

SEFE II CONFERENCE LIST OF ABSTRACTS

PLENARY SPEAKERS

Knut Aase (Bergen). The life cycle model with recursive utility: new insights on optimal consumption

Abstract: We analyze optimal consumption during the life time of a consumer using the life cycle model, when the consumer has recursive utility. The model framework is that of continuous-time with diffusion driven uncertainty. The relationship between substitution of consumption and risk aversion is highlighted, and clarified in the context of the life cycle model. We find the optimal consumption in closed form, and illustrate how the consumer wants to smooth consumption shocks across states of the world and time. The recursive consumer wants to mitigate a shock to the economy, in situations where the conventional consumer just follows in the wake of others. This has consequences for what products the financial industry should offer consumers. The resulting model can be used to explain empirical consumption puzzles for aggregates, while indicating a plausible choice for the parameters of the utility function, for the 'average' consumer in the context of life cycle model.

Elisa Alos (Barcelona). On the short-time behaviour of the implied volatility skew for random strike options and applications to option pricing approximation

Abstract: We propose a general technique to develop first and second order closed-form approximation formulas for short-time options with random strikes. Our method is based on a change of numeraire and on Malliavin calculus techniques, which allow us to study the corresponding shorttime implied volatility skew and to obtain simple closed-form approximation formulas depending on the derivative operator. The numerical analysis shows that these formulas are extremely accurate and improve some previous approaches on two-assets and three-assets spread options as Kirks formula or the decomposition method presented in Als, Eydeland and Laurence (2011). This methodology is not model dependent and it can be applied to the case of random interest rates and volatilities. (joint work with J. A. Len)

Andreas Basse O'Connor(Aarhus). Limit theorems for stationary increments Levy driven moving average processes

Abstract: In this talk we will consider some new limit theorems for power variation of k-th order increments of stationary increments Levy driven moving average processes. In this infill sampling setting, the asymptotic theory gives very surprising results, which (partially) have no counterpart in the theory of discrete moving average processes. More specifically, we will show that first order limit theorems

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and the mode of convergence strongly depend on the interplay between the given order of the increments, the considered power $p \geq 0$, the Blumenthal-Gettoor index of the driving Levy process and the behaviour of the kernel function at 0. First order asymptotic theory essentially comprise three cases: stable convergence towards a certain infinitely divisible distribution, an ergodic type limit theorem and convergence in probability towards an integrated random process. We also prove the second order limit theorem connected to the ergodic type result. When the driving Levy motion is a symmetric stable process we obtain two different limits: a central limit theorem and convergence in distribution towards a stable random variable with a different index of stability than the Levy process. This talk is based on joint work with Raphael Lachieze-Rey (University Paris V) and Mark Podolskij (Aarhus University).

Francesca Biagini (Munich). Risk-minimization for life insurance liabilities

Abstract: In this talk we study the pricing and hedging of life insurance liabilities by means of the well-known risk-minimization approach. We first consider the simplified case of one single life case. Then we extend this approach to the case of an insurance portfolio with individuals of different age cohorts.

In the first part of the talk we allow for hedging of the risk inherent in the insurance liabilities by investing not only in the stock and money market account, but also in a longevity bond, representing the systematic mortality risk, and a pure endowment contract, accounting for the unsystematic mortality risk. We are able to compute the risk-minimizing strategy in a very general setting regarding the underlying asset price and the structure of the insurance payment process, as well as to relax certain technical assumptions such as the existence of the mortality intensity and the independence of the underlying processes.

In the second part of the talk we extend the above mentioned results for life insurance liabilities written on an insurance portfolio including different age cohorts. The cross generational dependency structure of the portfolio is captured by modeling mortality the mortality surface as a random field parameterized in time and age at inception of the contract, similarly to the approach of [3]. Main novelty of this work is that we study risk-minimization at an aggregate level for a general class of life insurance contracts by simultaneously considering different age cohorts.

This talk is based on the papers [1] and [2].

References

- [1] F. Biagini and I. Schreiber. Risk-minimization for life insurance liabilities. *SIAM Journal on Financial Mathematics*, 4(1):243264, 2013.
- [2] F. Biagini, C. Botero, I. Schreiber. Risk-minimization for life insurance liabilities with dependent mortality risk. Accepted in *Mathematical Finance*.
- [3] E. Biffis and P. Millossovich. A bidimensional approach to mortality risk. *Decisions in Economics and Finance*, 29(2):7194, 2006.

Jose Manuel Corcuera (Barcelona). About the optimality of payoffs

Abstract: In this work we discuss the notion of cost-efficiency payoff introduced by Dybvig (1988). We show that under this criterium path dependent options can beat options depending only on the terminal value of the stock, contrarily to what is

claimed. We also consider some extensions of this notion when we have constraints and state dependent preferences and we introduce a dynamic and local version of this concept.

