

Group Project

This **group** assignment is due no later than Sunday 4/27 at 11:59pm CST. Groups can have a maximum of three students. Pick one of the groups I created on Canvas called FIN 451 Project XX and add your names to it. Do not create your own group names.

The deliverable of this assignment is a report that reads like a professional document. Replace the generic titles below (Part1, Part2 and Part 3) by appropriate titles that describe what you do in each part.

Each part of the report should have paragraphs with words describing what you do and what you find. Format your document professionally, as the way your report looks will affect your grade in the assignment. For each part, I do not want to see something like *1. I do this*, *2. Some table*, *3. Some graph*. Make the report to read like a paper. You can use subsections if you want to separate different parts within each section, but each subsection must have a title. Your graphs and tables must be formatted professionally as well.

On Canvas, submit a PDF version of your report and either an Excel spreadsheet detailing your computations, or Python code that can be used to replicate your results. If you use Python, your code must be such that if I paste it in a Jupyter notebook and I press Ctrl+Enter, your code must be able to run without errors.

The data for the assignment can be found [here](#). The file contains daily values for the price of Amazon stock (AMZN), the level of the S&P 500 and the spot price of Bitcoin futures (BTC) from 1/2/2025 until 3/31/2025.

Part 1

1. Compute daily percentage price changes for AMZN, the S&P 500 and BTC as follows:

$$r_{t+\Delta t} = \frac{P_{t+\Delta t} - P_t}{P_t},$$

where r_t denotes a daily rate of return for each asset, and P_t denotes the closing price for the same. You can report the daily returns values on an Appendix at the end of your report.

2. Generate individual plots for each time-series, and describe briefly the evolution of the daily returns during the time period. In particular, comment about whether the volatility of the daily returns looks constant over time.

- Using the Excel function STDEV.S, compute the standard deviation of daily returns for each asset. This number represents an estimate of the volatility per day. In order to obtain an annualized figure, you need to multiply it by $\sqrt{252}$, that is:

$$\sigma_{\text{annualized}} = \sqrt{252} \times \sigma_{\text{daily}}.$$

Report your estimates in a nicely formatted table, explaining how you obtained your numbers.

Part 2

On 4/2/2025, you collect the closing price of each asset:

Asset	Closing Price
AMZN	196.01
S&P 500	5,670.97
BTC	82,485.71

On that date, you see that SOFR is 4.37% per year with continuous compounding and you can assume that SOFR will stay constant for the next three months.

- Build an 10-period binomial tree for AMZN as of 4/2/2025. To compute up and down movements for each period, use $u = e^{\sigma\sqrt{\Delta t}}$ and $d = 1/u$, where $\Delta t = 1/40$. and σ is the annualized volatility that you computed in Part 1. That is, your tree will span a period of 3 months. You will use the binomial tree to compute the option values described below.
- Using the binomial tree above, compute the price of **European** call and put options as of 4/2/2025 written on AMZN, with strike price $K = 195$ and expiring in three months. Express the price of each option per share. Compare your results with the ones you would get using the Black-Scholes formula.
- Using the binomial tree above, compute the price of **American** call and put options as of 4/2/2024 written on AMZN, with strike price $K = 195$ and expiring in three months. Express the price of each option per share.
- Using the Black-Scholes model and the annualized volatility computed in Part 1, compute the price, delta, gamma, theta and vega of **European** call and put options as of 4/2/2025 written on the S&P 500, with strike $K = 5,650$ and expiring in three months. In your computations use a dividend yield of 1.30% per year expressed with continuous compounding.
- Using the Black-Scholes model and the annualized volatility computed in Part 1, compute the price, delta, gamma, theta and vega of **European** call and put options as of 4/2/2024 written on three-month BTC futures with strike price $K = \$83,500$ per Bitcoin and expiring in three months. Note that here you need to compute the three-month futures price first, as the price presented in the table is the spot price of Bitcoin.

Part 3

During the next few days, you observe the following daily returns for Amazon stock, the S&P 500 and the spot price of Bitcoin.

Date	AMZN	BTC	SP 500
4/3/2025	-8.98%	0.75%	-4.84%
4/4/2025	-4.15%	0.89%	-5.97%
4/7/2025	2.49%	-5.50%	-0.23%
4/8/2025	-2.62%	-3.74%	-1.57%
4/9/2025	11.98%	8.26%	9.52%

Use these numbers, in addition to any other relevant information that you can find online, to comment on the weaknesses of the assumptions behind the Black-Scholes model that we studied in class. In this part you can be creative, since there are many things you could say about the merits and deficiencies of the Black-Scholes model.