrecher
Université de Lausanne

We give a survey of some recent results on optimal dividend strategies in insurance risk theory, where part of the surplus in an insurance portfolio can be paid out as profits to the shareholders. In particular, we focus on optimality results under certain constraints including ratcheting, affine strategies and the presence of capital injections.

TUESDAY 10:15–10:40
Risk theoretic applications of PDMPs

Stefan Thonhauser
Graz University of Technology

Joint work with Gunther Leobacher, Peter Kritzer, Michaela Szölgyenyi

The class of piecewise deterministic Markov processes includes several common risk models and their generalizations. In this field many objects of interest such as ruin probabilities, penalty functions or expected dividend payments are typically studied by means of associated integro-differential equations. Unfortunately, only particular parameter constellations allow for closed form solutions such that in the general case one needs to rely on numerical methods. Instead of studying these associated integro-differential equations, we adapt the problem in a way that allows us to apply deterministic numerical integration algorithms such as QMC rules. For the derivation of error bounds for the numerical procedure we need to introduce a smoothing technique which is applied to the integrands involved. On the analytical side, we prove a convergence result for our PDMP approximation, which is of independent interest as it justifies phase-type approximations on the process level which are quite common in the actuarial literature.
Complementing existing results on minimal ruin probabilities, we minimize expected discounted penalty functions (or Gerber-Shiu functions) in a Cramér-Lundberg model by choosing optimal reinsurance. Reinsurance strategies are modelled as time dependent control functions, which leads to a setting from the theory of optimal stochastic control and ultimately to the problem’s Hamilton-Jacobi-Bellman equation. We show existence and uniqueness of the solution found by this method and provide numerical examples involving light and heavy tailed claims and also give a remark on the asymptotics.

We study an optimal stopping problem when the state process is governed by a general Feller process. In particular, we examine viscosity properties of the associated value function with no a priori assumption on the stochastic differential equation satisfied by the state process. Our approach relies on properties of the Feller semigroup. We present conditions on the state process under which the value function is the unique viscosity solution to an Hamilton-Jacobi-Bellman (HJB) equation associated with a particular operator. More specifically, assuming that the state process is a Feller process, we prove uniqueness of the viscosity solution which was conjectured by Palczewski, J. and Stettner, L. (2014). We then apply our results to study viscosity property of optimal stopping problems for some particular Feller processes, namely diffusion processes with piecewise coefficients and semi-Markov processes. Finally, we obtain explicit value functions for optimal stopping of straddle options, when the state process is a reflected Brownian motion, Brownian motion with jump at boundary and regime switching Feller diffusion, respectively.
We consider a fractional version of the Heston volatility model which is inspired by Guennoun, Jacquier, Roome, Shi (2018). Within this model we treat portfolio optimization problems for power utility functions. Using a suitable representation of the fractional part, followed by a reasonable approximation we show that it is possible to cast the problem into the classical stochastic control framework. This approach is generic for fractional processes. We derive explicit solutions and obtain as a by-product the Laplace transform of the integrated volatility. In order to get rid of some undesirable features we introduce a new model for the rough path scenario which is based on the Marchaud fractional derivative as defined in Samko, Kilbas, Marichev (1993). We provide a numerical study to underline our results.

References:
Long Run Control With Degenerate Observation

Łukasz Stettner
Polish Academy of Sciences, Warsaw

We consider average reward per unit time problem of controlled partially observed discrete time Markov processes in the case where the only observation of the state is in the form of a deterministic function of the current state of the process. Under nice ergodic assumptions we first solve the problem with at most countable observation space. Then we generalize it to uncountable observation space in which we don’t have explicit form of the filtering process and corresponding controlled transition operator. We also study the case of noisy but still degenerate observation.

Optimal Investment for Private Investors

Christoph Belak
Trier University

Joint work with Erhan Bayraktar, Sören Christensen, Lukas Mich, Frank Seifried

We study a portfolio optimization problem under various transaction cost structures which resemble those of a private investor:

1. proportional and fixed costs;
2. proportional costs floored and capped at fixed levels;
3. the limit of (1) as the fixed cost component tends to zero.

