

NWO/STAR/WONDER

**13th Winter School on
Mathematical Finance**

Main Lecturers:

Pierre Henry-Labordère

Eckhard Platen

January 20 – 22, 2014

Congrescentrum De Werelt, Lunteren

Sponsored by NWO, STAR, WONDER, and FWO

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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 20–22, 2014 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 13th winter school are *Martingale optimal transport* and *Benchmark approach*. These are the subjects of minicourses that will be taught by two distinguished speakers: Pierre Henry-Labordère (Société Générale, Paris) and Eckhard Platen (University of Technology, Sydney). Additionally there will be three one-hour lectures by Professors Jesper Andreasen (Danske Bank, Copenhagen), David Hobson (University of Warwick) and Agnès Sulem (Inria-Rocquencourt). Thirty-minute lectures on recent research work in The Netherlands will be presented by Servaas van Bilsen (Tilburg University), Zhenzhen Fan (Universiteit van Amsterdam), Jan de Kort (Universiteit van Amsterdam) and Yanbin Shen (Delft University of Technology).

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 December 1, 2013.

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 20, from 10:30 to 11:30, and ends on Wednesday, January 22, at 15:00. The following events are planned:

Minicourses

Pierre Henry-Labordère

Martingale optimal transport: a nice ride in Finance

Eckhard Platen

A benchmark approach to investing, pricing and hedging

Special invited lectures

Jesper Andreasen

Model independent Greeks

David Hobson

Gambling in contests

Agnès Sulem

Reflected BSDEs and robust optimal stopping for dynamic risk measures with jumps

Short contributions

Servaas van Bilsen

Optimal consumption and investment during retirement

Zhenzhen Fan

Home-bias in hedge fund returns: fears of contagion and ambiguity

Jan de Kort

Optimal investment under uncertain lifetime with stochastic mortality and stochastic interest rates

Yanbin Shen

Algorithmic counterparty credit exposure for multi-asset Bermudan options

Schedule of lectures

	Monday January 20	Tuesday January 21	Wednesday January 22
09:00 - 10:00		Henry-Labordère	Platen
10:30 - 11:30		Henry-Labordère	Platen
11:30 - 12:30	Platen	Andreasen	Hobson
14:00 - 15:00			Platen
15:00 - 16:00	Platen	Henry-Labordère	
16:00 - 17:00	Sulem	Henry-Labordère	
17:30 - 18:00	van Bilsen	Fan	
18:00 - 18:30	de Kort	Shen	

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 martingale optimal transport

Pierre Henry-Labordère (Société Générale, Paris)

Martingale optimal transport: a nice ride in Finance

Optimal transport, first introduced by G. Monge in his work “Théorie des déblais et des remblais” (1781), has recently spread out in various mathematical domains as highlighted by the last Fields medallist C. Villani. Let us cite the analysis of non-linear (kinetic) partial differential equations arising in statistical physics such as McKean-Vlasov PDE, infinite-dimensional linear programming, (linear) Monge-Kantorovitch duality, mean-field limits, convergence of particle’s methods and study of Ricci flows in differential geometry.

In this lecture, we will present various applications of optimal transport in mathematical finance: calibration of (hybrid) models on market smiles, arbitrage-free construction of smiles, computation of efficient model-independent bounds for exotic options, ...

- Part 1: Overview of important results in optimal transport: Monge-Kantorovich duality, Brenier’s theorem, Fréchet-Hoeffding solution, link with Hamilton-Jacobi equation.
- Part 2: Martingale optimal transport and its interpretation in mathematical finance. Link with Skorokhod embedding, pathwise inequalities. Numerical algorithms.
- Part 3: Mean field limit and particle method for McKean non-linear SDEs. Example: calibration of hybrid models.

