Minisymposium 14

Stochastische Marktmodelle

Leiter des Symposiums:

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Die Mathematik ist eine Schlüsseltechnologie zum Verständnis der Finanzmärkte. Seit den 70er Jahren hat sich eine reiche mathematische Theorie entwickelt, die immer wieder von neuen Fragestellungen der Praxis fruchtbar beeinflusst wird. In diesem Symposion werden neue Trends in der Finanzmathematik und mathematischen Ökonomie vorgestellt. Inhaltlich beschäftigen wir uns mit Fragen des Kreditrisikos, illiquiden Finanzmärkten, der Quantifizierung von Risiken (monetäre Risikomaße) sowie robusten optimale Portefeuilles.

Dienstag, 19. September

Zeichensaal, Mathematisches Institut, Wegelerstr. 10

14:00 – 14:50 **Peter Bank** *(Columbia University)*
Pricing and Hedging in Illiquid Financial Markets

15:00 – 15:50 **Christoph Kühn** *(Fankfurt)*
Optimal investment in financial markets with different liquidity effects

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16:00 – 16:50 **Michael Kupper** *(TU Wien)*
Composition of Time-Consistent Dynamic Monetary Risk Measures in Discrete Time

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17:00 – 17:50 **Christian-Oliver Ewald** *(Leeds)*
Malliavin differentiability of the Heston Volatility and an extension of the Hull & White pricing formula

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Mittwoch, 20. September

Zeichensaal, Mathematisches Institut, Wegelerstr. 10

14:00 – 14:50 **Ralf Korn** *(TU Kaiserslautern and Fraunhofer ITWM Kaiserslautern)*
Stocks paying discrete dividends: modelling, option pricing and optimal portfolios

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15:00 – 15:50 **Kay Giesecke** *(Stanford University)*
Pricing credit from the top down with affine point processes

16:00 – 16:50 **Stefan Weber** *(Cornell University)*
Optimal Portfolio Choice under Model Uncertainty

17:00 **Jörn Sass** *(RICAM Linz)*
Utility maximization with partial information and further constraints

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17:45 **Manfred Schäl** *(Bonn)*
The numeraire portfolio under transaction cost

Vortragsauszüge

Peter Bank *(Columbia University)*
Pricing and Hedging in Illiquid Financial Markets

Ever since the seminal work of Black, Scholes, and Merton, typical models studied in Mathematical Finance specify price dynamics exogenously via some more or less explicit semimartingale dynamics. This is contrast to the basic economic paradigm that prices ought to be determined by demand and supply. We propose a new model which bridges the gap (or at least tries to) between these two approaches by studying the dynamics of utility indifference prices. For exponential utility, the resulting nonlinear wealth dynamics allow for explicit solutions to the classical problems of pricing, hedging, and utility maximization in complete and incomplete financial markets.

Christoph Kühn *(Frankfurt)*
Optimal investment in financial markets with different liquidity effects

In an illiquid financial market trades of a large investor can move market prices quite significantly. In the last years different models have been suggested to capture the interdependency of the evolution of the asset price and the dynamic trading strategy of a large investor in the asset. Roughly speaking, there are two competing approaches in the literature. In Çetin, Jarrow, Protter (2004), Rogers, Singh (2006) and others, a transaction of a large trader only has a short-term price impact and the asset price jumps back to its previous level. By contrast, in Bank, Baum (2004), Esser, Mönch (2002), Frey, Stremme (1997) and Platen, Schweizer (1998) the market price stays at the new level after a transaction of the large investor.
We give a new microeconomic motivation of different illiquid market models and propose a continuous-time model which unifies both liquidity effects. The continuous-time self-financing condition for this model is obtained as a limit from so-called simple strategies. We analyze the large investor's utility maximization problem for utility functions which are finite on the whole real line and characterize the optimal strategy by a marginal utility property generalizing a well-known relationship in frictionless markets.

Michael Kupper *(TU Wien)*
Composition of Time-Consistent Dynamic Monetary Risk Measures in Discrete Time

In discrete time, every time-consistent dynamic monetary risk measure can be written as a composition of one-step risk measures. We exploit this structure to give new dual representation results for time-consistent convex monetary risk measures in terms of one-step penalty functions. We first study risk measures for random variables modelling financial positions at a fixed future time. Then we consider the more general case of risk measures that depend on stochastic processes describing the evolution of financial positions. In both cases the new representations allow for a simple composition of one-step risk measures in the dual. We discuss several explicit examples and provide connections to the recently introduced class of dynamic variational preferences.
It is joint work with Patrick Cheridito (Princeton University).