In the absence of short-selling and borrowing constraints, the value functions turn out to be truly discontinuous viscosity solutions of the corresponding quasi-variational inequalities, which can nevertheless be characterized uniquely within a suitable class of functions. Having established this unique characterization, we study the optimal trading regions numerically. For power utility investors, we find that the optimal no-trading region in (1) is approximately cone-shaped. For the cost structure (2), the situation is richer in that the optimal action depends on the cost regime (floored, proportional, capped) the investor is in. Finally, regarding (3), we show that the optimal strategies in (1) have an accumulation point which solves the problem with purely proportional costs.
Long Term Average Impulse Control Problems for Lévy Processes

Tobias Sohr

Universität Hamburg

Joint work with Sören Christensen

Impulse control problems deal with the question how to find an optimal payoff for a controlled continuous time process. The allowed strategies, impulse control strategies, allow to shift the process down at discrete stopping times. The aim here is to optimize the long-term average expected payoff. We present a solution technique for such a problem in the case that the underlying process is a Lévy process. We show under mild continuity assumptions onto running costs and payoff function that either an (s,S)-strategy, i.e. always shifting down the process to the level s, as soon as it exceeds S, is optimal or there is no optimal strategy at all. Furthermore, we establish a way to determine the boundaries s and S in many cases. Our solution technique first connects the impulse control problem to a stopping problem. We show that this stopping problem has an optimal threshold time that leads to the boundaries for the (s,S) policies. A main ingredient of the proof is the representation of the payoff function as an expected running supremum. Advantages of our approach are that we do not have to pose strong ergodicity assumptions upon the underlying process and that we are able to calculate the boundaries s and S relatively explicit in some important special cases. These include applications in optimal harvesting as well as in inventory control.

Optimal investment-consumption and life insurance selection problem under inflation

Calisto Guambe

University of Pretoria and Eduardo Mondlane University Maputo

Joint work with Rodwell Kufakunesu

In this talk, we discuss an optimal investment, consumption and insurance problem of a wage earner under inflation. Assume a wage earner investing in a real money account and three asset prices, namely: a real zero coupon bond, the inflation-linked real money account and a risky share described by jump-diffusion processes. Using the theory of quadratic-exponential backward stochastic differential equation (BSDE) with jumps approach, we derive the optimal strategy for the two typical utilities (exponential and power) and the value function is characterized as a solution of BSDE with jumps. Finally, we derive the explicit solutions for the optimal investment in both cases of exponential and power utility functions for a diffusion case.
Tuesday 16:45–17:10
Credit risk with asymmetric information and a switching default threshold

Imke Redeker

Brandenburg University of Technology

Joint work with Michaela Szölgyenyi, Ralf Wunderlich

We investigate the impact of available information on the estimation of the default probability within a generalized structural model for credit risk. The traditional structural model where default is triggered when the value of the firm’s asset falls below a constant threshold is extended by relaxing the assumption of a constant default threshold. The default threshold at which the firm is liquidated is modeled as a random variable whose value is chosen by the management of the firm and dynamically adjusted to account for changes in the economy or the appointment of a new firm management.

Investors on the market have no access to the value of the threshold and only anticipate the distribution of the threshold. We distinguish different information levels on the firm’s assets and derive explicit formulas for the conditional default probability given these information levels. Numerical results are presented to illustrate the impact of the information level on the estimation of the default probability and the associated credit yield spread.

Tuesday 17:10–17:35
Optimal investment and reinsurance strategies to maximize exponential utility of terminal wealth under a partially observable multivariate claim count model

Gregor Leimcke

Karlsruhe Institute of Technology (KIT)

We consider the surplus process of an insurance company with several insurance classes and assume that the insurance company is interested in an investment and reinsurance strategy which maximizes the expected exponential utility of terminal wealth. The claim arrivals of the insurance classes are modeled by a multivariate point process with interdependencies between the marginal point processes where the dependence modelling is reduced to the choice of thinning probabilities. We assume that the thinning probabilities are unobservable. This leads to a stochastic control problem under partial information. Using a Bayesian approach we overcome the issue of uncertainty and obtain a control problem with complete observation. With the help of stochastic control theory, we can identify an optimal investment and reinsurance strategy.
**Wednesday 08:30–09:15**

