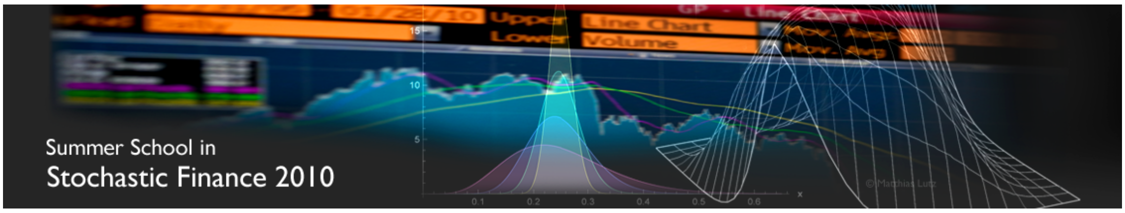
Abstracts



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Sören Christensen
Friday

On Optimal Stopping Problems for AR(1) Sequences

We consider a general optimal stopping problem with discounting for autoregressive processes. Our strategy for a solution consists of two steps: First we give elementary conditions to ensure that an optimal stopping time is of threshold-type. Then the resulting one-dimensional problem of finding the optimal threshold is to be solved explicitly. This second step is carried out for innovations of phase-type distribution using martingale techniques. The principle of continuous fit leads to explicit solutions. The talk is based on [1] and [2].

Bibliography

[1] *S. Christensen, A. Irle, A. Novikov* An Elementary Approach to Optimal Stopping Problems for AR(1) Sequences. Submitted to Sequential Analysis.

[2] *S. Christensen* Phase-Type Distributions, Autoregressive Processes and Overshoot. Preprint.

Alexander Gushchin
Tuesday, Thursday, Friday

Duality Methods in Robust Utility Maximization

In this short course we study a problem of maximizing the expected robust utility from terminal wealth. Duality methods provide a powerful approach to this problem under very general assumptions on a model. Our aim is to present a collection of mathematical ideas and methods used to realize this approach in full generality. The topics to be discussed are:

- minimax theorems reducing the problem to the case of standard utility;
- description of a dual problem, existence and uniqueness of solutions, dual characterization of the value function of the primal problem;
- conditions for the existence of a solution to the primal problem;
- connections to the arbitrage theory and super-replication prices.

For the most part of the course, we deal with an abstract (static or dynamic) setting of the problem which needs no prerequisites, though some familiarity with basic notions of functional and convex analysis (Banach spaces, weak topologies, Fenchel transform) may be helpful. From stochastic calculus, only the notion of a supermartingale is necessary for understanding.

Michael Kalkbrener
Wednesday

Understanding the Behavior of Credit Correlations Under Stress

We present a general approach to implementing stress scenarios in a multi-factor credit portfolio model. Although the methodology is developed in a particular factor model, the main concept - stressing risk factors through a truncation of their distributions - is independent of the model specification. We derive analytic formulae for asset correlations under stress in Gaussian and t-distributed factor models.

For the more general class of normal variance mixture (NVM) models, we calculate the asymptotic limit of the correlation under stress, which depends on whether the variables are in the maximum domain of attraction of the Frechet or Gumbel distribution. It turns out that correlations in heavy-tailed NVM models are less sensitive to stress than in medium- or light-tailed models. Our analysis sheds light on the suitability of this model class to serve as a quantitative framework for stress testing, and as such provides important information for risk and capital management in financial institutions, where NVM models are frequently used for assessing capital adequacy.

Rüdiger Kiesel
Wednesday, Thursday, Friday

Introduction to Energy Markets

Lecture 1: Introduction to Energy Derivatives

Within the last few years the markets for commodities, in particular energy-related commodities, has changed substantially. New regulations and products have resulted in a spectacular growth in spot and derivative trading. In particular, electricity markets have changed fundamentally over the last couple of years. Due to deregulation energy companies are now allowed to trade not only the commodity electricity, but also various derivatives on electricity on several Energy Exchanges (such as the EEX). We discuss basic principles of commodity markets and outline the stylized facts of electricity price processes. Then we introduce spot and forward models for Electricity. Finally, special derivatives for the electricity markets are analysed.