Michael Coulon (Sussex). Environmental market design: analyzing the impact of regulatory policy on certificate price dynamics

Abstract: Environmental markets for tradable certificates come in several categories, including both carbon emissions allowances and green (renewable energy) certificates. In both cases, a variety of market designs and structures exist, with rules sometimes even changing frequently within a given market. Relatedly, several fundamental weaknesses of environmental markets have been witnessed through history, including sudden price swings and extended periods of over- or undersupply, eroding market confidence. Such price behavior and regulatory uncertainty illustrates the need to investigate alternative design ideas and their likely impact on market dynamics. In this talk, we introduce several policy proposals which have been adapted to and tested on the New Jersey solar renewable energy certificate (SREC) market, together with a stochastic structural model for prices and solar generation. In particular we discuss the use of a sloped compliance penalty function instead of a traditional ‘cliff’ or binary function, together with a dynamic and adaptive mechanism for setting future requirement levels as a function of previous surpluses or shortages. We analyze the optimal decisions of market participants facing SREC submission and banking decisions, and compare the resulting implications for prices. Finally, we discuss briefly some related recent work on the design of a new global carbon market, which also embeds the crucial feature of responding to unexpected shocks via adaptive emissions reduction targets, this time with an additional focus on an equitable and transparent distribution of responsibilities across countries.

Albina Danilova (London). Risk aversion of market makers and asymmetric information

Abstract: We analyse the equilibrium impact of market makers’ risk aversion on the equilibrium in a speculative market consisting of a risk neutral informed trader and noise traders. The unwillingness of market makers to bear risk causes the informed trader to absorb large shocks in their inventories. The informed trader’s optimal strategy is to drive the market price to its fundamental value while disguising her trades as the ones of an uninformed strategic trader. This results in a mean reverting demand, price reversal, and systematic changes in the market depth. We also find that an increase in risk aversion leads to lower market depth, less efficient prices, stronger price reversal and slower convergence to fundamental value. The endogenous value of private information, however, is non-monotonic in risk aversion.

Mark Davis (London). Risk-sensitive asset management in a Markov chain factor model

Abstract: The risk-sensitive approach to asset allocation can be interpreted as ‘dynamic Markowitz’, i.e. the investor effectively maximises expected return subject

to a constraint on the variance of returns in a continuous-time dynamic model. We study this problem in the framework of a new jump diffusion regime-switching model which allows for linking jumps in asset prices with regime changes. In this model the Hamilton-Jacobi-Bellman equation characterising optimality reduces to an ordinary differential equation (ODE), as opposed to the PDE or PIDE which one normally expects in a continuous-time stochastic optimisation problem. (Joint work with G. Andruszkiewicz and S. Lleo.)

Damir Filipovic (Lausanne). Linear commodity futures models

Abstract: I present a systematic treatment of commodity futures models, where the spot price is modeled such that futures prices become linear functions of the current state. The spot price of a commodity, such as crude oil, natural gas, or electricity, is modeled as linear function of the factor process, which exhibits a linear drift. Futures prices are given in closed form as linear functions of the state in terms of a linear ODE. Futures options prices are derived in closed form for specific choices of the factor process. I discuss the unspanned stochastic volatility (USV) phenomenon, and show how linear futures models can produce USV. I also sketch generalizations to quadratic and higher order polynomial models.

Hans Föllmer (Berlin). An excursion to strictly pathwise finance

Abstract: In view of the pervasive issue of model uncertainty in applications of Probability in Finance, it is of interest to clarify the scope of strictly pathwise methods that do not rely on an underlying probabilistic model. We review some of them, including recent advances concerning the absence of arbitrage, the consequences of quadratic variation, and strictly pathwise local time.

Yaozhong Hu (Kansas). Brownian motion in a white noise environment

Abstract: This talk presents the weak and strong solutions to the stochastic differential equation $dX(t) = -\frac{1}{2}\dot{W}(X(t))dt + d\mathcal{B}(t)$, where $(\mathcal{B}(t), t \geq 0)$ is a standard Brownian motion and $W(x)$ is a two sided Brownian motion, independent of $\mathcal{B}$. It is shown that the Itô-McKean representation associated with any Brownian motion (independent of W) is a weak solution to the above equation. It is also shown that the Itô-McKean representation for an appropriately chosen Brownian motion is a strong solution to the equation. The uniqueness of the strong solution in a certain class of processes is also obtained. The main idea to deal with the singularity of drift term $\int_0^T \dot{W}(X(t))dt$ is to use the local time of the process X and to use the polygonal approximation W_π . Some new results on the local time of Brownian motion needed in our proof are established.

Saul Jacka (Warwick). The policy improvement algorithm for controlled diffusions

Abstract: As far as we know, there are no existing results for the convergence of the policy improvement algorithm for optimally controlled diffusions. We present some first steps for the case of one-dimensional infinite horizon problems and then for finite horizon multi-dimensional problems.