Portfolio diversification and model uncertainty: a robust dynamic mean-variance approach

Huyên Pham

*University Paris Diderot (Paris 7)*

Joint work with Xiaoli Wei, Chao Zhou

This talk is concerned with a multi-asset mean-variance portfolio selection problem under model uncertainty. We develop a continuous time framework for taking into account ambiguity aversion about both expected return rates and correlation matrix of the assets, and for studying the effects on portfolio diversification. We prove a separation principle for the associated robust control problem, which allows to reduce the determination of the optimal dynamic strategy to the parametric computation of the minimal risk premium function. Our results provide a justification for under-diversification, as documented in empirical studies. We explicitly quantify the degree of under-diversification in terms of correlation and Sharpe ratio ambiguity. In particular, we show that an investor with a poor confidence in the expected return estimation does not hold any risky asset, and on the other hand, trades only one risky asset when the level of ambiguity on correlation matrix is large. This extends to the continuous-time setting the results obtained by Garlappi, Uppal and Wang, and Liu and Zeng in a one-period model.

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**Wednesday 09:15–09:40**

Robust Utility Maximization and Asymptotic Behaviour of the Optimal Strategy

Dorothee Westphal

*TU Kaiserslautern*

Joint work with Jörn Sass

When modelling financial markets one is frequently confronted with model uncertainty. This is meant in the sense that parameters of the model, e.g. the drift of a stock, or the distributions of some factors in the model are only known up to a certain degree. Risk-averse investors in such a market try to maximize their worst-case expected utility. This naturally leads to considering robust optimization problems. We investigate optimal trading strategies for a robust utility maximization problem in a continuous-time Black-Scholes type financial market and impose a constraint that prevents a pure bond investment. The optimal strategy of an investor depends on how uncertain the parameters in the market are. We deduce a duality result for our robust optimization problem and show that as the degree of model uncertainty increases the uniform portfolio diversification strategy outperforms more sophisticated strategies. This carries over results from Pflug et al. (2012) from discrete time to continuous time. We also investigate the influence of the investor's risk aversion on the performance of the robust strategies.
**WEDNESDAY 09:40–10:05**

**A Multi-Asset Worst-Case Approach for Optimal Portfolios Facing Crash Scenarios**

*Elisabeth Leoff*

*Fraunhofer ITWM Kaiserslautern*

Joint work with Ralf Korn

We generalize the worst-case portfolio approach of Korn/Wilmott (2002), where the risky asset may have jumps downward, to a multi-asset setting. The main challenges arising in this setting are the nonuniqueness of indifference strategies and finding the optimal indifference strategy. For this, we employ a Lagrangian multiplier approach that makes use of the characterization of indifference strategies. We further analyze various examples in the case of both logarithmic and power utility.

**WEDNESDAY 10:05–10:30**

**Optimal timing for governmental control of the debt-to-GDP ratio**

*Neofytos Rodosthenous*

*Queen Mary University of London*

Joint work with Giorgio Ferrari

We study the problem of a government wishing to control the country’s debt-to-GDP ratio. The debt-to-GDP ratio evolves stochastically and the interest on debt is affected by an N-state continuous-time Markov chain, representing the country’s credit ratings. The debt-to-GDP ratio can be reduced through fiscal interventions or increased by public investments. The government aims to choose a policy minimizing the total expected cost of having debt and fiscal interventions counterbalanced by the gain from public investments. The problem is modelled by a bounded-variation stochastic control problem, that we explicitly solve through the analysis of an associated Dynkin game.
Optimal make-take fees for market making regulation

Nizar Touzi

École Polytechnique, Palaiseau

We address the mechanism design problem of an exchange setting suitable make-take fees to attract liquidity on its platform. Using a principal-agent approach, we provide the optimal compensation scheme of a market maker in quasi-explicit form. This contract depends essentially on the market maker inventory trajectory and on the volatility of the asset. We also provide the optimal quotes that should be displayed by the market maker. The simplicity of our formulas allows us to analyze in details the effects of optimal contracting with an exchange, compared to a situation without contract. We show in particular that it improves liquidity and reduces trading costs for investors. We extend our study to an oligopoly of symmetric exchanges and we studied the impact of such common agency policy on the system.

