NWO/STAR/WONDER/CentER

11th Winter School on Mathematical Finance

Special Topics:

Systemic risk

Volatility models

January 23 – 25, 2012
Congrescentrum De Werelt, Lunteren

Sponsored by NWO, STAR, WONDER and CentER

NWO/STAR/WONDER/CentER
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 23–25, 2012 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 11th winter school are *Systemic risk* and *Volatility models*. These are the subjects of minicourses that will be taught by two distinguished speakers: Professor Tom Hurd (McMaster University) and Professor Alexander Lipton (Bank of America Merrill Lynch and Imperial College). Additionally there will be three one-hour lectures by Professors Elyès Jouini (Université Paris-Dauphine), Yuri Kabanov (Université de Franche-Comté) and Josef Teichmann (ETH Zürich). Thirty-minute lectures on recent research work in the Netherlands will be presented by Paul Gruntjes (Universiteit van Amsterdam, Flow Traders), Verena Hagspiel (Tilburg University), Kolja Loebnitz (Twente University) and Bowen Zhang (TU Delft).

Auspices and sponsoring

The winter school takes place under the auspices of the following research schools:

- Center for Economic Research (CentER)
- STAR
- WONDER.

CentER is the research school of the Faculty of Economics and Business Administration of Tilburg University. 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 CenTER, STAR, WONDER and by the Netherlands Organization for Scientific Research (NWO). 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 five grants of € 200 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 those whose supervisor is a member of the network. Information about network members can be obtained from the institutional membership list at `www.stochmodfin.ugent.be`. Applications for the grant should be sent by email to both Hans Schumacher (`j.m.schumacher@uvt.nl`) and Peter Spreij(`spreij@uva.nl`). Applications are required to contain a brief motivation why the grant should be beneficial for the research of the applicant, a (link to) a CV of the applicant and the name of her/his principal supervisor. The deadline for applications is December 1, 2011.

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 23, from 10:30 to 11:30, and ends on Wednesday, January 26, at 16:00. The following events are planned:

Minicourses

Tom Hurd
Introduction to financial networks and systemic risk

Alexander Lipton
Applications of classical mathematical methods in finance

Special invited lectures

Elyès Jouini
Financial markets equilibrium with heterogeneous agents

Yuri Kabanov
On local martingale deflators and market portfolios

Josef Teichmann
Finite dimensional realizations for the CNKK-volatility surface model

Short contributions

Paul Gruntjes
Modeling dynamic default correlation in a Lévy world with applications to CDO pricing

Verena Hagspiel
Optimal investment strategies for product-flexible and dedicated production systems under demand uncertainty

Kolja Loebnitz
Liquidity risk meets economic capital and RAROC

Bowen Zhang
An efficient pricing method for Asian options based on Fourier cosine expansions

Schedule of lectures

	Monday January 23	Tuesday January 24	Wednesday January 25
09:00 - 10:00		Lipton	Hurd
10:30 - 11:30		Lipton	Hurd
11:30 - 12:30	Lipton	Hurd	Jouini
14:00 - 15:00			Hurd
15:00 - 16:00	Lipton	Hurd	Teichmann
16:00 - 17:00	Kabanov	Lipton	
17:30 - 18:00	Gruntjes	Hagspiel	
18:00 - 18:30	Loebnitz	Zhang	

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/route/EN/de_werelt`.

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 Systemic risk

Tom Hurd (McMaster University)

Introduction to financial networks and systemic risk

The study of contagion in financial systems is very topical in light of recent events in the global markets. "Contagion" refers to the spread of defaults through a system of financial institutions, with each successive default causing increasing pressure on the remaining components of the system. The term "systemic risk" refers to the contagion-induced threat to the financial system as a whole, due to the default of one (or more) of its component institutions. The ultimate question for me is how mathematical models can help us understand systemic risk.