Lecture 2: Pricing Forward Contracts in Power Markets by the Certainty Equivalence Principle

We provide a framework that explains how the market risk premium, defined as the difference between forward prices and spot forecasts, depends on the risk preferences of market players. In commodities markets this premium is an important indicator of the behaviour of buyers and sellers and their views on the market spanning between short-term and long-term horizons. We show that under certain assumptions it is possible to derive explicit solutions that link levels of risk aversion and market power with market prices of risk and the market risk premium.

Lecture 3: Emission Certificates

We provide a short introduction in the theoretical properties of permit price dynamics regarding the effect of banking, linking of different emissions trading schemes and safety-valve mechanisms on the permit price dynamics. Then explicit models for the price process are constructed and calibrated to historical data on the permit prices and emissions in the European Union. We show that permit prices in emissions trading schemes without inter-phase banking resemble Digital options and are inherently prone to price jumps and high volatility. Then we discuss so-called hybrid schemes and show that they can be decomposed into ordinary cap-and-trade schemes with plain-vanilla options on permits.

Alexander Kulikov
Monday, Tuesday

One-Dimensional and Multi-Dimensional Coherent Risk Measures: Examples, Properties and Applications to Different Problems in Mathematical Finance

Lecture 1: One-Dimensional Coherent Risk Measures

Traditional measures of risk are variance (semivariance) and V@R. But they have some drawbacks. For example, variance(semivariance) does not satisfy monotonicity property and V@R does not satisfy diversification property, which should be valid from financial point of view. So the notion of coherent risk measure was introduced in the landmark paper [1] by Artzner, Delbaen, Eber and Heath. In the paper [2] these authors proved the basic representation theorem. Since those papers, the theory of coherent risk measures has been evolving rapidly. The notion of convex risk measure was considered in [5].

Besides the task of risk measurement, the task of the allocation of risk between some parts of portfolio is also very important (for example, allocation of risk of the portfolio of a large firm between the units of this firm). This problem is closely connected with the problem of risk contribution. These problems are studied in [4], [11]. Here we give geometrical solution for these problems in terms of generator and probability solution in terms of extreme measures the notion of which were introduced in [3].

Also in [3] NGD condition based on classical coherent risk measures was introduced. Here we introduce geometric and probability analogue of the First Fundamental Theorem of Arbitrage Pricing with coherent risk measures. Also we consider intervals of fair prices sub- and superhedging strategies in terms of coherent risk measures.

The various examples of coherent risk measures are considered. The important coherent risk measure (Tail V@R) was introduced in [2]. Also such important property of coherent risk measures such as law invariance was considered in [10] by Kusuoka. In this paper he also proved that Tail V@R is the minimal coherent risk measure which is more than V@R.

Lecture 2: Multi-Dimensional Coherent Risk Measures

When we describe the portfolio consisting of some currencies it is more natural to use multidimensional approach given by Kabanov in [7], when the portfolio is not the number, but a vector, i-th component of which means the number of i-th currency in portfolio. The notion of multidimensional coherent risk measure was introduced in [6] by Jouini, Meddeb, Touzi. Their approach aims to take into account transactional costs while exchanging one currency to another. But in their model transactional costs are not random. So they do not take into account risk connected with changing of currency exchange rates that is one of the most important risks nowadays. In [8] we introduced the notion of multidimensional coherent risk measure which takes into account this type of risks and proved the representation theorem.

Besides the task of risk measurement, the task of the allocation of risk between some parts of portfolio is also very important. This problem is closely connected with the problem of risk contribution. Also we give the solution for these problems in terms of multidimensional coherent risk measures via the notion of multidimensional extreme element.

Also in [9] we consider NGD condition based on multidimensional coherent risk measures. The technique given is analogical to one considered in [3], and the sets of fair prices are much smaller than with using NA pricing (See [7]). Here we introduce examples when in multicurrency markets multidimensional coherent risk measures give more adequate result than one-dimensional ones.

The various examples of multidimensional coherent risk measures are considered. The multidimensional analogue of Tail V@R was introduced in [8] in the case of random cone of currency exchange rates. Also we introduce some important properties of multidimensional coherent risk measures such as as space consistency and law invariance.

