NWO/STAR/WONDER

15th Winter School on Mathematical Finance

Special topics:

Model Uncertainty, Market Impact, and Energy Markets

January 25–27, 2016
Congrescentrum De Werelt, Lunteren

Sponsored by NWO, STAR, WONDER, and FWO

NWO/STAR/WONDER
Winter School on Mathematical Finance

In recent years, the mathematical theory associated with financial risk management and the pricing of contingent claims has been a highly active field of research. The area has established itself as one of the most vigorously growing branches of applied mathematics. Model-based analysis of contracts and portfolios has become a standard in the finance industry, and the number of academic institutions offering curricula in financial mathematics is increasing rapidly. In this context, the winter school on Mathematical Finance that will take place January 25–27, 2016 in Lunteren aims at providing a meeting place for participants both from industry and from academia. The program provides ample opportunity for discussion.

The special topics of the 15th winter school are *Model uncertainty, Market impact*, and *Energy markets*. These are the subjects of minicourses that will be taught by two distinguished speakers: Professor Dirk Becherer (Humboldt-Universität zu Berlin) and Professor Fred Espen Benth (University of Oslo). Additionally there will be three one-hour lectures by Professors Nicole Bäuerle (Karlsruher Institut für Technologie), Sara Biagini (LUISS Guido Carli, Rome) and Thorsten Schmidt (University of Freiburg). Thirty-minute lectures on recent research work in the Netherlands will be presented by Hailong Bao (Tilburg University), Tim Boonen (Universiteit van Amsterdam), Fei Cong (TU Delft) and Asma Khedher (Universiteit van Amsterdam).

Auspices and sponsoring

The winter school takes place under the auspices of the research schools STAR and WONDER. The stochastics groups of the mathematics departments of the universities in The Netherlands cooperate in STAR. WONDER is the Dutch research school in Mathematics. The winter school is supported financially by STAR, WONDER, by the Netherlands Organization for Scientific Research (NWO) and by the Research Foundation - Flanders (FWO). Administrative assistance is provided by the Korteweg–De Vries Institute for Mathematics of the Universiteit van Amsterdam.

The FWO WOG research network Stochastic Modelling with applications in financial markets has made available a limited number of grants of € 250 each for young researchers (PhD students and postdocs) associated to the network to be used as a reduction on the registration fee for the winter school. Eligible for the grants are with priority those whose supervisor is a member of the network, but others are invited to apply as well. Applications for the grant can be sent by email to both Hans Schumacher and Peter Spreij (make sure that both are addressed). Applications are required to contain a brief motivation why the grant should be beneficial for the research of the applicant, a brief motivation why the applicant has a specific need for the grant, a (link to a) CV of the applicant and the name of her/his principal supervisor. The deadline for applications is November 20, 2015.

Organizers

The winter school is organized by:

Hans Schumacher (Department of Econometrics and Operations Research, Tilburg University; tel. 013-4662050, e-mail `jms@uvt.nl`)

Peter Spreij (Korteweg–De Vries Institute for Mathematics, Universiteit van Amsterdam; tel. 020-5256070, e-mail `spreij@uva.nl`).

Program outline

The program starts with registration and coffee on Monday, January 25, from 10:30 to 11:30, and ends on Wednesday, January 27, at 16:00. The following events are planned:

Minicourses

Dirk Becherer
Model uncertainty and market impact

Fred Espen Benth
Analysis of futures price models in commodity and energy markets

Special invited lectures

Nicole Bäuerle
Markov decision processes with applications to finance

Sara Biagini
Robust portfolio selection

Thorsten Schmidt
Dynamic term structure theory

Short contributions

Hailong Bao
Multi-period risk sharing under financial fairness

Tim Boonen
Pareto optima and competitive equilibria in markets with expected and dual utility

Fei Cong
Multi-period mean-variance portfolio optimization based on Monte-Carlo simulation

Asma Khedher
Model risk and robustness of quadratic hedging strategies

Schedule of lectures

	Monday January 25	Tuesday January 26	Wednesday January 27
09:00 - 10:00		Becherer	Becherer
10:30 - 11:30		Becherer	Becherer
11:30 - 12:30	Benth	Benth	Benth
14:00 - 15:00			Benth
15:00 - 16:00	Becherer	Benth	Bäuerle
16:00 - 17:00	Biagini	Schmidt	
17:30 - 18:00	Bao	Boonen	
18:00 - 18:30	Cong	Khedher	

Web page

Please see `www.mathfin.nl` for the latest information about the winter school.