Nonzero-Sum Submodular Monotone-Follower Games: Existence and Approximation of Nash Equilibria

Jodi Dianetti

Bielefeld University

Joint work with Giorgio Ferrari

We consider a class of $N$-player stochastic games of multi-dimensional singular control, in which each player faces a minimization problem of monotone-follower type with submodular costs. We call these games monotone-follower games. In a not necessarily Markovian setting, we establish the existence of Nash equilibria. Moreover, we introduce a sequence of approximating games by restricting, for each $n \in \mathbb{N}$, the players' admissible strategies to the set of Lipschitz processes with Lipschitz constant bounded by $n$. We prove that, for each $n \in \mathbb{N}$, there exists a Nash equilibrium of the approximating game and that the sequence of Nash equilibria converges, in the Meyer-Zheng sense, to a weak (distributional) Nash equilibrium of the original game of singular control. As a byproduct, such a convergence also provides approximation results of the equilibrium values across the two classes of games. We finally show how our results can be employed to prove existence of open-loop Nash equilibria in an $N$-player stochastic differential game with singular controls, and we propose an algorithm to determine a Nash equilibrium for the monotone-follower game.

References:
Stationary Equilibria of Mean Field Games with Finite State and Action Space

Berenice Anne Neumann

University of Hamburg

Mean field games formalize dynamic games with a continuum of players and explicit interaction, where the players can have heterogeneous states. As they additionally yield approximate equilibria of corresponding $N$-player games, they are of great interest for socio-economic applications. However, the techniques used for mean field games crucially rely on the assumption that for each population distribution the individual agent has a unique optimal response. For finite action spaces, this assumption will only hold for trivial models. Thus, the techniques used so far are not applicable. We propose a model with finite state and action space, where the dynamics are given by a time-inhomogeneous Markov chain that might depend on the current population distribution. We show existence of stationary mean field equilibria under mild assumptions and propose techniques to compute all these equilibria. More precisely, our results allow – given that the generators are irreducible - to characterize the set of stationary mean field equilibria as the set of all fixed points of a map that is completely characterized by the transition rates and rewards for deterministic strategies. For the case of non-irreducible generators, we propose several partial results.

Full Characterization of the Policy of a Central Bank

Patrick Schuhmann

Bielefeld University

Joint work with Giorgio Ferrari, Salvatore Federico

We consider a central bank which can adjust the (deterministic) key interest rate in order to influence the dynamics of the inflation rate. The inflation rate is modeled as an Ornstein-Uhlenbeck process in which the key interest rate affects the mean-reversion level. The problem is modeled as a degenerate two-dimensional singular stochastic control problem, in which the central bank aims at minimizing the total expected cost of having an inflation rate not aligned with an exogenous given target value, plus the total expected costs of interventions on the key interest rate (due to e.g. administration costs). We solve the problem by using a viscosity solutions approach. We find that the optimal solution is is triggered by two curves which separates three different regions corresponding to increasing respectively decreasing the key interest rate and an inaction region. We are able to prove a $C^2$ smooth fit property, which gives a full characterization of the value function and the corresponding curves.
Dynamic Hedging of Reinsurance Counterparty Credit Risk

Rüdiger Frey
Vienna University of Economics and Business

We study value adjustments and hedging for reinsurance counterparty risk (the risk that a reinsurer is unable to fulfill his contractual obligations towards the insurer). We propose a novel model that takes contagion effects between the default of the reinsurer and the price of the reinsurance contract into account. To compute the optimal strategy we apply the (local) risk-minimization approach. For this we derive regularity results for backward equations for self-exciting doubly stochastic point processes that are of general interest.

