Continuous Time Asset Pricing
IEOR E4707
Spring 2015
Department of Industrial Engineering and Operations Research, Columbia University,
Time: Monday and Wednesday, 11:40-12:55,
Where: Math 203

Instructor: Dr. Agostino Capponi, Office Hours: Tuesday, 11-12, Mudd 316, Email: ac3827@columbia.edu

Teaching Assistant: Jing Guo, Email: jg3222@columbia.edu
Office Hours: Monday, 5-6, Mudd 323
Recitation: Monday, 4-5 and Friday, 5-6 in Mudd 1127.

Course Assistant: Matthieu Barbiery, Email:mab2345@columbia.edu.

Email Communication with Instructor and Teaching Assistants: When emailing the instructor or TAs, please make the subject of the email the following – “IEOR E4707, YOUR LAST NAME, ISSUE”. This will be beneficial for tracking email communications. Please include the issue in the subject (e.g., Homework Problem Question). Additionally, your email should follow good business letter writing principles. You can find more about business letter writing from the Columbia Writing Center at http://www.college.columbia.edu/core/uwp/writing-center. The email should have a salutation, appropriate grammar, correct spelling and capitalization, a clear description of the question or issue, and your full name.

Prerequisite: The prerequisite for this class are

Some elementary exposure to partial differential equations can be helpful, but not mandatory. Knowledge of some programming language, such as Mathematica, Matlab or R can be useful.

Teaching facilities: I will use the classroom blackboard to explain to the class.

Textbook: The main textbook is

• Stochastic Calculus for Finance II: Continuous-Time Models, by S. Shreve.

Another excellent textbook resource is:

• Introduction to the Economics and Mathematics of Financial Markets (MIT Press), by Jaksa Cvitanic and Fernando Zapatero

However, I will write my lecture notes taking material from several sources. When using external material and research papers, I will make them available to the class.

Course Objectives: Continuous Time Asset Pricing lies at the heart of the modern theory of financial engineering

We will distinguish between complete markets, in which there is a unique no-arbitrage price, and incomplete markets, where absence of arbitrage is not sufficient to obtain uniqueness of prices. We will focus mostly on the framework of Brownian Motion driven models. The benchmark model will be the Black-Scholes-Merton pricing model, but we will also cover more general models, such as local and stochastic volatility models. We will discuss both the Partial Differential Equations approach, and the Martingale approach. They are related through the notion of the Feynman-Kac theorem. We will also discuss optimal portfolio investment in the above mentioned models, and discuss relationship to pricing and risk management.

Homework Assignments: There will be biweekly homework assignments that will test you on class material. Students are encouraged to collaborate with each other, but each student must complete and submit his/her homework individually. Copying homework solutions from other students will not be tolerated and considered as cheating. Make sure all pages of the assignments are stapled together. Late assignments will not be accepted. Homework solutions will be usually posted the day after the homework is due.
**Recitations:** Jing Guo will hold one recitation lecture the day before the homework is due, and one recitation lecture the day after the homework is due. The objective of the “pre-homework” recitation lecture is to go over the material tested on the homework and clarify concepts so to put students into the best conditions to successfully solve the problems. The objective of the “post-homework” recitation lecture is to discuss the most important points of the homework with students and answer any question related to the problem set.

**Exams:** There will be one midterm exam on March 11, 2015, and one final exam on May 8, 2015. Both exams will be closed book although a formula sheet will be provided. The final exam will be comprehensive and include all material covered in the class. The final exam will be held in Math 203 from 9am to 12pm.

**Weights**

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<tr>
<td>Homework</td>
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<td>Midterm</td>
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**Attendance Policy:** Attendance of each lecture is mandatory.

**Grading:** The final grade will be based on the total number of points earned during the semester. If you earn 89% of the available (weighted points) you are guaranteed at least an A-, 79% guarantees at least a B-, 69% guarantees at least a C-, etc… However, the final scores might be adjusted at the discretion of the course instructor and will also depend on the overall performance of the class.

**Course Topics:** We will cover the below mentioned course topics:

- Arbitrage-Free pricing and equivalent martingale measures.
- Option pricing: currency options, quanto options, lookback options, barrier options, Asian options.
- Change of Numeraire Technique.
- Local Volatility Formula.
- CEV model, Stochastic Volatility Models, Heston Model
- Dynamic Portfolio Optimization: Hamiltonian-Jacobi-Bellman equation, optimal strategies

Time allowing, we will also discuss the current hot trends in the academic and financial industry:

- Counterparty Risk, Funding Risk and Clearinghouses.
- Systemic Risk: network perspective and balance sheet contagion.