Venue

The winter school will take place at Congrescentrum De Werelt, Westhofflaan 2, Lunteren, tel. +31-(0)318-484641, fax +31-(0)318-482924. Located in the heart of the Veluwe forest, De Werelt is one of the top accommodations in the Netherlands in terms of attractiveness of surroundings. Access by car or by public transportation is easy. By train, the village of Lunteren can be reached in twenty minutes from Amersfoort, and in ten minutes from Ede-Wageningen. It takes about fifteen minutes to walk from the railway station in Lunteren to the conference center (see directions below). If you come by car, ANWB signs in Lunteren will guide you to the venue. It is also possible to take a taxi from the taxi stand at railway station Ede-Wageningen. To get a taxi in Lunteren, call +31-(0)318-484555. For further details please see `www.congrescentrum.com` (under De Werelt Lunteren and Route).

Directions from the railway station: leaving the station, turn right across the pebble-covered parking lot. Turn left into the forest (Boslaan). At the crossroads, turn right into Molenweg. The first turn left is Westhofflaan.

Abstracts

Mini-course on Model uncertainty and market impact

Dirk Becherer (Humboldt-Universität zu Berlin)

Model uncertainty and market impact

Model uncertainty (ambiguity) and market impact are relevant for many applications of mathematical finance. Moving beyond classical models, to devise optimal trading strategies for suitably refined models also leads to interesting problems in the theory of stochastic optimal control, and to new questions in modelling.

In the first part of the course, we formulate a robust approach to hedging and valuation in incomplete markets. To this end, we introduce a no good deal approach to optimal (partial) hedging, which corresponds to the valuation approach of good deal bounds. Hedging strategies are minimizers of some a-priori coherent dynamic risk measure. Tracking errors of hedging strategies satisfy a uniform supermartingale property. The approach permits for concise description and analysis of hedging strategies by backward SDE theory, and for constructive or explicit solutions in several examples. We discuss extensions beyond Itô processes to models with jumps from Poisson random measures (e.g. from Lévy processes or semi-Markov chains). Since common notions for good deals (like Sharpe ratios, expected utilities or else) are defined with respect to one given probability, ambiguity about the probabilistic model becomes a relevant problem for good deal theory. We investigate robust extensions for good deal hedging and valuation under model uncertainty about the market prices of risk or about the volatilities of asset prices.

In the second part of the course, we present a multiplicative model of market impact, where portfolio strategies of a large trader have an impact on the evolution of asset prices. The price impact is multiplicative and transient over time. This corresponds to a (shadow) limit order book with intertemporal resilience, whose shape is specified in terms of relative (instead of absolute) price changes, ensuring that asset prices remain positive. We discuss solutions for variations of the optimal trade execution problem (e.g. in/finite horizon, one/two-sided order books, aspects of risk averse preferences), explore properties of intertemporal stability and absence of market manipulation strategies. Some comparison is provided with properties of related pioneering models for additive impact in the literature. We explore advanced further questions, like e.g. stochastic resilience of market impact.

This series of talks is based on joint projects with Todor Bilarev, Peter Frentrup and Klebert Kentia.

Mini-course on Energy markets

Fred Espen Benth (University of Oslo)

Analysis of futures price models in commodity and energy markets

We formulate the stochastic dynamics of futures prices as the solution of a stochastic partial differential equation, inspired by the HJM-framework in fixed-income theory. Due to the high degree of idiosyncratic risk in some commodity markets like gas,

weather and power, the noise driving the dynamics is conveniently modelled as an infinite-dimensional Lévy process.