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[3] *A. S. Cherny.* Pricing with coherent risk. Probability Theory and Its Applications, **52** (2007), No. 3, p. 506–540.

[4] *T. Fischer.* Risk capital allocation by coherent risk measures based on one-sided moments. Insurance: Mathematics and Economics, **32** (2003), No. 1, p. 135–146.

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[9] *A. V. Kulikov* Pricing with multidimensional coherent risk measures. Survey of Applied and Industrial Mathematics, **15** (2008), No. 2, p. 211–228 (in Russian).

[10] *Kusuoka S.* On law invariant coherent risk measures. Advances in Mathematical Economics, **3** (2001), p. 83–95.

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Yaroslav Lyulko
Friday

Stochastic representations of max-type functionals from random walk

We consider the problems of finding stochastic representations of functionals $F = F(\omega)$ of random walk. We obtain both single and multiple representations of functionals $F_N = \max_{k\leq N} S_k$, $F_{\tau_{-a}} = \max_{k\leq\tau_{-a}} S_k$, where τ_{-a} is the time of the first reaching the level $-a$, $a \in N$ by random walk. Also we find a single representation of functional $F_{g_N} = \max_{k\leq g_N} S_k$, where g_N is the time of the last zero of random walk on $(0, N]$.

Aleksandar Mijatovic
Monday, Wednesday, Thursday

First Passage in Stochastic Volatility Models with Jumps: Applications in Financial Markets

In equity and foreign exchange markets the risk-neutral dynamics of the underlying asset are commonly represented by a stochastic volatility model with jumps. In this short course we will study a dense subclass of such models, given by Markov additive processes, and describe analytically tractable formulae for the prices of a range of first-generation exotic derivatives. The following topics will be discussed:

- Fourier transforms of vanilla and forward starting options,
- formula for the slope of the implied volatility smile for large strikes,
- formula for a variance swap price,
- one-dimensional integral representation for volatility and variance swaps and (if time permits),
- analytically tractable formula for the Laplace transform (in maturity) of the double-no-touch options based on complex-matrix Wiener-Hopf factorisation.

Prerequisites: good understanding of continuous-time Markov chain theory and of fundamental properties of Brownian motion are essential. Some familiarity with integral transforms is desirable.

Ulrich Rieder
Monday, Tuesday, Thursday

Markov Decision Processes with Applications to Finance

Lecture 1: Markov Decision Processes

The theory of Markov Decision Processes (MDPs) is the theory of controlled Markov processes. We treat MDPs with finite and infinite horizon and present the basic solution concepts and algorithms: verification theorems, Bellman equation, policy iteration, Howard's policy improvement and linear programming. The results are illustrated by a discrete-time consumption-investment problem.

Lecture 2: Partially Observable Markov Decision Processes

In many applications the decision maker has only partial information about the state process, i.e. part of the state cannot be observed. We consider partially observable MDPs and explain the reformulation as a filtered MDP. Of particular interest will be the filter equation. Important special cases are Hidden Markov Models and Bayesian Models. As applications we discuss bandit problems and a CRR-model with unknown up-probability.

Lecture 3: Continuous-Time Markov Decision Processes

We study continuous-time optimization problems where the state process is a piecewise deterministic Markov process. These processes form a general and important class of non-diffusions. It is assumed that both the jump behavior as well as the drift between two jumps can be controlled. Using an embedding procedure we solve the stochastic optimization problem by a discrete-time MDP. We highlight our findings by two examples from finance: a terminal wealth problem in a PDMP market and the liquidation of a large amount of shares in so-called dark pools.

Albert Shiryaev
Monday, Tuesday, Wednesday

Optimal Stopping with Local Time

In our lectures we describe a new approach to some problem of Sequential Analysis based on reduction to optimal stopping problems with local time. We concentrate our attention on solving of the Bayesian problem of testing three statistical hypotheses about the drift of a Brownian motion. It turns out that this problem can be reformulated as an optimal stopping problem for some diffusion process with a risk function defined by the local time of this process on two lines. The lectures are based on the results by Shiryaev and Zhitlukhin obtained in MSU and MIAN.