Derivative Pricing

Course Basic Information:

- Instructor: Lei (Jack) Sun

- Office: PHBS New Building 755

- Internal: (2603)3007

- Email: sunlei@phbs.pku.edu.cn

- Course Time: Tuesday & Friday 1:30-3:20 pm

- Location: TBD

- Office Hours: TBD (2 hours per week)

Course Objectives:

The goal of this course is to help students understand the valuation of a basic derivative - various options in financial markets, including European option, American option, barrier option, lookback option and etc. After the training, students are supposed to be capable of deriving analytical solutions for some basic type options. They are also expected to grasp numerical tools for derivative pricing, including monte carlo method, finite difference method, and etc. Programming skills (Matlab) are necessary and hence will be trained throughout this course.

Course Contents:

- Brownian Motion/Wiener Process, Ito Process, Geometric Brownian Motion, Continuous Time Model (Week 1)

- Binomial Distribution and Its Convergence to Continuous Time Model (Week 1)

- Risk Neutral Probability, Real World Probability, Pricing Contingent Claims (Week 2)

- The Black-Scholes Framework, Introduction to Options, Put-Call Parity, Option Bounds,

Convexity of the Payoffs (Week 2)

- Ito's lemma, Girsanov's Theorem, Radon-Nikodym Theorem, Martingale, Q Measure (Week 3)

- Black-Scholes Formula, BS PDE, Greeks, Delta Hedging (Week 3-4)

- Black-Scholes Model with Dividends, Cost of Carry, Garman-Kohlhagen (1983) Formula, Black's Formula (Week 4)

- Binomial Model, No Arbitrage, Complete Market, Arrow-Debreu Security, Its Application in American Option, Stopping Time, Early Exercise Boundary (Week 5)

- A Short Note on 'Cost of Carry' (Week 5)

- Barone-Adesi&Whaley (1987) Quadratic Approximation for American Option (Week 6)

- Finite Difference Method: Explicit/Implicit/Crank-Nicolson, the 'Log Transform' for American Option (Week 7)

- Monte Carlo Simulation and Least Square Monte Carlo Simulation for American Option (Week 7)

- Random Tree Simulation for American Option (Week 8)

- Analytical Solution to Lookback Option and Barrier Option Pricing, the Reflection Principle (Week 8)

- **Optiona**l: Estimation of Risk Neutral Probability from Option Data

Recommended Textbooks and Papers:

1: *Arbitrage Theory in Continuous Time,* by Thomas Bjork, Oxford University Press, 1998.

2: *Financial Calculus: An Introduction to Derivative Pricing*, by Baxter and Rennie, Cambridge University Press, 1996.

3: *Stochastic Calculus for Finance I: The Binomial Asset Pricing Model*, by Steven E. Shreve, Springer, 2004.

4: *Stochastic Calculus for Finance II: Continuous-Time Models*, by Steven E. Shreve, Springer, 2004.

5: *Options Futures and Other Derivatives*, by John Hull, Prentice Hall, 1993.

Recommended papers will be provided in lecture notes. My take is to focus on lecture notes, while treat these recommended textbooks as supplementary readings.

Grading:

Assignment: 30%

It is a group work and each group consists of 3-4 students subject to the class size. Group members are assigned randomly (I will do that). The assignment will be distributed by the end of week 5 and will be collected at the beginning of week 9. In week 9, each group will make a presentation for their assignment. The presentation should not exceed 25 minutes, including 5 minutes' Q&A. Active participation, which refers to asking and answering questions in the presentation, is appreciated. Grades are given based on both the assignment (10%) and the presentation (20%). All group members within one group will get the same score.

Please report 'free rider' problems to me as early as possible and I will investigate the fact.

Midterm Exam: 30%

It will be held at the first lecture in week 6, lasting for 90 minutes. The scope of the exam includes all the material taught by the end of week 5 (10 lectures).

Final Exam: 40%

It will be held at the end of this semester, lasting for 2 hours. It covers all the contents in this course, including the assignment.

If you anticipate any conflicts with the exam dates, please inform me as early as possible **before the exam**. I do not accept travel plans, job/internship interviews as a legitimate reason. For other conflicts with sufficient evidence, we can discuss them case by case.

Other Issues

1: Plagiarism: The penalties for any form of cheating or plagiarism are **severe**. Plagiarized written work will not be accepted and might, in some cases, lead to **failure** of the whole group in this

course.

2: Contacts: Please register your **correct** email when enrolling for this course as this is the main channel we contact each other throughout this course. Please check your email **daily** when it is possible. Treat these requirements as your own responsibility.

2: Discipline: I do not require attendance. But I strong encourage your appearance in class, as questions examined, both in the midterm or the final, are mostly likely to be those I emphasize in lectures. Besides, if you decide to come, show your respect to both the instructor and your peers. Make sure to come to class **on time** and not leave early. Switch off your mobile or at least keep it **quiet** during class.