Rüdiger Kiesel (Essen). Challenges in the European electricity markets

Abstract: European Electricity Markets changed rapidly in recent years. Due to market coupling the markets became more interconnected and at the same time due to the rising share of renewable energy more decentralised. We will introduce a multi-market structural model for coupled electricity markets and discuss its main properties. Furthermore, we will study intra-day trading of electricity and identify the price-driving factors.

Arne Løkka (London). Optimal liquidation in a general one-sided limit order book for a risk averse investor

Abstract: In a general one-sided limit order book with a general resilience function where the unaffected price process follows a Lévy process, we consider the problem of optimal liquidation for an investor with constant absolute risk aversion. Since liquidation normally takes place within a short time interval, modelling the risk as a Lévy process should provide a good statistical fit to observed market data. Our formulation also allows for discrete limit order book, as would be the case in practice. We derive an explicit expression for the value function and the optimal intervention boundary, which completely characterise the optimal liquidation strategy. In particular, this problem provides an example of a solvable two-dimensional Markovian optimal control problem with an optimal intervention boundary which tends to be discontinuous.

Edward Lungu (Gaborone). Impact of beliefs on the spread of Ebola

Abstract: Ebola spreads by contact with fluids of an infected person such as sweat, blood, saliva etc. The factors that can enhance the spread of Ebola are hygienic, cultural and religious. African villages and towns have communal water collection points that use borehole pumps. Individuals whose disease status is still asymptomatic can spread the disease to many people before anybody is aware there is an infectious disease around. In Africa we queue for anything in the banks, post offices etc. In these places we meet we meet friends whom we greet by shaking hands. If an infected person has sweaty hands the possibility of passing on the disease is there (small probability though). African funerals are probably the most likely places where Ebola thrives. Africans enjoy washing dead relatives, clothe the dead relatives etc. All these are ways in which Ebola can spread.

The health care systems are over burdened. Children are made to share beds in most hospitals. One child can easily pass on the disease to the other and to family of each child. Cultural practices are responsible for most of the disease spread. In Africa we eat from a common plate and wash hands from the same dish. As part of the Christian faith we shake hands to show our love for each other. Potentially this is another way Ebola can spread.

We have developed a mathematical model to investigate the impact of various practices on the spread of Ebola. The model includes infection of susceptible individuals by the reservoir, infected humans and the dead. Reference will be made to the current Ebola epidemic in West Africa.

Yiulia Mishura (Kiev). Statistical estimators in diffusion models

Abstract: We consider both standard diffusion models and the models involving fractional Brownian motion, construct nonstandard shift parameter estimators and establish strong consistency under high frequency data. Discretized schemes are studied as well.

Bernt Øksendal (Oslo). How to trade when you know more than you are supposed to: A white noise approach to optimal insider control.

Abstract: In stochastic calculus and optimal control theory, an insider is a person who has - and uses - information about the future values of some of the parameters of the system. Mathematically this means that the person can base her decisions upon a filtration which is larger than the natural filtration generated by the stochastic system. In finance this could be the case if an agent has classified information about the future value of a firm. Since this type of information is not publicly available, such trading is usually illegal.

This setup brings the stochastic control problem outside the classical semimartingale context, and we need to approach the problem by introducing appropriate anticipative calculus tools, like forward integrals, white noise theory and generalized Hida-Malliavin calculus. Using this, we show how to obtain a general machinery for solving such optimal insider control problems.

Then we apply the results to see how inside information can improve the performance in finance.

The presentation is based on recent joint work with Olfa Draouil, University of Tunis.

Markus Riedle (London). Cylindrical Lévy processes

Abstract: The objective of this talk is the introduction of cylindrical Lévy processes and their stochastic integrals in Hilbert spaces.

The degree of freedom of models in infinite dimensions is often reflected by the request that each mode along a dimension is independently perturbed by the noise. In the Gaussian setting, this leads to the *cylindrical Wiener process* including from a model point of view the very important possibility to model a Gaussian noise in both time and space in a great flexibility (space-time white noise). Up to very recently, there has been no analogue for Lévy processes.

Based on the classical theory of cylindrical processes and cylindrical measures we introduce *cylindrical Lévy processes* as a natural generalisation of cylindrical Wiener processes. We illustrate our abstract approach by several specific examples of cylindrical Lévy processes. We continue to characterise the distribution of cylindrical Lévy processes by a cylindrical version of the Lévy-Khintchine formula. The last part of the talk is devoted to explain the difficulty to introduce a stochastic integral with respect to cylindrical Lévy processes, and how we could solve this problem. (Parts of this talk are based on joint work with D. Applebaum or A. Jakubowski)

Emanuela Rosazza Gianin (Milano). Orlicz and Haezendonck-Goovaerts risk measures: axiomatization and robustification

Abstract: In this work we give an axiomatic foundation to Orlicz risk measures by exploiting a natural correspondence with shortfall risk measures, thus paralleling the characterization result in Weber (2006). From a financial point of view, Orlicz risk measures are suitable for returns, in contrast to the common use of risk measures to assess the stochastic nature of a position's value. The correspondence with shortfall risk measures leads us to several robustified version of the Orlicz risk measures and of the Haezendonck-Goovaerts risk measure, arising from a worst case approach under ambiguity as in Gilboa and Schmeidler (1989), Maccheroni, Marinacci and Ristichini (2006), or under a multiplicity of Young functions. We study the properties of these Robustified Orlicz premia and Robustified Haezendonck-Goovaerts risk measures, derive their dual representation and provide an axiomatic foundation. Joint work with Fabio Bellini and Roger Laeven.

