Department of Mathematics

Joint Risk & Stochastics and Financial Mathematics Seminar in 2016/17

Seminars are listed in reverse chronological order, most recent first

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27 April - Peter Kort (Tilburg)

Capacity Choice in (Strategic) Real Options Models

This paper considers investment decisions within an uncertain dynamic and competitive framework. Each investment decision involves to determine the timing and the capacity level. In this way we extend the main bulk of the real options theory where the capacity level is given. We consider a monopoly setting as well as a duopoly setting. In the duopoly setting we provide a fully dynamic analysis of entry deterrence / accommodation strategies. We find that the first investor overinvests in capacity in order to delay entry of the second investor. In very uncertain economic environments, the first investor always ends up being the largest firm in the market. If uncertainty is moderately present, a reduced value of waiting implies that the preemption mechanism forces the first investor to invest so soon that a large capacity cannot be afforded. Then it will eventually end up with a capacity level being lower than the second investor.

Then we extend the above setting to explicitly consider an incumbent-entrant framework. We find that the incumbent invests earlier than the entrant and that entry deterrence is achieved through timing rather than through overinvestment. This is because the incumbent invests earlier and in a smaller amount compared to a scenario without potential entry. If, on the other hand, the capacity size is exogenously given, the investment order changes and the entrant invests before the incumbent does.

Finally we consider an innovative incumbent that has an option to perform a product innovation. Question is whether, after introducing the new product on the market, the firm keeps on producing its old product. We provide scenarios under which this is optimal or when the firm will abandon the old product.

16 March - Sergio Pulido (ENSIIE)

Density of probability measures with the martingale representation property

Using the theory of analytic maps, we prove density results for measures satisfying

a backward formulation of the martingale representation property. These results are useful to study equilibrium-based mechanisms of pricing. This is joint work with Dmitry Kramkov.

13 March - Yuri Imamura (Tokyo University of Science)

Asymptotic Static Hedge via Symmetrization
In the talk, we are interested in the risk to cover (some portion of) the price of the option at a default time. The risk, which we call timing risk, is a risk of uncertain dividend, especially of its payment time. Credit derivatives typically are exposed to the risk. We will discuss how it could be hedged by a static position of European path-independent options, generalizing P. Carr and J. Picron (1999) where they applied the semi-static hedging formula of barrier options to hedge a payment at a stopping time in a Black-Scholes environment. We will give an exact hedging formula in an multi-dimensional general diffusion setting.

9 March - Romain Blanchard

Robust optimal investment in discrete time for unbounded utility function
We investigates the problem of maximising worst case expected terminal utility in a discrete time financial model with a finite horizon under non-dominated model uncertainty. We use dynamic programming framework together with measurable elections arguments to prove that under mild integrability assumption, an optimal portfolio exists for unbounded utility function defined on the half-real line. We revisit also the non-arbitrage condition in the robust framework.

2 March - Dirk Becherer (HU Berlin)

Stochastic illiquidity
In classical models from math. finance, dynamic trading strategies are executed against price processes which are exogenously given, and are not affected by the strategies. Economically, this means to assume that liquidity is unlimited or investors are 'small'. We discuss optimal control problems from mathematical finance in models for large investors, whose trading strategies have an intertemporal effect on the prices, against which they are executed. An original feature of the model, that we discuss, is that the transient price impact due to illiquidity in our model is stochastic and multiplicative, instead of being additive and deterministic (as a function of the strategy).

Joint work with Todor Bilarev, Peter Frentrup, HU Berlin, some related papers are on arxiv.

24 February - Agostino Capponi (Columbia)

Bail-ins and Bail-outs: Incentives, Connectivity, and Systemic Stability
We analyze the stability of an interbank network, in which rescues in the form of subsidized bail-ins or public bailouts can be coordinated to stop financial contagion. The coordination of a rescue consortium between a benevolent social planner and the banks is modeled as a sequential game. We show that the equilibrium welfare losses are generically unique, depending heavily on the network structure, which influences whether or not the social planner's threat to not intervene is credible. We provide conditions under which the threat is credible and characterize the optimal intervention plan.

Our analysis shows that sparsely connected networks may enhance financial stability in two ways: (i) a smaller amplification of the shock without intervention may enhance credibility of the social planner's threat and (ii) because default resolution costs are concentrated, the creditors of defaulting banks can be incentivized to make large contributions to a subsidized bail-in. This may make a sparsely connected network socially preferable over a more densely connected network, even if the densely connected network is financially more stable in the absence of any intervention.

Based on joint work with Benjamin Bernard and Joseph Stiglitz

16 February - Peter Johnson (Manchester)

Sequential Testing problems for Bessel Processes
Consider the motion of a Brownian particle that takes place either in a two-dimensional plane or in the three-dimensional space. Given that only the distance of the particle to the origin is being observed, the problem is to detect the true dimension as soon as possible and with minimal probabilities of the wrong terminal decisions. This talk will discuss the solution to this problem in the Bayesian formulation under any prior probability of the true dimension when the passage of time is penalised linearly.

This is nice example of tackling an optimal stopping problem for a 2-dimensional coupled Markov process. The solution uses a measure change, a stochastic time-change, Mayer and Lagrange reformulations, and allowing for negative initial times, which could help provide ideas for solving other 2-dimensional optimal stopping problems.

13 February - Zbyszek Palmowski (Wroclaw University of Science and Technology)

Ruin probabilities: exact and asymptotic results

Ruin theory concerns the study of stochastic processes that represent the time evolution of the surplus of a stylized non-life insurance company. The initial goal of early researchers of the field, Lundberg (1903) and Cramer (1930), was to determine the probability for the surplus to become negative. In those pioneer works, the authors show that the ruin probability decreases exponentially fast to zero with initial reserve tending to infinity when the net profit condition is satisfied and clam sizes are light-tailed.