More specific topics and questions I intend to address in this minicourse include:

1. What is a good working definition of systemic risk?
2. How do banks fail?
3. What is a random graph?
4. What is the basic economic picture of the financial system as a random graph?
5. What conclusions have resulted from various economic studies of the financial systems of different countries?
6. What important effects did pre-crisis models miss that we can now learn from?
7. What is the mathematics of cascading defaults in a random graph?
8. What does the theory of random graphs hint about the nature of the financial system?
9. Are there some useful "deliberately simplified models of systemic risk"?

Mini-course on Volatility models

Alexander Lipton (Bank of America Merrill Lynch and Imperial College)

Applications of classical mathematical methods in finance

Recently, most fundamental and long-considered solved problems of financial engineering, such as construction of yield curves and calibration of implied volatility surfaces, have recently turned out to be more complex than previously thought. In particular, it has become apparent that one of the main challenges of options pricing and risk management is the sparseness of market data for model calibration, especially in severe conditions. Market quotes can be very sparse in both strike and maturity. As the spot price moves, options that were close to at-the-money at inception become illiquid, so that one has to find ways to interpolate and extrapolate the implied volatilities of liquid options to mark them to market. Moreover, for certain asset classes the concept of implied volatility surface is badly defined. For instance, for commodities it is not uncommon to have market prices of options for only a single maturity, while for foreign exchange it is customary to quote option prices with no more than five values of delta and very few maturities.

The calibration of a model to sparse market data is needed not only for the consistent pricing of illiquid vanilla options, but also for the valuation of exotic options. The latter is particularly demanding since it requires the construction of implied and local volatility surfaces across a wide range of option strikes and maturities.

In this mini-course we shall discuss a universal volatility model (UVM) and discuss its applications to pricing of financial derivatives. First, we describe three sources of UVM, namely, local volatility model; stochastic volatility model; and jump-diffusion model. Second, we describe three component parts of UVM, namely, calibration of the model to the market; pricing of vanilla and first-generation exotic options; pricing of second-generation exotics. Third, we discuss main analytical, semi-analytical, and numerical techniques needed for efficient implementation of UVM from a practical standpoint with a particular emphasis on the Lewis-Lipton formula and its applications.

Lecture 1: Market overview. How mathematical finance is used in practice.
Lecture 2: Three sources and three component parts of the universal volatility model.
Lecture 3: Local volatility model.
Lecture 4: Stochastic volatility model and the Lewis-Lipton formula.
Lecture 5: Universal volatility model.

Special invited lectures

Elyès Jouini (Université Paris-Dauphine)

Financial markets equilibrium with heterogeneous agents

This paper presents an equilibrium model in a pure exchange economy when investors have three possible sources of heterogeneity. Investors may differ in their beliefs, in their level of risk aversion and in their time preference rate. We study the impact of investors heterogeneity on the properties of the equilibrium. In particular, we analyze the consumption shares, the market price of risk, the risk free rate, the bond prices at different maturities, the stock price and volatility as well as the stock's cumulative returns, and optimal portfolio strategies. We relate the heterogeneous economy with the family of associated homogeneous economies with only one class of investors. We consider cross sectional as well as asymptotic properties. (joint work with Jaksa Cvitanic, Semyon Malamud, Clotilde Napp)

Yuri Kabanov (Université de Franche-Comté)

On local martingale deflators and market portfolios

Local martingale deflator is a multiplicator, transforming value processes into local martingales. If the inverse of such a deflator is the value process of portfolio, the latter is called market portfolio. We provide some conditions for the existence of the mentioned objects.

Josef Teichmann (ETH Zürich)

Finite dimensional realizations for the CNKK-volatility surface model

We show that parametrizations of volatility surfaces (and even more involved multivariate objects) by time-dependent Lévy processes (as proposed by Carmona-Nadtochiy-Kallsen-Krühner) lead to quite tractable term structure problems. In this context we can then ask whether the corresponding term structure equations allow for (regular) finite dimensional realization, which necessarily leads to models driven by an affine factor process. This is another confirmation that affine processes play a particular role in mathematical finance. The analysis is based on a careful geometric analysis of the term structure equations by methods from foliation theory.