Robert Stelzer (Ulm). Optimal investment with stochastic endowments over time and should young investors really invest more in stocks?

Abstract: In this talk we consider a stochastic control problem appearing for example when investing a fraction of a time-varying random salary in the financial market in order to get a lump-sum payment at retirement. In a one-dimensional Black-Scholes market we consider the problem of maximizing the expected utility of terminal wealth resulting from investing an initial wealth and a continuous endowment stream which is given by a diffusion correlated with the stock price dynamics. As we assume that the salary/endowment stream is not perfectly correlated with the stock price, this results in an incomplete market.

For power utility functions and the contribution rate given by a time inhomogeneous Brownian motion correlated with the stock price we are able to reduce the resulting HJB equation by one dimension which allows us to nicely compute the optimal wealth and the optimal strategy numerically. Furthermore, we are able to show asymptotics for the value function and the optimal strategy and we can give sufficient conditions for the HJB equation to have a smooth solution.

Based on these results we study whether the popular investment advice (behind e.g. so called target date funds) that young people should invest more in stocks than older ones is indeed true. It turns out that the truth of this rule critically depends on the correlation between the stock market and the personal income in our model.

This talk is based on joint work with An Chen and Carla Mereu (both Ulm University).

Agnes Sulem (Paris). Stochastic control with nonlinear expectations

Abstract: Markovian stochastic control problems on a given horizon of time T can typically be written as

$$\sup_{\alpha \in \mathcal{A}} \mathbb{E} \left[\int_0^T g(\alpha_s, X_s^\alpha) ds + h(X_T^\alpha) \right],$$

where $\mathcal{A}$ is a set of admissible control processes α_s , and (X_s^α) is a controlled jump diffusion process. The random variable $h(X_T^\alpha)$ may represent a terminal reward and

$g(\alpha_s, X_s^\alpha)$ an instantaneous reward process. Using dynamic programming principle and under appropriate assumptions, the associated value function of the stochastic control problem can then be characterized as the solution, in a certain sense, of a Hamilton-Jacobi-Bellman equation.

We are interested here in generalizing these results to the case when the linear expectation $\mathbb{E}$ is replaced by a nonlinear expectation induced by a Backward Stochastic Differential Equation (BSDE). Typically, such problems in the Markovian case can be formulated as

$$\sup_{\alpha \in \mathcal{A}} \mathcal{E}_{0,T}^\alpha[h(X_T^\alpha)],$$

where $\mathcal{E}^\alpha$ is the nonlinear conditional expectation associated with a BSDE with jumps with controlled driver $f(\alpha_t, X_t^\alpha, y, z, k)$. Note that when the driver f does not depend on the solution of the BSDE, that is when $f(\alpha_t, X_t^\alpha, y, z, k) \equiv g(\alpha_t, X_t^\alpha)$, then we are back to the classical linear expectation case.

In this talk, we shall consider the case when there is an additional control in the form of a stopping time. We shall thus study mixed generalized optimal control/stopping problems of the form

$$\sup_{\alpha \in \mathcal{A}} \sup_{\tau \in \mathcal{T}} \mathcal{E}_{0,\tau}^\alpha[h(X_\tau^\alpha)],$$

where $\mathcal{T}$ denotes the set of stopping times.

We first establish a dynamic programming principle (DPP) for our mixed problem with f -expectation. This requires some specific techniques of stochastic analysis and BSDEs to handle measurability and other issues due to the nonlinearity of the expectation. The value function of the problem is not a solution of a reflected BSDE and hence the DPP does not follow from the flow property for reflected BSDEs. The method we propose allows us to handle the case when the value function is not measurable, thus leading to a *weak* dynamic programming principle. Using this principle and properties of reflected BSDEs, we then prove that the value function of our mixed problem is a viscosity solution of a generalized Hamilton-Jacobi-Bellman (HJB) variational inequality. Uniqueness of the viscosity solution is obtained under additional assumptions. Illustrating examples in mathematical finance are provided.

Joint work with Roxana Dumitrescu and Marie-Claire Quenez.

Jan Ubøe (Bergen). Modelling congestion flows and relocation patterns in an urban geography.

Abstract: In this paper we use a special approach to build state dependent Markov transitions related to characteristics of an urban geography. State dependent Markov chains are interesting since they admit multiple equilibria, and in the talk I will focus some examples where different equilibria are reached depending on which actions that are taken.