We define various Lévy processes of interest for power markets, and follow up with a detailed analysis of the futures price and its properties. In particular, we show that the futures price dynamics essentially is an infinite-factor Ornstein-Uhlenbeck process. Moreover, we may use this insight to approximate in an arbitrage-free manner the futures price dynamics.

We define power futures via integral operators and discuss pricing and hedging of some commonly traded energy options. Also, cross-commodity futures price models are introduced, leading to a discussion of covariance operators of "bivariate" Wiener processes in Hilbert space.

A certain class of stochastic volatility models is introduced for the futures price dynamics. We extend the Barndorff-Nielsen and Shephard stochastic volatility process to operator-valued processes, and analyse its properties for models of the futures price dynamics. We show a connection to ambit fields, which is a different class of models for energy futures prices.

The series of lectures are based on work in collaboration with Paul Krühner (Vienna), Barbara Rüdiger (Wuppertal) and André Süß (Zurich).

Special invited lectures

Nicole Bäuerle (Karlsruher Institut für Technologie)

Markov decision processes with applications to finance

Markov Decision Processes are controlled Markov processes in discrete time. They appear in various fields of applications like e.g. economics, finance, operations research, engineering and biology. The aim is to maximize the expected (discounted) reward of the process over a given time horizon. We consider problems with arbitrary (Borel) state and action space with a finite and an infinite time horizon. Solution methods and the Bellman equation are discussed as well as the existence of optimal policies. For problems with infinite horizon we give convergence conditions and present solution algorithms like Howard's policy improvement or linear programming. The statements and results are illustrated by examples from finance and insurance like consumption-investment problems and dividend pay-out problems.

Sara Biagini (LUISS Guido Carli, Rome)

Robust portfolio selection

We derive a closed form portfolio optimization rule for an investor who is diffident about mean return and volatility estimates, and has a CRRA utility. The novelty is that confidence is here represented using ellipsoidal uncertainty sets for the drift, given a volatility realization. This specification affords a simple and concise analysis, as the optimal portfolio allocation policy is shaped by a rescaled market Sharpe ratio, computed under the worst case volatility. The result is based on a max-min Hamilton-Jacobi-Bellman-Isaacs PDE, which extends the classical Merton problem and reverts to it for an ambiguity-neutral investor.

Thorsten Schmidt (University of Freiburg)

Dynamic term structure theory

We visit dynamic term structure theory from a theoretical viewpoint allowing for infinitely many traded assets. Taking this seriously, a number of interesting mathematical questions arise: when is this market free of arbitrage and in what sense? This leads to surprisingly nice conditions which point towards a class of term-structure models having cadlag properties in the additional parameter, maturity. Taking this as starting point we develop a generalized forward rate approach where the introduced codebook is designed in such a flexible way, that this class is nicely parametrized. For practical applications we study a new class of affine models, also sharing the cadlag property and hence allowing for stochastic discontinuities. This has a number of surprising applications where we study the credit risk case as prime example.

Short contributions

Hailong Bao (Tilburg University)

Multi-period risk sharing under financial fairness

We work with a multi-period system where a finite number of agents need to share multiple monetary risks. We look for the solutions that are both Pareto efficient utility-wise and financially fair value-wise. A buffer enables the inter-temporal capital transfer. A risk-neutral measure is essential for determining the risk sharing rules. It can be shown that in the model setting there always exists a unique risk sharing rule that is both Pareto efficient and financially fair. An iterative algorithm is introduced to calculate this rule numerically.

Tim Boonen (Universiteit van Amsterdam)

Pareto optima and competitive equilibria in markets with expected and dual utility

This paper analyzes optimal risk sharing between agents that are endowed with either expected utility preferences or with dual utility preferences. We find that Pareto optimal risk redistributions and the competitive equilibria are obtained via bargaining with a hypothetical representative agent of expected utility maximizers and a hypothetical representative agent of dual utility maximizers. The representative agent of expected utility maximizers resembles an average risk-averse agent, whereas the representative agent of dual utility maximizers resembles a least risk-averse agent. This leads to an allocation of the aggregate risk to both groups of agents. The optimal contract for the expected utility maximizers is proportional to their allocation, and the optimal contract for the dual utility maximizing agents is given by "tranching" of their allocation. We show a method to derive the equilibrium prices. We identify a condition under which prices are locally independent of the expected utility functions, and given in closed form. Moreover, we characterize uniqueness of the competitive equilibrium via one condition on the dual utility preferences.