Short contributions

Paul Gruntjes (Universiteit van Amsterdam, Flow Traders)

Modeling dynamic default correlation in a Lévy world with applications to CDO pricing

In this talk I will present an intuitive, practical, Lévy-based, dynamic default correlation model, with applications to CDO pricing. More specifically, we first model marginal default probabilities using a dynamic structural Variance Gamma (VG) model. Then we propose a dynamic correlation structure between the individual obligors that is based on these marginal probabilities. The key advantage of our correlation structure is that it is intuitive, dynamic, and allows for easy calibration on the market since the underlyings are market observables, for which there is ample data available. In case of a homogeneous basket of obligors, our model is as easy as the copula approach. In case of a non-homogeneous basket, the evaluation of our model is fast and accurate, and therefore does not impose any restrictions on numerical computations. In this case our model relies on the computation of convolutions to calculate a recursion, which can be efficiently and accurately done using numerical Laplace transform inversion. The complexity of the algorithm is low.

Verena Hagspiel (Tilburg University)

Optimal investment strategies for product-flexible and dedicated production systems under demand uncertainty

This paper studies the optimal investment strategy of a firm having the managerial freedom to acquire either flexible or dedicated production capacity. Flexible capacity is more expensive but allows the firm to switch costlessly between products and handle changes in relative volumes among products in a given product mix. Dedicated capacities restrict to manufacture one specific product but for lower acquisition costs. Specifically, I model the investment decision of a monopolist selling two products in a market characterized by price-dependent and uncertain demand, in a continuous time setting. I find that flexibility especially pays off when uncertainty is high, substitutability low, and profit levels of the two products are substantially different. In the flexible case, the firm just produces the most profitable product under high demand, while if demand is low the firm produces both products to make total market

demand bigger. In the dedicated case the firm invests in both capacities only if the substitutability rate is low and profitability of both products high enough. Otherwise, it restricts investment to one dedicated capacity for the more profitable product. Considering a firms decision to change from dedicated to flexible capacity, it is shown that despite perfectly positively correlated demand the firm will undertake this switch even for very low demand cases if the profitability of the products is substantially different. The option to increase total capacity accelerates investment in flexible capacity when the profit levels of both products are high enough.

Kolja Loebnitz (Twente University)

Liquidity risk meets economic capital and RAROC

A bank's liquidity risk lies in the intersection of funding risk and market liquidity risk. We offer a mathematical framework to make Economic Capital and RAROC sensitive to illiquidity. We introduce the concept of a liquidity cost profile as a quantification of a bank's illiquidity at balance sheet level. This leads to the concept of liquidity-adjusted risk measures defined on the vector space of asset and liability pairs. We show that convexity and positive super-homogeneity of risk measures is preserved under the liquidity adjustment, while coherence is not, reflecting the common idea that size does matter. We indicate how liquidity cost profiles can be used to determine whether combining positions is beneficial or harmful. Finally, we address the liquidity-adjustment of the well known Euler allocation principle. Our framework may be a useful addition to the toolbox of bank managers and regulators to manage liquidity risk.

Bowen Zhang (TU Delft)

An efficient pricing method for Asian options based on Fourier cosine expansions

I will give a talk on our pricing method for Asian options. It is an efficient pricing method for arithmetic and geometric Asian options under Lévy processes, based on Fourier–cosine expansions and Clenshaw–Curtis quadrature. The pricing method works for both European–style and American–style Asian options, and for both discretely and continuously monitored versions. The exponential convergence rate of cosine expansions and Clenshaw–Curtis quadrature reduces the computational time of the method to less than one millisecond for geometric Asian options and to 2 seconds for arithmetic Asian options. Our method can be seen as an alternative for existing pricing methods for Asian options. The algorithm for arithmetic Asian options gives the prices in a robust way when the number of monitoring dates increases, for example, for Lévy processes, like CGMY or NIG processes. The method's accuracy is illustrated by a detailed error analysis and its performance is further demonstrated through various numerical examples.

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 23 and 24, 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)
standard	€1650	€1900
full-time university staff	€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 cancelations received before January 1, 2012.

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

11th Winter School on Mathematical Finance

Lunteren, January 23–25, 2012

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, 2012* 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.