During the lecture we explain when and why we can observe this phenomenon and discuss also the heavy-tailed case. We demonstrate main techniques and results related with the asymptotics of the ruin probabilities: Pollaczek-Khinchin formula, Lundberg bounds, change of measure, Wiener-Hopf factorization, principle of one big jump and theory of scale functions of Levy processes.

2 February - Julio Backhoff (TU Vienna)

Existence of extremal diffusions matching a continuum of marginal and applications

Given the law of a diffusion process, we consider the problem of adjusting its drift via change of measure in a cost-optimal way so as to meet a prescribed continuum of marginals. When the cost criterion is the relative entropy, the optimizer is a singular diffusion (the so called critical Nelson process), extensively studied in the literature typically through approximation or large deviation techniques. In this talk we will consider different optimality criteria, and using convex duality as well as stochastic control techniques, obtain the existence of a singular optimal diffusion. As an application, we will discuss the link between this problem and imperfect hedging with static portfolios.

This is work in progress with J. Fontbona.

19 January - Athena Picarelli (Oxford)

High-order filtered schemes for time-dependent second order HJB equations

In this work, we present and analyse a class of "filtered" numerical schemes for second order Hamilton-Jacobi-Bellman equations.

Our approach follows the ideas recently introduced in B.D. Froese and A.M. Oberman, "Convergent filtered schemes for the Monge-Ampère partial differential equation" (SIAM J. Numer. Anal., 2013) and more recently applied by other authors to stationary or time-dependent first order Hamilton-Jacobi equations.

For high order approximation schemes (where "high" stands for greater than one), the inevitable loss of monotonicity prevents the use of the classical theoretical results for convergence to viscosity solutions.

The work introduces a suitable local modification of these schemes by "filtering" them with a monotone scheme, such that they can be proven convergent and still show an overall high order behaviour for smooth enough solutions.

We give theoretical proofs of these claims and illustrate the behavior with numerical tests from mathematical finance, focusing also on the use of backward differencing formulae for constructing the high order schemes.

24 November - Aditi Dandapani (ETH Zurich)

Strict Local Martingales and Initial Expansions of Filtrations

Beginning with a non negative model following a stochastic differential equation with stochastic volatility, we show how a strict local martingale might arise from a true martingale as a result of an enlargement of the underlying filtration. More precisely, we implement a particular type of enlargement, an "initial expansion" of the filtration, for various kinds of stochastic differential equation models, and we provide sufficient conditions such that this expansion can turn a martingale into a strict local martingale. Applications of our work include the modeling and detection of financial bubbles. For example, one might postulate that a bubble arises as a result of the arrival of new information, which we can model via an enlargement of the filtration.

17 November - Martin Larsson (ETH Zurich)

Conditional infimum and recovery of monotone processes

Monotone processes, just like martingales, can often be reconstructed from their final values. Examples include the running maximum of supermartingales, of fractional Brownian motion, and more generally, running maxima and local times of sticky processes. An interesting corollary is that any positive local martingale can be reconstructed from its final value and its global maximum. These results are derived from a simple no-arbitrage principle for monotone processes on certain complete lattices, analogous to the fundamental theorem of asset pricing in mathematical finance. The framework of complete lattices is sufficiently general to handle also more exotic examples, such as the process of convex hulls of multidimensional diffusions,

and the process of sites visited by a random walk. The notion of conditional infimum is at the center of all of these results.

10 November - Paolo Guasoni (Dublin City)

Leveraged Funds: Robust Replication and Performance Evaluation
Leveraged and inverse exchange-traded funds and certificates seek daily returns equal to a multiple of an index' return. The trading costs implied by the frequent portfolio adjustments required create a tension between tracking error, which reflects short-term correlation with the index, and excess return, the long-term deviation from the leveraged index' performance. With proportional trading costs, the optimal replication policy is robust to the index' dynamics. Overall fund

performance depends on the implied spread, the product of tracking error and excess return, rescaled for leverage and volatility. The implied spread is insensitive to the risk premia and allows to compare funds tracking different factors of the same index.

27 October - Christoph Frei (Alberta)

Systemic Influences on Optimal Investment in Stocks and Credit Default Swaps
Recent events have shown that the dependence structure of financial markets is more complex than what is captured by classical models. For example, during the 2008 financial crisis, the financial instability of some companies spread out to affect other companies. The goal of this talk is to analyze how such systemic influences are reflected in optimal investment decisions. To this end, we introduce a model with dependence structure between market risk and default risk of the companies. An investor can use stocks and credit default swaps (CDSs) to participate in the market. We derive an explicit expression for the optimal investment strategy in stocks and CDSs. This allows us to analyze the mechanisms driving the optimal investment decisions. We then develop a novel calibration procedure so that we can fit the model to historical time series of stock and CDS data. An empirical analysis reveals the critical role of systemic risk in portfolio monitoring. This talk is based on joint work with Agostino Capponi (Columbia).

13 October - Frank Seifried (Trier)

Epstein-Zin Stochastic Differential Utility: Foundations, Properties, and Portfolio Optimization

This talk presents some recent contributions to the theory and applications of Epstein-Zin (EZ) stochastic differential utility.

First, we provide novel results on existence, uniqueness and concavity as well as a utility gradient inequality for EZ utility in a general semimartingale setting. In the second part, I would like to address consumption-portfolio choice with EZ utility.
We develop a new approach to solve such problems in a large class of incomplete market models, based on fixed point arguments and the associated FBSDE system. Finally, using an asymptotic analysis we show how small proportional transaction costs influence optimal consumption and investment decisions of an agent with EZ utility.