Zürich Spring School on Lévy Processes

Poster abstracts

31 March 2015

Akhlaque Ahmad

Option Pricing Using Fourier Transforms: An Integrated Approach

In this paper, we model stochastic volatility using three stochastic processes Ornstein-Uhlenbeck (OU) process, Square Root (SR) process and Double Square Root (DSR) process. In similar manner, we model stochastic interest rate utilizing above mentioned three stochastic processes. To capture large and small events in the market, we model jumps in stock prices using Poisson process (Simple Jump process and Lognormal Jump process) and Levy process (Normal Inverse Gaus- sian process and Variance Gamma process). We treat stochastic volatility, stochas- tic interest rate, Poisson Jumps and Levy Jumps as a factors affecting option premiums. We derive characteristic functions ($\phi 1$ and $\phi 2$) of each specification of the every factor and obtain combined characteristic functions using multiplicative property. We use Inverse Fourier transform to estimate the option prob- abilities F1 and F2 and calculate call option prices for each model. We observe significant corrections in option prices produced by integrated models and these models produces higher prices for ITM call options and Lower prices for OTM call options in comparison of Black Scholes Model and generate a down sloping smile. To estimate model parameters, we utilized daily data of India VIX, Mibor and CNX-Nify for volatility, interest rate and stock prices respectively.

Matyas Barczy

Parameter estimation for Heston models

First, we study asymptotic properties of maximum likelihood estimators for Heston models based on continuous time observations of the log-price process. We distinguish three cases: subcritical (also called ergodic), critical and supercritical. In the subcritical case, asymptotic normality is proved for all the parameters, while in the critical and supercritical cases, non-standard asymptotic behavior is described.

Next, we study asymptotic properties of some parameter estimators for subcritical Heston models based on discrete time observations derived from conditional least squares estimators of some modified parameters.

References:

[1] M. Barczy, G. Pap: Asymptotic properties of maximum likelihood estimators for Heston models based on continuous time observations. ArXiv 1310.4783

[2] M. Barczy, G. Pap, T. T. Szabo: Parameter estimation for subcritical Heston models based on discrete time observations. ArXiv 1403.0527

Kamil Bogus

Green function of hyperbolic Brownian motion

The most well known examples of Lévy processes are Brownian motions. In this presentation we consider Brownian motion on hyperbolic space (called hyperbolic Brownian motion). We obtain representation formulas for the lambda-Green function of the interior of the horocycle for the hyperbolic Brownian motion. Moreover, using results from [1] we derive sharp two-sided estimates of these lambda-Green function, which will be published in the forthcoming paper [2].

Reference:

[1] K. Bogus, J. Małecki "Sharp Estimates of Transition Probability Density for Bessel Process in Half-Line", Potential Analysis (2015) DOI 10.1007/s11118-015-9461-x

[2] K. Bogus, T. Byczkowski, J. Małecki "Sharp estimates of Green function of Hyperbolic Brownian Motion", preprint (2015)

Xuecan Cui

EQUILIBRIUM ASSET AND OPTION PRICING UNDER JUMP DIFFUSION WITH TIME DEPENDENT PARAMETERS

We develop an equilibrium and option pricing model in a production economy driven by Levy processes with time dependent parameters. We will provide analytical formulas for the equity premium of a representative investor with constant relative risk aversion utility function and for the contribution of the skewness of index returns to the equity premium. Moreover, we will compute the pricing kernel. We then estimate our model with the S&P 500 index from 1985 to 2005 and compare the results to the one obtained by the most important other option pricing models with underlying Levy processes that can be found in the financial literature.

Tobias Fissler

Testing the maximal rank of the volatility process for continuous diffusions observed with noise

We present a test for the maximal rank of the volatility process in continuous diffusion models observed with noise. Such models are typically applied in mathematical finance, where latent price processes are corrupted by microstructure noise at ultra high frequencies. Using high frequency observations we construct a test statistic for the maximal rank of the time varying stochastic volatility process. Our methodology is based upon a combination of a matrix perturbation approach and pre-averaging. We show the asymptotic mixed normality of the test statistic and obtain a consistent testing procedure.

Jevgenijs Ivanovs

SPARRE-ANDERSEN IDENTITY: THERE IS MORE TO IT

It is shown that the celebrated result of Sparre Andersen for random walks and Lévy processes has intriguing consequences when the last time of the process in the negative half-line is added to the picture. In the case of no positive jumps this leads to six random times, all of which have the same distribution.

