ADVANCED DERIVATIVES (MFE), FALL 2016

Professor:
Anders B. Trolle, anders.trolle@epfl.ch. Office: Extranef 216.

Lectures: Mondays, 9h15-11h in BS 260.

Assistant:
Yuan Zhang, yuan.zhang@epfl.ch. Office: Extranef 129.

Exercise session: Thursdays, 15h15-16h in Extranef 126.

When meeting with Yuan outside of the exercise session, please write him an email before to fix an appointment and indicate the nature of your question. Always include MFE in the subject line of emails.

Content:
The course covers a list of advanced topics in derivative securities such as local volatility, stochastic volatility, jumps, pricing of standard put and call options by Fourier inversion techniques, numerical methods including finite difference methods and pricing of American-style options by simulation, exotic derivatives, structured products, volatility derivatives, and term structure modeling with unspanned stochastic volatility.

Prerequisites:
Students must have taken basic derivatives and stochastic calculus courses. There will be an emphasis on implementation of models and numerical methods. Therefore, the course requires familiarity with a software package that can be used for numerical computation. I prefer MATLAB, and I will present and distribute various MATLAB programs as we go along. However, students are free to use any software package they prefer.

Course material:
The main textbook for the course is: Jim Gatheral, The Volatility Surface, Wiley, 2006.

The first printing of the book contained quite a few typos, a list of which is available here: http://faculty.baruch.cuny.edu/jgatheral/BookErratum.pdf.
I believe the second printing of the book corrects most of these typos.

In addition, I will use a number of journal articles, which will be posted on the course website. I will also make slides and sample MATLAB programs available on the course website.

Class participation and seating arrangements:
Class participation and discussion are essential to learning. Participation in the class will not be explicitly graded, but I will keep track of who participates and who doesn’t, and this information will be used in determining grades in the borderline cases. To help me keep track of who you are, I would like you to sit in the same seat each class. Please choose your preferred seat during the second class session.
**Requirements and grading:**
There will be weekly mandatory assignments, which can be done in groups of up to four people. Two types of assignments are given: 1) Practical assignments that involve implementing models and methods covered in class 2) Theoretical assignments that will help you understand the material and prepare for the final exam. No late assignments will be accepted.

There will also be a final exam, which is closed-book, closed-notes. However, you are permitted to bring a calculator.

In calculating the grade for the course, the combined weight on assignments given during the course will be 40%, and the weight on the final exam will be 60%.

**Course website:**

**Preliminary course outline:**

---

**Lecture 1: Equity derivatives**
Properties of asset returns, implied volatility surfaces, the general stochastic volatility setting

Readings: [The Volatility Surface](http://example.com) chapter 1 (p. 1-7)

---

**Lecture 2: Equity derivatives (cont.)**
The Heston model, calibration to volatility surfaces

Readings: [The Volatility Surface](http://example.com) chapters 2 and 3 (p. 36-42), Heston (1993) *A Closed-Form Solution for Options with Stochastic Volatility with Applications to Bond and Currency Options*, and Mikhailov and Nogel (2003) *Heston's Stochastic Volatility Model Implementation, Calibration and Some Extensions*

---

**Lecture 3: Equity derivatives (cont.)**
Adding jumps, the Merton and Bates models

Readings: [The Volatility Surface](http://example.com), chapter 5

---

**Lecture 4: Equity derivatives (cont.)**
The Carr-Madan approach to pricing, the Fast Fourier Transform, the empirical performance of stochastic volatility jump diffusion models, the SABR model

Lecture 5: *Equity derivatives (cont.)*
Local volatility and implied binomial trees.

Readings: *The Volatility Surface* chapter 1 (p. 7-14) and 7 (p. 89-94), Derman and Kani (1994) *The Volatility Smile and its Implied Tree*

---

Lecture 6: *Numerical procedures*
Pricing derivatives by simulation


---

Lecture 7: *Numerical procedures (cont.)*
Pricing American-style derivatives by simulation


---

Lecture 8: *Numerical procedures (cont.)*
Finite difference methods


---

Lecture 9: *Exotic equity derivatives*
Structured products, forward starting options, cliquets, reverse cliquets, Napoleons, model risk

Readings: *The Volatility Surface* chapter 10

---

Lecture 10: *Volatility derivatives*
Variance swaps, volatility swaps, options on variance, VIX derivatives, the volatility risk premium

Readings: *The Volatility Surface* chapter 11 and Carr and Wu (2009) *Variance Risk Premia*

---

Lecture 11: *Interest rate derivatives*
Unspanned stochastic volatility, pricing of caps and swaptions

Lecture 12: Commodity and energy derivatives
The convenience yield, unspanned stochastic volatility, pricing of futures and options, real options


Final exam in class