MScFE 620 DERIVATIVE PRICING

Group Work Project # 2

See grading rubric here.

Scenario

This assignment uses similar questions as for the GWP1 assignment that you submitted in Week 3; however, for this submission, you will use a DIFFERENT PRICING METHOD. Unless stated otherwise, use the same input data as the referenced question in GWP#1.

Note that even if each team member is assigned a different task, the whole group will benefit from mutual collaboration in all tasks!

Tasks

Step 1

Here, you will repeat questions 5,6, and 7 from GWP#1 under different pricing methods for European options. Specifically:

1. **Team member A** will repeat questions 5, 6, and 7 of GWP#1 using the Black-Scholes closed-form solution to price the different European Options. For Q7 on vega, you can use Black-Scholes closed-form solution.
2. **Team member B** will repeat questions 5, 6, and 7 of GWP#1 using Monte-Carlo methods under a general GBM equation with daily time-steps in the simulations. As was the case with the number of time steps in the trees, make sure you run a large enough number of simulations. For Q7 here you can rely on the same intuition as in the trees, just 'shock' the volatility parameter and recalculate things.
3. **Team member C** will be in charge of:
    a. Checking that Put-Call parity is satisfied under both methods (BS and MC).
    b. Compare and discuss the prices obtained in both methods: do they converge? why/why not?

Step 2

In step 2, you will still work with the **input data** from questions from 5, 6, and 7 from GWP#1, in this case for American derivatives. Specifically

4. **Team member A** will use Monte-Carlo methods with regular GBM process and daily simulations on an **American Call option**. Remember to answer the different questions in the original GWP#1: price (Q5), calculate delta (Q6) and vega (Q7) **only for the Call option case**.
5. **Team member B** will use Monte-Carlo methods with regular GBM process and daily simulations on an **American Put option**. Remember to answer the different questions in the original GWP#1: price (Q5), calculate delta (Q6) and vega (Q7) **only for the Put option case**.
6. **Team member C** will take as input the code from team members for the previous 2 questions and use it to:
    a. Under Monte-Carlo simulation for daily time-steps, repeat questions 15 and 16 from GWP#1 (i.e., price options for different levels of moneyness for American Calls and Puts).
    b. Graph the relationship between option price and moneyness for call and put (i.e., 2 different graphs).

Step 3

Finally, you will work on hedging under Black-Scholes for European options, as well as pricing different exotic instruments.

7. **Team member A** will work with European options with same characteristics as GWP#1 under different levels of moneyness:
    a. Price an European Call option with 110% moneyness and an European Put with 95% moneyness using Black-Scholes. Both have 3 months maturity. b. You build a portfolio that buys the previous Call and Put options. What is the delta of the portfolio? How would you delta-hedge this portfolio? c. You build a second portfolio that buys the previous Call option and sells the Put. What

is the delta of the portfolio? How would you delta-hedge this portfolio?

8. **Team member B** will work with Monte-Carlo methods with daily time steps to **price an Up-and-Out (UAO) barrier option**. The option is currently ATM with a barrier level of 141 and:

$$\text{□□}_0 = 120;\ \text{□□} = 6\%;\ \sigma = 30\%;\ \text{□□} = 8\ \text{□□□□□□□□}h\text{□□}$$

9. **Team member C** will repeat the previous question (barrier option), in this case considering an **Up-and-In barrier (UAI)** option with the same barrier as before. Specifically:
   a. Compute the price of the UAI option.
   b. Compute the price of the vanilla option (same characteristics, no barrier)
   c. What is the relationship between the prices of the UAO, UAI, and vanilla option? Explain.

When it comes to the reporting of your results for all questions, produce a table similar to the following one:

5	ATM Call	Eur	Binomial	BS	$5.00	$4.90	(5-4.90)/5=2%
9	ATM Put	Amer	Trinomial	MC	$2.00	$1.50	0.50/2=25%

***Note**: Prices are illustrative and are not the actual prices.*

In a group of two students, you will omit Team Member C's responsibilities.

Submission Requirements and Format

One team member submits the following on behalf of the entire group:

1. A **zipped folder** including:
    a. An executable Jupyter notebook* that includes the code, its output, and the answer to each question along with the solution
        i. Option prices MUST be rounded to the nearest cent: for example, 39.51, not 39.50941851234124151
        ii. Option prices should be neatly organized in a table and NOT presented individually

    b. A duplicate version of the Jupyter notebook above in PDF or HTML format. In order to include the output of the code, you must RUN the code before downloading the PDF.
2. **1 PDF document** with the question number and the written answers to ALL the questions (the document will have the same content as the ones above but without the code)
    a. Use the available Report Template and fill out the required information in the first page.

***Use Google Colab or GitHub to collaborate** in completing the executable Python program.*

*The PDF file with the answers to the questions must be uploaded **separately** from the zipped folder that includes any other types of files. This allows Turnitin to generate a similarity report.*

Rubric

Your instructor will evaluate your group submission for GWP2 using the following rubric:

The group is able to apply results, formulas, and their knowledge of theory to real-life finance scenarios by doing the following: ● Providing all the necessary information to support their arguments. ● Presenting arguments that reflect group discussion and research. ● Using authoritative references to support a position and provide updated information. ● Concluding with practical takeaways for more insightful financial decision-making.	Technical Reports contain 3 parts: 1) **code** for each question (be sure to explicitly state the question number), 2) the corresponding output of that **code**, and 3) **interpretations** and/or **recommended courses of action** that reasonably follow from those results. **Note**: Technical reports will include the technicalities of models, such as names, methods of estimation, parameter values, etc., and exclude generalities about the work done. It should NOT include names of Python code that were used. Non-Technical Reports contain 3 parts: 1) clear explanation of results; 2) the recommended course of action that follows; and 3) the identification of factors that impact each portfolio. **Note**: AVOID all references to model names, algorithms, and unnecessary details. Instead, focus on the investment decision.	A submission that looks professional should: ● Include the axes, labels, and scales in graphs. ● Be free of significant grammar errors or typos. ● Be organized, well structured, and easy to read. ● Contain proper citations and a bibliography in MLA format.