Yupeng Jiang

Real-Time Risk Management: An AAD-PDE Approach

We apply adjoint algorithmic differentiation (AAD) along with PDE methods to manage the risk exposures associated with holding derivative securities. With simple examples, we show how AAD can be applied to both forward and reverse PDEs in a straightforward manner. In particular, in the context of a one-factor default intensity model, we show how one can compute price sensitivities more accurately and much faster than with standard finite-difference methods by combining (i) the adjoint of a forward PDE solver for calibrating the parameters of the intensity model, (ii) the adjoint of a backward PDE solver for pricing the derivative security, and (iii) the implicit function theorem.

Tomasz Juszczyszyn

Estimates of hitting times of points for symmetric Lévy processes with completely monotone jumps

I will present small-space and large-time estimates and asymptotic expansion of the distribution function and the density function of hitting times of points for some symmetric Lévy processes. More precisely, we assume that the Lévy measure has completely monotone density function, and we impose a scaling-type condition on the Lévy-Khintchine exponent. Proofs are based on generalised eigenfunction expansion for processes killed upon hitting the origin. These results originate in my joint paper with Mateusz Kwaśnicki.

Sri Krishnamurthy

Levy processes in Credit Risk

A tour on how levy processes are used in credit risk applications with a sample case study to illustrate results.

Balazs Nyul

Statistical examinations in forward interest rate models

J. Gáll, Gy. Pap and M. V. Zuijlen described a special interest rate model and introduce a new type of Heath-Jarrow-Morton forward interest rate model. In this model we give the no-arbitrage criteria and we estimate parameters of the model (for example volatility) on special samples by maximum likelihood estimation. Finally we observe the asymptotic behaviour of the maximum likelihood estimator in each cases.

Sandra Palau Calderon

Continuous state branching processes in a Brownian random environment.

The present model generalizes the recent paper by Boinghoff and Hutzenthaler, in which they studied the case when the continuous state branching process is the Feller-diffusion. In particular, we study different aspects of this type of process as: probability of extinction or their conditioned version at survival. Special attention is given to the self-similar case.

References

1. Boinghoff, C. and Hutzenthaler, C. (2012). Branching diffusions in random environment. Markov Process and Related Fields, 18, 269-310.

2. Fu, Z. and Li, Z. (2010). Stochastic equations of non-negative processes with jumps. Stochastic Processes and Their Applications, 120, 306-330.

3. Hutzenthaler, M. (2011). Supercritical branching diffusions in random environment. Electronic Communications in Probablity, 16, 781-791.

Vytaute Pilipauskaite

Joint aggregation of random-coefficient AR(1) processes

We study joint temporal and contemporaneous aggregation of random-coefficient AR(1) processes driven by either idiosyncratic or common i.i.d. innovations, when the autoregressive coefficients are i.i.d. r.v.'s that have a probability density regularly varying at $a = 1$ with exponent either $-1 < \beta < 1$ or $-1/2 < \beta < 0$. Different limiting distributions of normalized aggregated partial sums are shown to exist when number of processes N and time scale n increase to infinity simultaneously so that $N^{1/(1+\beta)}/n$ tends to (i) ∞, (ii) 0, (iii) $0 < \mu < \infty$. The new limit process arising under (iii) enjoys 'intermediate' properties between fractional Brownian motion limit in (i) and Brownian motion with random variance in (ii). It is a joint work with Donatas Surgailis (Vilnius University).

Davide Tedeschini

Evaluating models jointly with economic and statistical criteria

We introduce a new criterion for estimation of models used in finance, which explicitly incorporates the models' ability to provide signals for trading strategies. An out-of-sample analysis reveals that an investor using this estimator may enjoy significant excess returns over a competitor who employs purely statistical criteria such as GMM or ML.

Juozas Vaicenavicius

Bayesian sequential testing of the drift of a Brownian motion

We study a Bayesian statistics problem of sequentially testing the sign of the drift of an arithmetic Brownian motion for a general prior distribution; a classical framework of the '0-1' loss function and a constant cost of observation per unit of time is used. The statistical problem is reformulated as an optimal stopping problem with the current conditional probability that the drift is non-negative as the underlying process. We prove monotonicity and continuity of the optimal stopping boundaries as well as characterise them in the finite-horizon case as the unique continuous solution to a pair of integral equations. In the infinite-horizon case, the boundaries are shown to solve another pair of integral equations and a convergent approximation scheme for the boundaries together with the long-term asymptotes is provided. Joint work with E. Ekström.