8^{th} European Summer School in Financial Mathematics

"Networks and interactions"

Dates : 31 August (Mon) – 4 September (Fri), 2015
Venue : Institut du Risque et de l'Assurance du Mans (Le Mans, France)

Young researchers talks

Tuesday 11.00 – 12.30

Randomized Strategies and Prospect Theory in a Dynamic Context - *Alex Tse* (University of Warwick)
Applying prospect theory (PT) in a dynamic context brings new challenges. We study PT agents facing optimal timing decisions and consider the impact of allowing them to follow randomized strategies. In the discrete model of casino gambling of Barberis (2012) we show that allowing randomization leads to gains in PT value. In the continuous analog (Ebert and Strack (2015)) we show that allowing randomization can significantly alter the predictions of the model. Ebert and Strack show that a naive investor never stops. We show that allowing PT agents to use randomized strategies leads to predictions which are closer to reality and include voluntary cessation of gambling. (This talk is based on a joint work with V. Henderson and D. Hobson.)

British Strangle Option - *Shi Qiu* (University of Manchester)
We present a new strangle options in British style where the holder enjoys the early exercise feature of American options on its payoff is the 'best prediction' of the European payoff under the hypothesis that the true drift of the stock price equals a contract drift. For underlying asset with high volatility, investor can construct 'traditional' British strangle options (buying the British call and put options) to make profit. However, as contract drift closed to risk free interest r, it is optimal to exercise both of them immediately. To solve this problem, we design the British strangle option for underlying asset with high fluctuation. Change-of-variable will be applied to get the closed form expression for the arbitrage-free price. By the financial analysis of the British strangle option, we shows that with contract drift properly selected the British strangle option become attractive alternative to the classic American strangle option.

Hedging with transient price impact - *Moritz Voss* (TU Berlin)
We consider the problem of hedging a European contingent claim in the Bachelier model with transient price impact 'a la Almgren and Chriss (2000). Following Rogers and Singh (2010) the hedging problem can be regarded as a cost optimal tracking problem of the frictionless hedging

strategy. We solve this problem explicitly for general target strategies. It turns out that the optimal policy trades towards a weighted average of expected future target positions generalizing an insight from Garleanu and Pedersen (2014) from their homogenous Markovian optimal investment problem to a general hedging problem. This result complements a number of previous studies and sheds further light on the general structure of optimal tracking strategies in illiquid financial markets. This is joint work with Peter Bank and H. Mete Soner.

Wednesday 9.00 – 10.30

Optimal martingale transport in higher dimension - *Tongseok Lim* (University of British Columbia)
Optimal martingale transport theory concerns optimal transport problems where there is martingale constraint on the transportation plans. We explain the basic problem, comparing it with optimal transport without the constraint. Then we explain some recent progress.

Complements on the Pathwise Functional Ito calculus with applications to Mathematical Finance - *Iryna Voloshchenko* (University of Mannheim)
Recently, there has been increased interest in the strictly pathwise Föllmer's Ito calculus, because it allows to handle Knightian uncertainty. Mathematically speaking, we derive the associativity property of the pathwise Ito integral in a functional setting, which then allows us to establish existence and uniqueness results for functional linear Ito differential equations. On one hand, the functional associativity is a result of independent interest. On the other hand, it allows for a series of financial applications. For instance, we show that Stochastic Portfolio Theory, especially the Master formula, and its functional extension works in Föllmers's strictly pathwise setting. Our results are robust, in the sense that they are not subject to model risk. Since we use only Real Analysis techniques, they are not a "by-product" of the classical stochastic integration theory.

Robust Portfolio Optimisation with Uncertainty in the Covariance Matrix - *Gonçalo Simoes* (Univ of Oxford)
Estimation errors of the first moment of returns have been the focus of Robust Portfolio Optimisation, mainly due to its massive impact on the resulting optimal portfolio. While the covariance matrix has often been regarded as constant, market participants are aware that different covariance structures arise when market conditions change. In this talk we will have a look at how one can invest in the presence of uncertainty in the covariance matrix, in particular when one is compared against multiple benchmarks.