Fei Cong (TU Delft)

Multi-period mean-variance portfolio optimization based on Monte-Carlo simulation

We propose a simulation-based approach for solving the constrained dynamic mean-variance portfolio management problem. For this dynamic optimization problem, we first consider a sub-optimal strategy, called the multi-stage strategy, which can be utilized in a forward fashion. Then, based on this fast yet sub-optimal strategy, we pose two approaches to improve the solution. The first one depends on breaking the "self-financing" rule and allows withdrawing money from the portfolio in some cases. The other one is to involve backward recursive programming. We design the backward recursion algorithm specially such that the result is guaranteed to converge to a solution, which is at least not worse than the one generated by the multi-stage strategy. In our numeric tests, highly satisfactory asset allocations can be achieved for the dynamic portfolio management problem in case various constraints are cast on the control variables.

Asma Khedher (Universiteit van Amsterdam)

Model risk and robustness of quadratic hedging strategies

In incomplete markets, there is no self-financing hedging strategy which allows to attain the contingent claim at maturity. In other words, one cannot eliminate the risk completely. However it is possible to find 'partial' hedging strategies which minimize some risk. One way to determine these 'partial' hedging strategies is to introduce a subjective criterion according to which strategies are optimized. We consider two types of quadratic hedging strategies. In the first approach, called mean-variance hedging (MVH), the strategy is self-financing and one minimizes the quadratic hedging error at maturity in mean square sense. The second approach is called local risk-minimization (LRM). These strategies replicate the option's payoff, but they are not self-financing and the risk is minimized in a 'local' sense. We study the relation of such strategies with the theory of backward stochastic differential equations and we apply this to the approximation and simulation of MVH and LRM strategies. (This mini lecture is based on a work in collaboration with Michèle Vanmaele.)

Registration

To register for the winter school, please use the electronic registration form that is available at the web page of the winter school (see `www.mathfin.nl` or `www.science.uva.nl/~spreij/winterschool/winterschool.html`). Alternatively, you may complete the registration form on the last page and return it to ms. E. Wallet, Korteweg–De Vries Institute for Mathematics, PO Box 94248, 1090GE Amsterdam.

The registration fee includes accommodation (single room) for the nights of January 25 and 26, all meals starting with lunch on Monday up to and including lunch on Wednesday, and tea and coffee during breaks. Payment can be made by transferral to IBAN account number: NL27 INGB 0007388994 of Winter School Amsterdam, Secretariaat Korteweg–De Vries Instituut, Amsterdam and (for international money transfers) BIC: INGBNL2A. The fee schedule is as follows:

	early registration (before December 1)	late registration (after December 1)
industry professional	€1195	€1350
full-time academic	€395	€445

Inquiries concerning fees for partial attendance may be directed to ms. Wallet at the address given below. Registration will be valid after full payment has been received. Refunds can be given only for cancellations received before January 1, 2016.

Accommodation at the venue is limited. Therefore, reservations will be treated on a first-come-first-served basis with priority for full arrangements. Participants who cannot be lodged at the venue will be accommodated in a hotel nearby. Transportation from the hotel to the venue and vice versa will be taken care of by the organization.

Further information

For further information regarding the scientific program, please contact one of the members of the organizing committee. For information concerning registration please contact:

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15th Winter School on Mathematical Finance

Lunteren, January 25–27, 2016

Registration Form

Last name: _____

First name: _____

Affiliation: _____

Address: _____

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_____

Telephone: _____

Fax: _____

Email address: _____

Date: _____

Signature: _____

Please return the completed form *before January 1, 2016* to:

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Registration is valid only after full payment has been received following the fee schedule.