Mini-course on the benchmark approach

Eckhard Platen (University of Technology, Sydney)

A benchmark approach to investing, pricing and hedging

This mini-course introduces into the benchmark approach, which provides a general framework for financial market modelling. It allows for a unified treatment of portfolio optimization, derivative pricing and hedging, financial planning, insurance and risk management. It extends beyond the classical asset pricing theories, with significant differences emerging for portfolio optimization and long dated contracts. The Law of the Minimal Price will be presented for valuation. A Diversification Theorem allows forming an extremely well performing proxy for the numéraire portfolio. The richer modelling framework of the benchmark approach leads to the derivation of tractable, realistic models under the real world probability measure. It will be explained how the approach differs from the classical portfolio optimization approach, the standard risk neutral approach and the classical insurance approach. Examples on long term and extreme maturity derivatives will demonstrate the important fact that a range of contracts can be less expensively priced and hedged than suggested by classical theory. Topics:

- Best performing portfolio as benchmark
- Portfolio optimization
- Various approaches to asset pricing
- Benchmarked risk minimization
- The affine nature of diversified wealth dynamics.

Special invited lectures

Jesper Andreasen (Danske Bank, Copenhagen)

Model independent Greeks

In the presence of stochastic volatility, the minimum variance delta, as introduced by Föllmer and Schweizer (1986), is the position in the underlying stock that minimises the (local) risk of the total portfolio. Using implied volatility expansion techniques, we show that for short maturity and at-the-money, the minimum variance delta is uniquely determined by the slope of the implied volatility smile. This holds for all models where the underlying exhibits continuous dynamics. Further, we show that for low strike calls, the minimum variance delta is uniformly higher than for stochastic volatility models than for local volatility models, and vice-versa for high strikes. Results extend to the at-the-money minimum variance gamma which can be shown to be uniquely determined by the curvature of the implied volatility smile. This can be used to i) produce an estimate of the theta of option prices and ii) establish a link between the curvature of the implied volatility smile and slope the implied volatility surface in the maturity direction. Implications for option trading and empirical results are discussed.

David Hobson (University of Warwick)

Gambling in contests

In a recent paper in the Journal of Economic Theory, Seel and Strack introduced a gambling contest. Each agent observes an independent copy of a diffusion and chooses when to stop it (based solely on the information from their own process). The winner of the contest is the agent whose stopped process has the highest value.

In this talk we rederive the form of the optimal strategy for the agents, and discuss several extensions. (Joint work with Han Feng.)

Agnès Sulem (Inria-Rocquencourt)

Reflected BSDEs and robust optimal stopping for dynamic risk measures with jumps

In the Brownian case, the links between dynamic risk measures and Backward Stochastic Differential Equations (BSDEs) have been widely studied. We consider here the case with jumps. We first study the properties of BSDEs driven by a Brownian motion and a Poisson random measure and then give some properties of dynamic risk measures induced by BSDEs with jumps. We provide a representation property of such dynamic risk measures in the convex case as well as some results on a robust optimization problem in the case of model ambiguity. We then study the optimal stopping problem for dynamic risk measures represented by Backward Stochastic Differential Equations (BSDEs) with jumps and its relation with reflected BSDEs (RBSDEs) in the case when the obstacle process is a RCLL adapted process. In a Markovian framework, we show that the solution of the reflected BSDE corresponds to the unique viscosity solution of a Partial Integro-differential Differential Variational Inequality. We further investigate robust optimal stopping problems related to the case with model ambiguity and their links with mixed control/ optimal stopping game problems. Finally we turn to the study of double barrier reflected BSDEs with jumps and their links with generalized Dynkin games.

Short contributions

Servaas van Bilsen (Tilburg University)

Optimal consumption and investment during retirement

The paper explores how a retired individual without a bequest motive should optimally spend and invest a given amount of financial wealth during the rest of his life. The individual faces various sources of risk (stock market, interest rate and inflation risk) and can insure longevity risk. We consider both complete and incomplete financial markets. The desired consumption path is framed in terms of the desired growth of median consumption and the desired standard variation of either the level of consumption, the growth rate of consumption or a mix of both. We show that this model includes various preference models such as constant relative risk aversion utility and habit formation.

