Jacobs University
Fall 2022

December 4, 2022

Stochastic Methods Lab

Take-Home Exam

Due on December 23, 2022

Note: The deadline for uploading this take-home exam on git is anytime before December 23, 23:59. Extensions are only granted if you have been sick (confirmed by a doctor's note) for more than 4 days in between Dec. 4 and Dec. 23. Please also be reminded of Academic Integrity. This includes clearly stating all your sources. You are allowed to use your own code from previous homework submissions, but copying code from somebody else is not allowed. By submitting the project, you certify that you have worked on the project by yourself!

Problem 1

Choose a stock for which you can find recent time series data as well as quotes on European call or put options for different parameters. (For the option quotes, choose at least two reasonably different maturities, and 30 different strike prices for each maturity.)

(a) Analyze the time series: How good is the assumption of normally and independently distributed log-returns? Estimate the volatility of the stock. Comment on the results.

(b) Determine a suitable risk-free interest rate for pricing the options for which you found quotes. (Note: A very rough interpolation, if necessary, will suffice.)

(c) Price the options with an algorithm of your choice for all maturities and strike prices for which you can find data to compare, and compare with the data. Discuss your result, and possibly explain deviations.

(d) List all methods for finding option prices that were discussed in class. In very brief bullet points, list advantages and disadvantages that were discussed in class of the different methods. (This is a theoretical exercise and should be written as comment in the source code.)

Your submission should contain a discussion of the choices you made and of the results (e.g., as comments in the code). Submit the Python code as a single runnable .py file along with all input data files in csv format.

Problem 2

Write a short summary of the following topic *in your own words* based on the references provided. The maximum length is one A4 page. Focus on the important points, and explain where exactly it connects to the class content. The topic you work on depends on the first letter of your last name:

A-B Options on Dividend Paying Stocks (Lyuu, Chapter 9.6)

C-K Traversing the Tree Diagonally (Lyuu, Chapter 9.7)

L-O The Vasicek Model (Provide a brief overview on what the model is, what properties it has, and what it is used for.) (Lyuu Chapter 25.1 and Hull "The Vasicek Model" in Chapter 31.2)

P-R The Cox-Ingersoll-Ross Model (Provide a brief overview on what the model is, what properties it has, and what it is used for.) (Lyuu Chapter 25.2 and Hull "The Cox, Ingersoll, and Ross Model" in Chapter 31.2)

S-Z Sensitivity Measures ("The Greeks") (Explain what sensitivity measures there are, how they can be computed and what their properties are.) (Lyuu Chapter 10.1)

In the grading, the different levels of difficulty will be taken into account.