Josep Vives (Barcelona). A Malliavin-Skorohod calculus in L^0 and L^1 for additive and Volterra-type processes

Abstract: In this paper we develop a Malliavin-Skorohod type calculus for additive processes in the L^0 and L^1 settings, extending the probabilistic interpretation of the Malliavin-Skorohod operators to this context. We prove calculus rules and obtain

a generalization of the Clark-Hausmann-Ocone formula for random variables in L^1 . Our theory is then applied to extend the stochastic integration with respect to volatility modulated Lévy-driven Volterra processes recently introduced in the literature. Our work yields to substantially weaker conditions that permit to cover integration with respect, e.g. to Volterra processes driven by α -stable processes with $\alpha < 2$. The presentation focuses on jump type processes. (Joint work with Giulia Di Nunno)

Tusheng Zhang (Manchester). Wong-Zakai approximations to backward doubly stochastic differential equations

Abstract: In this talk I will present a recent result on Wong-Zakai approximations of backward doubly stochastic differential equations and its applications to SPDEs.

CONTRIBUTED TALKS

Roberto Baviera (Milano). Going hybrid: a joint model for temperature and natural gas

Abstract: Natural gas spot prices and temperatures have been studied in detail in the literature as separate processes. We propose a simple joint model that, in spite of its parsimony, describes accurately many stylized facts of the two time series: in particular we show the role played by a time-delay parameter in order to take into account the impact of temperature forecast in cross-dependency. We discuss in detail a stepwise procedure in order to calibrate model parameters, describing the elementary estimation techniques involved and the statistical accuracy achieved. In the analysis we focus on the benchmark market in the U.S.A. (Henry Hub) and the temperatures in the Northeast and Midwest regions; we observe a clear seasonal pattern for one of the main parameters in the joint model: gas-temperature correlation, negative in the cold season, becomes positive (even if not statistically significant) in the warm period.

Krzysztof Bogdan (Warsaw). Lévy systems and moment formulas for interlaced multiple Poisson integrals

Abstract: I will report joint work with Lukasz Wojciechowski and Jan Rosinski. We propose Mecke-Palm formulas for multiple integrals with respect to a Poisson random measure interlaced with its intensity measure. We apply the formulas to multiple mixed Lévy systems of Lévy processes and to moment identities for products of interlaced multiple Poisson integrals.

The work is available at <http://arxiv.org/abs/1411.7952>

Kristina R. Dahl (Oslo). Singular recursive utility

Abstract: In this paper, we introduce the concept of *singular recursive utility* and study the corresponding optimal singular consumption strategies. The classical way of measuring the total utility of a consumption process by integrals has been criticized from an economic point of view: one cannot just add utilities like that. Instead, Duffie and Epstein [1] proposed to use recursive utility, which is defined via a BSDE. We study how we can model the recursive utility of a *singular* consumption process. This leads to *singular BSDEs*, which, to the best of our knowledge, have not been considered before. We study existence and uniqueness of such singular BSDEs, and solve the singular recursive utility optimal control problem. Finally, we show how this can be applied to solve an optimal harvesting problem. This is joint work with Bernt Øksendal.

References:

[1] D. Duffie and L.G. Epstein, Stochastic Differential Utility, *Econometrica*, Vol. 60, Issue 2, pp. 353-394, 1992.

Claudio Fontana (Paris). A general HJM framework for multiple yield curve modeling

Abstract: We propose a general framework for modeling multiple yield curves which have emerged since the last financial crisis. In a general semimartingale setting, we provide an HJM approach to model the term structure of multiplicative spreads between (normalized) FRA rates and simply compounded OIS risk-free forward rates. We derive an HJM drift and consistency condition ensuring absence of arbitrage and we show how to construct models such that multiplicative spreads are greater than one and ordered with respect to the tenor's length. This is joint work with Christa Cuchiero and Alessandro Gnoatto.

Miriyana Grigorova (Berlin). Reected BSDEs with ladlag lower barrier

Abstract: We study reected backward stochastic differential equations (RBSDEs) with lower barrier which is assumed to be left- and right-limited but not necessarily right-continuous. We provide existence and uniqueness result for such RBSDEs in appropriate Banach spaces. The result is established by using some notions and tools from the general theory of processes, such as optional strong supermartingales (generalizing the "classical" notion of right-continuous supermartingales) and Mertens decomposition of optional strong supermartingales (generalizing Doob-Meyer decomposition). We also use an appropriate generalization of Ito's formula due to Gal'chouk-Lenglart.

This is a joint work with P. Imkeller, E. Oen, Y. Ouknine, and M.-C. Quenez.