Zhenzhen Fan (Universiteit van Amsterdam)

Home-bias in hedge fund returns: fears of contagion and ambiguity

We propose an affine jump-diffusion model which is able to generate contagion effects both over time and across different markets. We solve in closed-form the portfolio optimization problem for an ambiguity averse investor in such a contagious market. We propose to use portfolio return moments in addition to equity index return moments in GMM estimation and show that, by accounting for the extra information on portfolio choice, the jump parameters of the asset return model can be much better identified than when using asset returns alone. We apply our model and estimation methodology to a dataset of hedge fund portfolio returns and equity index returns. We find that the optimal portfolio weights implied by our model have interesting economic implications. In particular, we show that the home bias (puzzle), typically observed in hedge fund investors' portfolios, can be explained by two phenomena: fears of contagion and ambiguity aversion. The empirical analysis rejects the nested models without time-varying jump intensities and without ambiguity aversion.

Jan de Kort (Universiteit van Amsterdam)

Optimal investment under uncertain lifetime with stochastic mortality and stochastic interest rates

This talk concerns the the optimal asset allocation of an investor in the presence of stochastic interest rates and a nonnegative stochastic mortality rate. A complete market setting is assumed where wealth can be invested in a zero-coupon bond, a q-forward contract and the money-market account. A q-forward contract, which pays the difference between realized and expected mortality of a given population, can be thought of as an insurance against changes in survival probabilities. The investor, whose lifetime is uncertain, derives utility from accumulated wealth at his/her retirement date and utility from intermediate consumption. The mortality of the agent is modelled by a doubly stochastic Poisson process; the mortality rate and the short rate are assumed to follow independent Cox-Ingersoll-Ross processes. It will be shown that this problem has a closed-form solution. Conditions for existence of an optimal solution will be provided in terms of the model parameters.

Yanbin Shen (Delft University of Technology)

Algorithmic counterparty credit exposure for multi-asset Bermudan options

The efficient quantification of counterparty credit risk of high dimensional exotic options is an important and challenging problem both in academics and in the industry. In this paper, an advanced method based on the Longstaff-Schwartz regression idea, which we call Stochastic Grid Bundling Method (SGBM), is applied to the computation of counterparty credit exposure profiles of multi-asset Bermudan options. We reduce the dimensionality of the problem by regressing the next time step option value along a set of functions of the coordinates of the underlying stock price process, instead of regressing along the multidimensional stock price process itself. Then, we partition the state space in bundles and for every bundle we compute the regression, resulting in a significant improvement of the accuracy. If we choose these functions in a smart way, the calculation problem reduces to conditional moment calculation of the coordinates of the stock price. This enables us to compute exposure profiles where the underlying is from a large set of Markov processes, for which closed form formulas or analytical approximations of the conditional moment exist. We analyse the accuracy of the SGBM in the one-dimensional case by benchmarking. Apart from benchmarking against the European options, we also benchmark against Bermudan options, which we price by a combination of Monte Carlo and COS Method (MCCOS). The error analysis for the one-dimensional case shows that the results produced by the SGBM method are very accurate. Finally, we apply the established method to several important examples of multi-asset payoffs. For the Bermudan option we are able to analyse the connection between the exposure profiles and the exercise intensity, where we compute these under both real world measure and risk neutral pricing measure. The efficient calculation of expected exposure (EE) for multi-asset options can be further applied to the computation of the credit value adjustment (CVA).

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 20 and 21, 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 account 7388994 of Winter School Amsterdam, Secretariaat Korteweg–De Vries Instituut, Amsterdam. For international money transfers please use the bank codes IBAN: NL27 INGB 0007388994 and BIC: INGBNL2A. The fee schedule is as follows:

	early registration (before December 1)	late registration (after December 1)
industry professional	€1650	€1900
full-time academic	€375	€425

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, 2014.

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:

ms. E. Wallet
Korteweg–De Vries Institute for Mathematics
Universiteit van Amsterdam
PO Box 94248
1090GE Amsterdam
e-mail: e.wallet@uva.nl
tel.: +31-(0)20-5255217
fax: +31-(0)20-5257820

13th Winter School on Mathematical Finance

Lunteren, January 20–22, 2014

Registration Form

Last name: _____

First name: _____

Affiliation: _____

Address: _____

Telephone: _____

Fax: _____

Email address: _____

Date: _____

Signature: _____

Please return the completed form *before January 1, 2014* to:

ms. E. Wallet
KdV Institute for Mathematics
Universiteit van Amsterdam
PO Box 94248
1090GE Amsterdam
fax: +31-(0)20-5257820

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