Christian-Oliver Ewald *(Leeds)*
Malliavin differentiability of the Heston Volatility and an extension of the Hull & White pricing formula

The talk is based on results obtained jointly with Elisa Alos, UPF Barcelona. We show that the Heston volatility or equivalently the Cox-Ingersoll-Ross process satisfying

$$dv_t = \kappa\left(\theta - v_t\right)dt + \nu\sqrt{v_t}dW_t$$

is Malliavin differentiable and give an explicit expression for the derivative. This result assures the applicability of Malliavin calculus in the framework of the Heston stochastic volatility model and the Cox-Ingersoll-Ross model for interest rates. Furthermore we derive conditions on the parameters κ,θ and ν which guarantee the existence of the second Malliavin derivative of the Heston volatility. We apply this result in order to obtain an extension of the classical Hull and White formula to the Heston model with correlation and derive an approximate option pricing formula. Our numerical experiments document that the approximation delivers excellent results.

Ralf Korn *(TU Kaiserslautern and Fraunhofer ITWM Kaiserslautern)*
Stocks paying discrete dividends: modelling, option pricing and optimal portfolios

Usually any dividends on stocks are modelled as continuously paid streams, but in reality dividends are always paid discretely, often after some announcement of the amount of the dividend. It is not entirely clear how such discrete dividends are to be handled; simple perturbations of the Black-Scholes model often fall into contradictions. The approach presented here is to recognise the stock price as the net present value of all future dividends, and to model the (discrete) dividend process directly. The stock price process is then deduced, and various option-pricing formulae derived. Further, the standard portfolio problem will be solved.

Kay Giesecke *(Stanford University)*
Pricing credit from the top down with affine point processes

The value of any credit derivative is a function of market wide risk factors generated by the complex web of relationships in the economy. To incorporate these factors, we estimate the value of credit derivatives from the top down by modeling aggregate credit losses directly. We show how to make this approach computationally tractable within the class affine point processes, which are intensity-based jump processes driven by affine jump diffusions. An affine point process is sufficiently flexible to account for both cyclical dependence in the economy and market contagion. Further, it supports Fourier transform based pricing and calibration. We illustrate our top down approach in the context of CDS index and tranche spreads.

Stefan Weber *(Cornell University)*
Optimal Portfolio Choice under Model Uncertainty

We consider the problem of utility maximization under model uncertainty in the presence of both cost and risk constraints. Downside risk is measured by *utility-based shortfall risk*.
We first review the properties of utility-based shortfall risk. The acceptance sets of these risk measures are defined in terms of a convex loss function and a fixed threshold level.

Second, we discuss utility maximization under both cost and risk constraints, if there is no model uncertainty. By means of its dual problem, the optimization problem can explicitly be solved.
Finally, we characterize the solution of the robust utility maximization problem under robust constraints. In this case, model uncertainty involves three aspects: the measurement of the utility, the cost and the downside risk. We assume that investors take a worst case approach.

Jörn Sass *(RICAM Linz)*
Utility maximization with partial information and further constraints

We consider a multi-stock market model where prices satisfy a stochastic differential equation with instantaneous rates of return modeled as an unobserved stochastic process, e.g. a continuous time, finite state Markov chain. The investor wishes to maximize the expected utility of terminal wealth but for his investment decisions only the prices are available to him.
It is convenient to use continuous-time models to approximate the discrete-time trading on the market, since these models often allow us to derive optimal trading strategies quite explicitly, in this case by using HMM filtering results and Malliavin calculus. But in these models where the drift of the stock returns is not constant, the optimal strategy may lead to extreme long and short positions which can result in bankruptcy if we trade in discrete time only.
In this talk we compare different constraints and model reformulations which may lead to more stable strategies: E.g. using non-constant volatility models, Levy-noise, convex costraints (no short selling), or risk constraints like e.g. bounded shortfall risk.

Manfred Schäl *(Bonn)*
The numeraire portfolio under transaction cost

This is joint work with Joern Sass. The existence of the numeraire portfolio is studied for a discrete – time financial market under proportional transaction cost. For pricing derivative securities, expectation of the claim is carried through with respect to a martingale measure. The numeraire portfolio allows to replace this usual change of measure by a change of numeraire. For models with transaction cost, the concept of a martingale

measure and thus the concept of a numeraire portfolio have to be modified. A well-known approach (for models without transaction cost) is maximization of the log-utility. The same approach turns out to work for the present models with transaction cost.