Thursday 11.00 – 12.30

A Practical Approach to Financial Crisis Indicators Based on Random Matrices - *Antoine Kornprobst* (Université Paris 1 Sorbonne)
The aim of this work is to build financial crisis indicators based on market data time series. After

choosing an optimal size for a rolling window, the market data is seen every trading day as a random matrix from which a covariance and correlation matrix is obtained. Our indicators deal with the spectral properties of these covariance and correlation matrices. Our basic financial intuition is that correlation and volatility are like the heartbeat of the financial market : when correlations between asset prices increase or develop abnormal patterns, when volatility starts to increase, then a crisis event might be around the corner. Our indicators will be mainly of two types. The first one is based on the Hellinger distance, computed between the distribution of the eigenvalues of the empirical covariance matrix and the distribution of the eigenvalues of a reference covariance matrix. As reference distributions we will use the theoretical Marchenko Pastur distribution and, mainly, simulated ones using a random matrix of the same size as the empirical rolling matrix and constituted of Gaussian or Student-t coefficients with some simulated correlations. The idea behind this first type of indicators is that when the empirical distribution of the spectrum of the covariance matrix is deviating from the reference in the sense of Hellinger, then a crisis may be forthcoming. The second type of indicators is based on the study of the spectral radius and the trace of the covariance and correlation matrices as a mean to directly study the volatility and correlations inside the market. The idea behind the second type of indicators is the fact that large eigenvalues are a sign of dynamic instability.

Regime switching model for financial data : empirical risk analysis - *Khaled Salhi* (Université de Lorraine et INRIA)
We construct a regime switching model for the univariate Value-at-Risk estimation. Extreme value theory (EVT) and hidden Markov models (HMM) are combined to estimate a hybrid model that takes volatility clustering into account. In the first stage, HMM is used to classify data in crisis and steady periods, while in the second stage, EVT is applied to the previously classified data to rub out the delay between regime switching and their detection. This new model is applied to prices of numerous stocks exchanged on NYSE Euronext Paris over the period 2001-2011. We focus on daily returns for which calibration has to be done on a small dataset. The relative performance of the regime switching model is benchmarked against other well-known modeling techniques, such as stable, power laws and GARCH models. The empirical results show that the regime switching model increases predictive performance of financial forecasting according to the number of violations and tail-loss tests. This suggests that the regime switching model is a robust forecasting variant of power laws model while remaining practical to implement the Value-at-Risk measurement.

Hawkes and integer-valued autoregressive (INAR) processes - *Matthias Kirchner* (ETH Zurich)
In this talk, we show that Hawkes processes are continuous-time versions of INAR processes and that INAR processes are discrete-time versions of Hawkes processes. More specifically, given a Hawkes process N, we construct an INAR-based sequence of point processes and establish its convergence to N. As a consequence, we may approximate the distribution of the bin-count sequence of a Hawkes process with the distribution of specific INAR time series. This time series view on point processes is very fertile : we propose possible applications. In particular, our approach yields a simple nonparametric estimation method for multivariate Hawkes processes.

Friday 11.00 – 12.30

Pricing and Calibration in Local Volatility Models via Fast Quantization - *Lucio Fiorin* (Università di Padova)
In this paper we propose the first calibration exercise based on quantization methods. Pricing and calibration are typically difficult tasks to accomplish : pricing should be fast and accurate, otherwise calibration cannot be performed efficiently. We apply in a local volatility context the recursive marginal quantization methodology to the pricing of vanilla and barrier options. A successful calibration of the Quadratic Normal Volatility model is performed in order to show the potentiality of the method in a concrete example, while a numerical exercise on barrier options shows that quantization overcomes Monte-Carlo methods.

A short rate for the multiple curve affine LIBOR model and application to CVA - *Robert Wardenga* (TU Dresden)
We present an extension of the recently developed Affine-LIBOR Models to continuous tenor, introducing the corresponding interpolating function, which enables us to derive a representation for the forward rate in terms of an affine transformation of the driving process. Under certain conditions on the original Affine LIBOR model, an interpolating function is constructed such that the extended model fits any initail forward curve. Further, we show that under a change to the spot measure implied by the forward rate, the affine structure is preserved. Finally, we apply our results to consistently compute the CVA and other adjustments for interest rate derivatives, in a post crisis setup. (This is joint work with A. Papapantoleon)

Utility maximization with random horizon : a BSDE approach - *Thibaut Mastrolia* (Université Paris Dauphine)
We study a utility maximization problem with random horizon and reduce it to the analysis of a specific BSDE, which we call BSDE with singular coefficients, when the support of the default time is assumed to be bounded. We prove existence and uniqueness of the solution for the equation under interest. Our results are illustrated by numerical simulations. This is a joint work with Monique Jeanblanc, Dylan Possamaï and Anthony Réveillac.