Bachelier Finance Society: Mathematical Finance

Organizer: Peter K. Friz (*TU and WIAS Berlin, DE)*

Thursday, July 5, 16:15–18:15, Small Hall

Talks:

Jan Obloj (*Oxford University, UK*), Coauthors: Sergey Nadtochiy, **Robust hedging with beliefs**

Stefan Gerhold (*TU Vienna, AT*), Coauthors: P. Friz and S. De Marco, **Extrapolation analytics for Dupire's local volatility**

Mike Tehranchi (*Cambridge University, UK*), Coauthors: Arun Thillaisundaram, **Put-call symmetry and self-duality**

Peter K. Friz (*TU and WIAS Berlin, DE*), Coauthors: J.-D. Deuschel, A. Jacquier and S. Violante, **Generalized sub-Riemannian cut loci and volatility smiles**

Robust hedging with beliefs

Jan Obloj
Oxford University, UK

We give an overview of the proposed new robust framework for pricing and hedging derivatives which incorporates model uncertainty with coherent use of market data. The modelling starts with no probability measure. Instead market information (e.g. option prices) are combined with beliefs about possible paths. The latter could be based on statistical information (time series of past data) and include both beliefs about the asset as well as derivatives on it. As a result, we aim to find a hedging strategy for a given derivative contract using the available hedging instruments, so that it succeeds in any model as long as certain observed market indicators stay within a prescribed range (i.e. our beliefs are fulfilled). More specifically, we will concentrate on the problem of static hedging of barrier options with the European ones, given beliefs about the range of market implied volatility. We will identify a dense family of models in which the exact static hedge of a given barrier option does exist (and can be efficiently computed numerically) and which can serve as the "extreme" models in building the robust sub- and super-replicating strategies. Joint work with Sergey Nadtochiy (University of Oxford).

Coauthors: Sergey Nadtochiy

Extrapolation analytics for Dupire's local volatility

Stefan Gerhold
TU Vienna, AT

A robust implementation of a Dupire type local volatility model is an important issue for every option trading floor. Typically, this (inverse) problem is solved in a two step procedure :
(i) a smooth parametrization of the implied volatility surface;
(ii) computation of the local volatility based on the resulting call price surface. Point (i), and in particular how to extrapolate the implied volatility in extreme strike regimes not seen in the market, has been the subject of numerous articles, starting with Lee (Math. Finance, 2004). In the present paper we give direct analytic insights into the asymptotic behavior of local volatility at extreme strikes. (Joint work with P. Friz and S. De Marco)

Coauthors: P. Friz and S. De Marco

Put-call symmetry and self-duality

Mike Tehranchi
Cambridge University, UK

We discuss generalisations of the notions of put-call symmetry and self-duality. These notions have found applications in the pricing and hedging of certain path-dependent contingent claims. Our results include a classification of the possible forms of self-duality in one-dimension: in addition to the arithmetic and geometric duality already appearing the literature, there exists exactly one other type among continuous models. We also give a description of the possible forms of put-call symmetry for common models: in dimension greater than two, interesting new symmetries appear. (Joint work with Arun Thillaisundaram.)

Coauthors: Arun Thillaisundaram

Generalized sub-Riemannian cut loci and volatility smiles

Peter K. Friz
TU and WIAS Berlin, DE

Density expansions for hypoelliptic diffusions $(X^1, ..., X^d)$ are revisited. In particular, we are interested in density expansions of the projection $(X_T^1, ..., X_T^l)$, at fixed time $T > 0$, with $l \leq d$. ("Marginal density expansions") Global conditions are found which replace the well-known "not-in-cutlocus" condition known from heat-kernel asymptotics (Molchanov, Bismut, Ben Arous, ...). Our small noise expansion allows for a "second order" exponential factor, not present in small time expansions. Applications include tail and implied/local volatility asymptotics in some correlated stochastic volatility models. In particular, we are able to analyze the Stein–Stein model in case of negative correlation (the typical case in equity markets), thereby solving a problem left open by A. Gulisashvili and E.M. Stein. (Joint work with J.-D. Deuschel, A. Jacquier and S. Violante).

Coauthors: J.-D. Deuschel, A. Jacquier and S. Violante