Optimal dividends and capital injection under dividend restrictions

Kristoffer Lindensjö
Department of Mathematics, Stockholm University
Joint work with Filip Lindskog

We study a singular stochastic control problem faced by the owner of an insurance company that dynamically pays dividends and raises capital in the presence of the restriction that the surplus process must be above a given dividend payout barrier $b_r$ in order for dividend payments to be allowed. Bankruptcy occurs if the surplus process becomes negative and there are proportional costs $k$ for capital injection. We show that one of the following strategies is optimal: (i) Pay dividends and inject capital in order to reflect the surplus process at an upper barrier and at 0, implying bankruptcy never occurs. (ii) Pay dividends in order to reflect the surplus process at an upper barrier and never inject capital — corresponding to absorption at 0 — implying bankruptcy occurs the first time the surplus reaches zero. We show that if the costs of capital injection $k$ are low, then a sufficiently high dividend payout barrier $b_r$ will change the optimal strategy from type (i) (without bankruptcy) to type (ii) (with bankruptcy). Moreover, if the costs $k$ are high, then the optimal strategy is of type (ii) regardless of the dividend payout barrier $b_r$. The uncontrolled surplus process is a Wiener process with drift.
A Term Structure Interest Rate Model with the Exit Time from the Quantitative Easing Policy

Kentaro Kikuchi
Shiga University

For several years, the Bank of Japan has implemented the quantitative easing policy (QE). Against this backdrop, Japanese short- and medium-term interest rates have stayed negative. In this study, we model the short rate as the sum of the positive part and the lower bound in order to capture negative yields. We model the former part as the quadratic form of the Gaussian process. For the latter part, we model it as the Brownian bridge on the random interval pinning at 0 on the end date of the QE where the Brownian bridge on random intervals was introduced by Bedini et al. (2017). For this setting, we derive the zero coupon bond price representation by imposing the no-arbitrage condition. Furthermore, we conduct an empirical analysis based on this proposed model. Using Japanese yield curve data, we calibrate model parameters and estimate an implied exit time from the Bank of Japan’s quantitative easing.

References:

Stochastic differential equations with multiple invariant measures: beyond ergodic theory?

Michela Ottobre
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In 1968 Hörmander introduced a sufficient condition to ensure hypoellipticity of second order partial differential operators. As is well known, this seminal work of Hormander had deep repercussions both in the analysis of PDEs and in probability theory and the ergodic theory for hypoelliptic SDEs is by now well developed. In this talk we will first review the significance of the Hormander condition in analysis, probability and control theory. We then present the UFG condition, which is weaker than the Hormander condition. Such a condition was introduced by Kusuoka and Strook with probabilistic motivations, and, independently, by Sussman, Hermann and Lobry, this time in the field of control theory. In particular, Kusuoka and Strook showed that it is still possible to build a solid PDE theory for diffusion semigroups even in absence of the Hörmander condition. We will present new results (the first of this type) on control-theoretical aspects and long time behaviour of diffusion semigroups that do not satisfy the Hormander condition and that do not admit just a single invariant measure (i.e., the Markov process is not irreducible). We will highlight how, loosely speaking, UFG diffusions constitute a large class of SDEs which exhibit multiple equilibria (invariant measures) and such that it is possible to determine in a systematic way the basin of attraction of each equilibrium state.
In this talk, we investigate a large-scale stochastic system with bilinear drift and linear diffusion term. Such high dimensional systems appear for example when discretizing a stochastic partial differential equations in space. We study a particular model order reduction technique called balanced truncation (BT) to reduce the order of spatially-discretized systems and hence reduce computational complexity. We introduce suitable Gramians to the system and prove energy estimates that can be used to identify states which contribute only very little to the system dynamics. When BT is applied the reduced system is obtained by removing these states from the original system. In this talk, we present an $L^2$-error bound for BT for stochastic bilinear systems. This result is new even for deterministic bilinear equations. In order to achieve it, we develop a new technique which is not available in the literature so far.