Yerkin Kitapbayev (Manchester). On the optimal exercise boundaries of swing put options

Abstract: We use probabilistic methods to characterise the optimal exercise region of a swing option with put payoff, n exercise rights and finite maturity. The underlying assets dynamics is given by a geometric Brownian motion according to the Black-Scholes model. The optimal exercise region of each right (except the last) of the swing option that we consider is characterised in terms of two boundaries which

are continuous functions of time and uniquely solve a system of coupled integral equations of Volterra-type. The swing options price is then provided as the sum of a European part and an early exercise premium depending on the optimal exercise boundaries.

This is joint work with Tiziano de Angelis.

Marta Leniec (Uppsala). Dynkin games with heterogeneous beliefs

Abstract: We study zero-sum optimal stopping games between two players: Player 1 and Player 2, whose beliefs about the drift of the underlying process are various. Moreover, we assume that they agree to disagree in the sense that the players know about each others beliefs. Generally, since the players have different beliefs about the drift, the common value of the game option does not exist. Namely, they both calculate the future expected pay-off under different measures. However, we show that for every game, there exists a Nash equilibrium of stopping times. To find the Nash equilibria, we formulate a verification theorem. Then, we consider an example of an American game option, where Player 1 is the buyer and Player 2 is the seller of the option. They both model the underlying stock price process as a geometric Brownian motion. However, the drift for Player 1 differs from the drift of the Player 2. For various regimes for the drifts, we characterize the Nash equilibria. In particular, we show that in some cases we get different Nash equilibria that lead to different values of the game for the both players.

The talk is based on joint work with Erik Ekstrom and Kristoffer Glover.

Salvador Ortiz-Latorre (Oslo). A new flexible pricing measure in the Barndorff-Nielsen & Shephard model for commodity markets

Abstract: We consider a commodity spot price dynamics given by an Ornstein-Uhlenbeck process with Barndorff-Nielsen and Shephard stochastic volatility. We price forwards using a class of pricing measures that simultaneously allow for change of level and speed in the mean reversion of both the price and the volatility, while preserving the affine structure of the model. We demonstrate that the theoretical risk premium in our model can provide the typical shapes observed in energy markets. In particular, it allows for a stochastic change of sign and it can attain positive values in the short end of the forward curve and negative in the long end.

Ekaterina Palamarchuk (Moscow). Long-run stabilization and risk evaluation in a stochastic environmental control problem

Abstract: We consider a long-run problem of stock pollutant control adjusting the current emissions in the presence of additive uncertainty with the goal to track a target level of pollution. The performance of a control strategy over the planning horizon is measured by a quadratic loss functional which also includes the decision makers time preference. The time preference relates to evaluation of costs occurred at different points in time and may have quite general form being positive, zero or negative. In our work we assume that the time preference can be expressed in terms of a monotone discount function. Introducing the expected total cost per unit of cumulative discount criterion, we obtain so called average optimal control over an infinite-time horizon. Next, we estimate risk from implementing this control

as a long-run policy. Such a risk arises due to the stochastic nature of the costs. We perform a pathwise comparison of costs corresponding to the average optimal and any admissible control by means of deterministic upper bounds. The time-preference impact on long-term stabilization of optimal paths is also discussed.

Anca Pircalabu (Aalborg). Volumetric risk associated with wind power trading - a copula approach

Abstract: The production uncertainty following wind power generation introduces, together with price uncertainty, severe supply side volumetric risk when the energy is traded in markets with a high penetration of wind power. Our work presents an in-depth analysis of volumetric risk by modeling the dependence structure of day-ahead electricity prices and total wind power production in Western Denmark, and is a continuation of [1]. The analysis is of particular interest to energy trading companies that manage a large share of wind turbines, and offer fixed priced products to wind turbine owners (i.e. forward contracts where a fixed price per produced MWh is paid over an agreed-upon period of time). Such contracts imply a simultaneous risk exposure to changes in electricity prices and wind power production. We propose a seasonal long-memory time series model for the conditional mean of daily day-ahead electricity prices, and a seasonal ARIMA model for the conditional mean of the daily total wind power production. Furthermore, we employ GARCH models for the conditional variance of both time series. After specifying the two marginal models, we propose a copula approach that allows for the study of the dependence structure separate from the marginal distributions of the related variables. We consider time-varying copula models, since we find evidence of autocorrelation in the rank correlations. However, since no evidence for time-varying dependence related to one time breaks is found, we restrict our attention to models where the actual copula remains the same, but the dependence parameter varies according to an observation driven model of autoregressive type ([2],[3]). We assess the goodness of fit of the proposed copula models by performing goodness-of-fit tests based on the Rosenblatt transform. Finally, we perform Monte Carlo simulations in order to make inference on the difference between the average wind weighted electricity price and the average electricity price. We conclude that our model satisfactorily captures the dynamics and distributional properties of this quantity.

This is joint work with Thomas Hvolby.

