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Fall 2020

Financial Engineering

Final Term Project

- Due date is Monday (99/10/15) midnight at 23:55.
- You should upload a file in CW, the names of which should be in the format of "FE-Project-Student Number". If you also have an excel file compress both files and send a .zip or .rar file named with aforementioned format. Note that the only accepted format for your assignments is word or pdf, and any handwritten reports should be delivered in these formats.
- Score Reduction Policy:
  You are allowed a maximum of 7 days delay (in total) for the submission of all your assignments and your project. Note that the delay will be calculated "daily", not hourly (meaning that a 5-minute delay for a given assignment will be considered as 1 day).
- For the questions needing Excel (if any), also copy the tables of final answers (if it is not too big) in the Word/pdf file as well. Therefore, the Word/pdf file will have everything for all questions but the calculations will be in Excel. In other words, the Word file should be a standalone file.
- Personal integrity is the key to your success in career and life. Any cheating, dishonesty, or plagiarism will NOT be tolerated. If a student is found guilty of academic dishonesty, the student will receive an 'F' for the course in addition to any punishment determined by the university. You are allowed to consult with other students in solving the questions. However, all the work including problem sets and exams should reflect your effort only. **Too similar assignments will get zero, therefore, do not copy the result of others' efforts.**

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1. **Binomial tree option pricing**

   Write a **function** to estimate the price of a standard **European** option. It receives all required inputs as **function arguments** including the number of steps and the type of option (Call or Put).

   a. The program should display the tree.
   b. Report a comparison of your results with the results obtained by DerivaGem only for one sample.

2. **Gap option & Standard option using Monte Carlo simulation**

In this problem, the goal is to determine two types of options prices by using Monte Carlo simulation. you are required to **randomly** select **10** European call options **exercise prices** and $\mathbf{S_0}$. Then, you estimate the prices of both **gap** and **standard** call using Monte Carlo simulation approach, assume that the asset S(t) follows the Geometric Brownian motion. Simulate at least 1000 paths for each estimation. The option price corresponds to the average value of its discounted future payouts under the risk- neutral probability.

a. Report the results in only **one** table that includes following results: (hint: pandas DataFrame can be used for this purpose)
   i. Stock price (S_0)
   ii. Strike price (K_1)
   iii. Second strike price (K_2) (use this one for standard option)
   iv. Gap option price using Monte Carlo
   v. Standard option prices using Monte Carlo
   vi. Standard option prices using BSM model
   vii. Column 4 – Column 5
   viii. $(K_2 - K_1)e^{-rt}N(d_2)$

b. Plot one of the path price movement in Monte Carlo

c. Compare seventh and eighth columns.

d. Is GBM-based estimation reliable? (hint: it can be resulted from comparison of fourth and fifth columns)

Assumptions:

S_0	K_1	K_2	T	Volatility	Risk-free rate
Lognormal distribution with **μ=95 , σ=10**	Integers in range **[80,90]**	Integers in range **[90,100]**	**1 year**	**25%**	**12%**

Gap option:

If $S_T \geq K_1 \Longrightarrow call\ payoff = S_T - K_2$

3. **Binary option using Monte Carlo**

In this problem, the goal is to determine Binary option by using Monte Carlo simulation. you are required to **randomly** select **10** European call options exercise prices and S_0 . Then, you estimate the prices of call using Monte Carlo simulation approach, assume that the asset S(t) follows the Geometric Brownian motion. Simulate at least 1000 paths for each estimation. The option price corresponds to the average value of its discounted future payouts under the risk- neutral probability.

a. Report the results in only **one** table that includes following results:
   i. Stock price (S_0)
   ii. Strike price (K)
   iii. Binary option price using Monte Carlo
   iv. $Qe^{-rt}N(d_2)$

b. Compare third and fourth columns, Explain why?

Assumptions:

S_0	K	Q	T	Volatility	Risk-free rate
Lognormal distribution with **μ=95 , σ=10**	Integers in range **[90,100]**	**20**	**1 year**	**25%**	**12%**