In this talk we propose a new symmetrized version of the classical Euler scheme for the Cox-Ingersoll-Ross (CIR) process with jumps. We analyse the convergence of weak and strong errors of this scheme. We also use the simulation study to analyse the effect of jumps on the error term.
**Markov decision processes with quasi-hyperbolic discounting**

Anna Jaskiewicz

*Wroclaw University of Technology*

The standard theory in Markov control processes that assumes a use of a constant discount rate contradicts strong empirical evidence that people apply larger discount rates in the short run than in the long run. Such a behavior exhibits a time inconsistency, a situation in which the preferences of the decision maker may change over time. To circumvent these serious problems associated with time inconsistency, a dynamic game solution is proposed. In this view, an individual is modelled as a sequence of autonomous temporal selves playing a dynamic game between one’s current self and each one’s future selves. We show that for a model on a Borel state space there exists a solution in stationary strategies and under additional assumptions this solution can be replaced by a deterministic stationary strategy. Moreover, in case of countable state space, there exists a solution in deterministic Markov strategies.

**Dynamic reinsurance in discrete time minimizing the insurer’s cost of capital**

Alexander Glauner

*Karlsruhe Institute of Technology*

In the classical static optimal reinsurance problem the cost of capital for the insurer’s risk exposure determined by a monetary risk measure is minimized over the class of reinsurance treaties represented by increasing Lipschitz retained loss functions. We consider a dynamic extension of this reinsurance problem in discrete time which can be viewed as a risk-sensitive Markov Decision Process. The model allows for both insurance claims and premium income to be stochastic and operates with general risk measures and premium principles. We derive the Bellman equation and show the existence of an optimal reinsurance policy. The result is illustrated with an example where the optimal policy can be determined explicitly.
Credit is the cost-effective tool for fighting against poverty. It serves as an agitator in the development of our socio-economic conditions for the poor people who can not borrow from the banking institutions because majority of them do not have any collaterals. If the poor can get financial resources based on some terms and conditions that are reasonable and appropriate, then the millions of these small people with their small pursuit can create a significant increment in the development of the country. From these small millions of people, majority are women usually from Sub-Saharan region in Africa which is one of the poorest regions in the world, where only 5% to 25% of people have access to financial services. It is substantially under-served by micro-finance, with only 2% of the world’s micro-finance institutions.

It is the aim for every company to make profit thereby increasing their interest rate which makes it unfavorable for the poor people and they default. The aim of this research is to provide a suitable model for a micro-finance company, estimate the optimal interest rate needed to charge the borrowers and also put measures in place for borrowers who default to make the company sustainable.

References:

THURSDAY 16:20–17:05

Risk-based optimal portfolio of an insurer with regime switching and noisy memory

Rodwell Kufakunesu

University of Pretoria

Joint work with Calisto Guambe, Lesedi Mabitsela

We consider a risk-based optimal investment problem of an insurer in a regime-switching jump diffusion model with noisy memory. Using the model uncertainty modeling, we formulate the investment problem as a zero-sum, stochastic differential delay game between the insurer and the market, with a convex risk measure of the terminal surplus and the Brownian delay surplus over a period $[T - \varrho; T]$. Then by the BSDE approach, the game problem is solved. Finally, we derive semi-analytical solutions of the game problem, for a particular case of a quadratic penalty function.

THURSDAY 17:05–17:30

Optimal Installation of Solar Panels under Price Impact

Torben Koch

Bielefeld University

Joint work with Tiziano Vargiolu

In this talk we consider a price-maker company which produces energy and sells it in the spot market. The company can increase its level of installed power by irreversible installations of solar panels. In absence of any actions of the company, the energy’s spot price evolves as an Ornstein-Uhlenbeck process, and therefore it has a mean-reverting behavior. The current level of the company’s installed power has a permanent impact on the energy’s price and affects its mean-reversion level. The company aims at maximizing the total expected profits from selling energy in the market, net of the total expected proportional costs of installation. This problem is modeled as a two-dimensional singular stochastic control problem in which the installation strategy is identified as the company’s control variable. We follow a guess-and-verify approach to solve the problem. We find that the optimal installation strategy is triggered by a curve which separates the waiting region, where it is not optimal to install additional panels, and the installation region, where it is. Such a curve is a strictly increasing function which depends on the current level of the company’s installed power. Finally, our study is complemented by a numerical analysis of the dependency of the optimal installation strategy on the model’s parameters.
In the G-framework, we establish existence of an optimal stochastic relaxed control for stochastic differential equations driven by a G-Brownian motion. The purpose of this work is to study optimal control of systems subject to model uncertainty or ambiguity due to incomplete or inaccurate information, or vague concepts and principles. We prove the regularity conditions realized by this control.