References:

- [1] A. Pircalabu, R. P. Vilstrup, and T. Hvolby. Volumetric risk associated with wind power: A copula approach. Math.-Econ. AAU masters thesis in collaboration with Neas Energy, 2014.
- [2] A. J. Patton. Copula methods for forecasting multivariate time series. Handbook of Economic Forecasting, Vol. 2, pages 899-960. Elsevier B.V., 2013.
- [3] D. D. Creal, S. J. Koopman, and A. Lucas. Generalized autoregressive score models with applications. Journal of Appl. Econometrics, 28(5):777-795, 2013.

Kenichiro Shiraya (Tokyo). Pricing basket options under local stochastic volatility with jumps

Abstract: This paper develops a new approximation formula for pricing basket options in a local-stochastic volatility model with jumps. In particular, the model admits local volatility functions and jump components in not only the underlying asset price processes, but also the volatility processes. To the best of our knowledge, the proposed formula is the first one which achieves an analytical approximation for the basket option prices under this type of the models. Moreover, some numerical experiments confirm the validity of the method. This is joint work with Akihiko Takahashi.

Maren Schmeck (Köln). Electricity price modelling with stochastic time change

Abstract: Electricity prices from liberalized electricity markets exhibit characteristic features that are not observed in other commodity markets. Besides strong seasonalities, electricity exhibits large price spikes, which arise due to non-storability of electricity. The occurrence and severity of such spikes are related to power generating plant outages, but also depend strongly on the demand, which increases dramatically during periods of abnormally high or low temperatures. Moreover, price volatility is also related to demand, being higher during periods of high demand, leading to seasonal patterns in volatility. These features make electricity price modelling a challenging task.

The powerful technique of stochastic time change allows to incorporate stochastic as well as deterministic (e.g., seasonal) features in stochastic process volatility. By specifying the base process as a mean reverting jump diffusion and the time change as an absolutely continuous stochastic process with seasonal component, we are able to simultaneously model seasonal and stochastic effect in volatility and jump components of the electricity price. We use temperature time series as a proxy for the stochastic time change and show that this choice leads to realistic price paths. We discuss model calibration and its applications in Monte Carlo price simulations and risk management.

This is joint work with Svetlana Borovkova.

Pietro Siorpaes (Oxford). Optimal investment and price dependence in a semi-static market

Abstract: This paper studies the problem of maximizing expected utility from terminal wealth in a semi-static market composed of derivative securities, which we assume can be traded only at time zero, and of stocks, which can be traded continuously in time. Using a general utility function defined on the positive real line, we first study existence and uniqueness of the solution, and then we consider the dependence of the outputs of the utility maximization problem on the price of the derivatives, investigating not only stability but also differentiability, monotonicity, convexity and limiting properties.

Ralf Wunderlich (Brandenburg). Partially observable stochastic optimal control problems for an energy storage

Abstract: We address a real option problem consisting of the valuation of a energy storage facility in the presence of stochastic energy prices. Such problems arise in case of natural gas dome storage and hydroelectric pumped storage. The valuation

problem is related to the problem of determining the optimal injection/withdrawal strategy that maximizes the expected value of the resulting discounted cash flows over the lifetime of the storage. Special features are an energy price model containing an unobservable factor process driving the mean-reversion level, operational constraints on the strategy and the storage level.

We formulate the problem as a stochastic control problem in continuous time, resulting in a Hamilton-Jacobi-Bellman equation for the value function. We use numerical methods such as policy improvement and finite difference schemes for computing approximations of the value function and the optimal strategy. Finally, we illustrate our results with some numerical examples.

This is joint work with Anton Shardin.

Vilimir Yordanov (Karlsruhe). Dynamic CDO pricing and hedging in a forward setting

Abstract: Dynamic CDO modeling became a hot topic prior to the crisis. The latter, however, showed clearly the inadequacy of static models based on Gaussian copula for pricing, hedging, and risk management. Further, the financial innovation in the market fueled a demand for dynamic models that can capture in a consistent way the default, spread, correlation, contagion, diversification, and recovery effects arising in the basket credit derivatives segment. Encompassing all of them in a tractable arbitrage free model happened to be a highly non-trivial task and posed a big challenge both to practitioners and academics. The purpose of the paper is to address the open problems from the maturity of the post-crisis environment and provide a possible analytic toolkit with a view towards the expected new development of the credit correlation segment. Employing the general HJM forward abstract setting of Sidenius, Piterbarg, and Andersen (2008) as a workhorse, we modify and upgrade it appropriately so that all of the above mentioned effects are incorporated. Then the focus is turned to pricing and hedging. Formal pricing rules are derived and different hedging strategies are discussed. The model is calibrated to market data and its hedging performance is analyzed.

Joint work with Markus Hochstotter.

POSTERS

David R. Banos (Oslo). Construction of higher order differentiable strong solutions of SDEs with discontinuous coefficients driven by fractional Brownian motion

Abstract: In this paper we present a new method for the construction of strong solutions of SDEs with merely integrable or bounded drift coefficients driven by a multidimensional fractional Brownian motion with Hurst parameter $H < 1$. Furthermore, we prove the rather surprising result of the higher order Fréchet differentiability of stochastic flows of such SDEs in the case of a small Hurst parameter. In establishing these results we use techniques from Malliavin calculus combined with new ideas based on a local time variational calculus. We expect that our general approach can be also applied to the study of certain types of stochastic partial differential equations as e.g. stochastic conservation laws driven by rough paths.

We also believe that the higher order differentiability of the solution with respect to the initial condition for singular coefficients may have interesting applications, such as for instance, in the study of sensitivities with respect to initial data in finance. This is joint work with Torstein Nilssen and Frank Proske.

Håkon Hoel (Oslo). Construction of a mean square error adaptive Euler–Maruyama method with applications in multilevel Monte Carlo

Abstract: Stochastic Differential Equations (SDE) are non-deterministic processes used to model natural processes with uncertainty, such as multi-scale particle dynamics and the evolution of financial assets. A practical way of generating approximations of realizations of SDE is by numerical integration on a mesh of uniformly spaced time increments, but in settings with low regularity, one may achieve substantial improvements in the accuracy by adapting the step-size of the mesh to the instabilities of the considered problem. Monte Carlo (MC) methods are a class of convenient and robust algorithms for approximating quantities of interest of a given stochastic model through sample averaging of stochastic realizations. Multilevel Monte Carlo (MLMC) is an extension of classical MC methods which by sampling stochastic realizations on a hierarchy of resolutions may reduce the computational cost of weak approximations by orders of magnitude.

In this poster we give an outline of MLMC and present a recently developed application of MLMC for weak approximations of SDE with *a posteriori* step-size control in the Euler–Maruyama numerical integration of SDE realizations. A numerical example illustrating the potential efficiency gain of adaptive time stepping MLMC over uniform time stepping MLMC is provided for a low regularity problem. This is joint work with Juho Häppölä and Raúl Tempone.

Nils Christian Framstad (Oslo). Revisiting some results and counterexamples in stochastic portfolio optimization

Abstract: This talk addresses selected issues from classics of portfolio theory, like Borch, Cass and Stiglitz, Fama, Feldstein, Ross and Tobin. Some refuted assertions concerning location–dispersion (“mean–variance”) trade-off are reformulated to capture their insight in a more precise way, some (counter-) examples are found impossible, and some – to my knowledge – unpublished distributional results are given. Finally, the applicability to insurance and to continuous-time stochastic finance is discussed.

Nina Lange (Copenhagen). Approximation formula for the pricing of double structure options

Abstract: In energy markets, market prices and demand are often positively correlated leading to an amplified risk for e.g., retail energy companies. Because of standardized derivatives’ inability to hedge this risk, market participants have turned to using contracts that pay of dependent on both energy prices and a load-correlated variable such as a weather index. An example of such a contract is the so-called “energy quanto” option that only pays out if both prices and the weather index are high (or if both are low). Under the assumption of a log-normal framework, we show that the energy quanto option price can be approximated by a pricing

formula involving the correlation, current asset prices and option prices, volatilities and Greeks. All of these quantities are known or assessed by market participants, thereby yielding a fast pricing method for energy quanto options.

This is joint work with Fred Espen Benth.

Sara Solanilla Blanco (Oslo). Approximation of the HDD and CDD temperature futures price dynamics

Abstract: We propose an approximation which makes the HDD and CDD temperature futures price dynamics linearly dependent on the underlying temperature. The approximation is analysed both theoretically and empirically. We base our analysis on a continuous-time autoregressive stochastic dynamics for the time evolution of temperature in a given location. The model is fitted to temperature data collected in New York over a long time period. We apply our results to derive a simple version of the Black-76 formula for pricing a call option on CDD and HDD futures.

Junwei Xu (London). Optimal liquidation in the Almgren-Chriss framework with Lévy processes

Abstract: We consider an optimal liquidation problem in the Almgren-Chriss framework with infinite time horizon, where the unaffected asset price follows a Lévy process. The temporary price impact is described by a general function which satisfies some reasonable conditions. We consider an investor with constant absolute risk aversion, who wants to maximise the expected utility of the cash received from the sale of his assets, and show that this problem can be reduced to a deterministic optimisation problem which we are able to solve explicitly. In order to compare our results with the common exponential Lévy models, which provides a very good statistical fit with observed asset price data for short time horizons, we derive the (linear) Lévy process approximation of such models. In particular, we derive expression of approximation to the exponential Variance-Gamma Lévy process, and study properties of the corresponding optimal liquidation strategy. We find that for the widely believed power-law temporary impact function, the optimal liquidation speed is too large so that it may be practically impossible. We therefore study the case where the temporary impact function follows a power-law for small liquidation speeds, but tends to infinity faster than the power-law as the liquidation speed goes to infinity. In particular, we obtain an explicit expression for the connection between the temporary impact function for the Lévy model and the temporary impact function for the Brownian motion model, for which the optimal liquidation strategies from these two models are exactly the same.

This is joint work with Arne Løkka.