References:
We study some optimal and epsilon-optimal control problems which involve the solution of stochastic Schrödinger type equations, considered in a variational formulation. We use Galerkin approximations.

We consider a controlled linear stochastic Schrödinger equation driven by a linear multiplicative cylindrical fractional Brownian motion and introduce an optimal control with quadratic objective functional where the incoming operators are diagonalizable. The admissible controls are defined by time dependent potentials. An optimality condition of maximum principle type is proved by using of the theory of stochastic backward equations.

References:
The talk is concerned with a class of two-sided stochastic processes of the form $X = W + A$. Here $W$ is a two-sided Brownian motion with random initial data at time zero and $A \equiv A(W)$ is a function of $W$. Elements of the related stochastic calculus are introduced. In particular, the role of finite dimensional projections arising from the Lévy-Ciesielski representation of the Brownian motion are discussed. The calculus is adjusted to the case when $A$ is a jump process.

Absolute continuity of $(X, P_\nu)$ under time shift of trajectories is investigated. For example under various conditions on the initial density with respect to the Lebesgue measure, $m = d\nu/dx$, and on $A$ with $A_0 = 0$ we verify

$$\frac{P_\nu(dX_{t-})}{P_\nu(dX_0)} = \frac{m(X_{t-})}{m(X_0)} \cdot \prod_i |\nabla W_0 X_{t-}^i|$$

a.e. where the product is taken over all coordinates. Here $\sum_i (\nabla W_0 X_{t-}^i)$ is the divergence of $X_{t-}$ with respect to the initial position. Crucial for this is the \textit{temporal homogeneity} in the sense that $X(W_{v+} + A_v 1) = X_{v+}(W)$, $v \in \mathbb{R}$, where $A_v 1$ is the trajectory taking the constant value $A_v(W)$.

An application is relative compactness of sequences of processes of the form $X^n = W + A^n$, $n \in \mathbb{N}$.

References:

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In the literature, it is a recurring feature that explicit solutions to stochastic optimization problems are linked to deterministic controls. In this talk, we raise the question if it is possible to state the nature of the optimal control before solving the problem. In standard power utility problems, we observe that changing the wealth at a given time changes the value function by a constant only. Hence, any amount leads to the same optimal controls. This indicates that the optimal controls are independent of the optimal wealth process and therefore deterministic.

We are going to explore this idea further and determine consequences and areas of future research. For example, we replace the HJB equation with a quadratic equation and a Calculus of Variations problem. This is a work in progress.
We study the consequences of the burst of an asset price bubble in a financial system. We model the robustness of banks in a financial network by a system of stochastic differential equations coupled by their drift. We assume that the attractiveness of a node depends on its “fitness”, and that a group of banks happen to hold a bubbly asset.

We see that, due to this preferential attachment mechanism, the bubble causes a distortion in the network: the banks holding the bubble have a bigger influence on the system, so that they are the biggest propagators of a possible shock.

Supposing that the number of banks holding the bubble remains constant, but that their impact on the periphery does not vanish when the total number of the banks goes to infinity, we also study the case of large networks: the influence of the bubble, through the action of the banks in the core, results in a term which does not average out in the drift of the diffusions. Because of this term, also the banks of the periphery are indirectly affected when the bubble bursts.

This results in a riskier system, as shown in simulations where we investigate how the burst of a bubble impacts systemic risk.

According to conventional wisdom, ambiguity accelerates optimal timing by decreasing the value of waiting in comparison with the unambiguous benchmark case. We extend the analysis focusing on the stopping of linear diffusions to a multifactor setting and investigate the joint impact of ambiguity and the volatility of the driving stochastic dynamics in a multidimensional setting.
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