BT4016: Team Project
Crypto Portfolio Risk Management

Due: 16th April, 2023, Sunday, 11:59 pm
Total Marks: 28 marks

Submission Requirement

- Each team only need to make one zipped submission to Canvas.
  - Project report **(.pdf):** this is **mandatory**. A norm is single line space, 12pt font, and within 25 pages inclusive of everything (cover page, content list, figures etc). Make sure to include all the analysis, answers to Q1 from Q5, and explanations of the logic and graphs required.
    Marking is not based on length, but clarity, quality, and critical thinking.

  - Python 3 notebook (.ipynb): this is **optional**. You can choose to include more codes and results here. The notebook will not necessarily be read, so do not insert link to the notebook in the report. It is meant to help our TAs to better assess when you used additional data, which is unlikely the case.

- Remember to include student numbers (e.g., A0123456X) of all team members on the cover page of the report.

- Remember to include the peer assessment section (2 marks) at the end of your project report. This section should have this table below **and** a paragraph describing succinctly the contributions of each of the members in your team. (This paragraph should be within 100 words, or one sentence for each member)

For each member, indicate the extent to which you agree with the statement on the left (under Evaluation Criteria), using a scale of 1-4 (1=strongly disagree; 2=disagree; 3=agree; 4=strongly agree).

Evaluation Criteria	**Group Member:**	**Group Member:**	**Group Member:**	**Group Member:**
Attends and contribute to the team discussions.				
Completes assigned work on time.				
Demonstrates a cooperative and supportive attitude.				

Instructions

Download two-year of prices and other useful data (from 2020-2-1 to 2022-2-1) from Yahoo Finance for the following 4 cryptocurrencies (They are among the crypto assets with the highest trading volume, hint: you can re-use the codes from tutorials).

Symbols: BTC-USD, ETH-USD, DOGE-USD, MATIC-USD

This project requires you to work as a team and:

1) Access the crypto prices and perform basic analysis of the a crypto portfolio
2) Run Markowitz's Mean-Variance Optimization method on this portfolio
3) Assess the risk for the component assets
4) Hedge portfolio risk by crypto options
5) Develop and implement your own option strategies.

Question 1 (3 marks). Basic analysis and visualizations of the portfolio

(a) Retrieve the daily prices of the 4 cryptos online (2020-2-1 to 2022-2-1) and calculate the daily log returns. (The same process as how we retrieved the stock prices in the tutorial.)
(b) For this period, plot the asset return correlations using a matrix heatmap, and plot the annualized Sharpe ratios of the four crypto assets using a bar chat.
(c) What can you observe? (< 100 words)

Question 2 (5 marks). Markowitz MVO and simulated portfolio value

(a) Assume we are long only, with total weights equal to 1, run a Mean-Variance Optimization on the crypto assets to minimize risk. Plot the resultant holding weights for two constraint settings, one with the maximum holding weight limit to 0.5, and one with no limit on maximum holding weight. So you will have two graphs, each has 4 lines of different colors. Each line has 731 values between 0-1, representing the holding weight for that asset on each day.

(b) Report the annualized returns and volatilities for the two portfolio settings and compare the results. (comparison<50 words)

Question 3 (4 marks). Calculate the VaR(5%) for the component assets

(a) At α = 5% level, estimate daily VaR and ES of the percentage return (not value) of: all the individual component crypto assets and the portfolio (no limit to holding weights setting). Plot and show the VaR and ES curves for one year (2021-2-1 to 2022-2-1). So you will have 5 graphs, each has two lines of different colors (VaR and ES).

(b) Identify the most risky component asset from the above evidence and justify your choice. (<100 words)

Question 4 (6 marks). Hedge by Options

(a) Compare Bitcoin (BTC-USD) and Ether (ETH-USD), which coin's prices do you think is more volatile? (You can choose to also consider the upside and downside risks separately.)

(b) **Download the file 'okex_option_trade.csv' (BTC's and ETH's call and put options trade data).**
Sample data format is shown below:

side	trade_id	price	qty	instrument_id	timestamp
buy	6	0.001	1	BTC-USD-210226-7000-P	2020-12-17T12:35:08.298Z
buy	2	0.0025	2	BTC-USD-210226-10000-P	2020-12-24T01:58:50.915Z

(Take the first row instrument here for example, in the instrument_id: "BTC-USD" refers to the underlying asset, "210226" refers to its expiration date which is 2021/02/26, "US$7000" is the strike price. You can take the price column as the market price. That means, on 2020/12/17, someone bought qty=1 unit of this instrument at a price of BTC 0.001, so this put option price at that timestamp is BTC 0.001)

Note that:

1. The data file is not chronologically ordered by timestamps, you may need to perform some data sorting/filtering.
2. Assume you will not have liquidity issue, that is, you can successfully buy any quantity of the instrument at the given market prices, with no spread or fees.

For your no limit setting portfolio from Q2, on 2021/01/01, for each one unit of the asset your team deemed to be the most volatile, **buy one straddle (buy one put + buy one call). That expires on 2021/01/08.** You can choose the exercise prices as close as to minus/plus one standard deviation of asset return (minus one standard deviation for buying a put and plus one standard deviation for buying a call option). You can determine your cost using the last transacted option prices on 2021/01/01 as the market price. Suppose your cost is **externally financed** and to be returned/deducted on 2021/01/08, with no interest rate.
What are the instrument_ids that you decided to buy?

(c) Report the two-year portfolio performance (annualized return and Sharpe ratio) with or without this **one-off straddle hedging**.

Question 5 (8 marks). Design your own hedging strategies

Now assume your option cost is **self-financed**. That means, if on 2021/01/01, my portfolio is 100% 1BTC, so the portfolio value is USD 29374.
If I decide to buy a one-week put at 29000, it cost BTC 0.0345. (I can successfully buy because of this transaction record: 5950,buy,14,0.0345,2,BTC-USD-210108-29000-P,2021-01-01T16:35:30.548Z)
So now my portfolio will become "BTC 0.9655 plus one put"
On 2021/01/08, the put expires and worth nothing. So the portfolio value becomes:

0.9655* USD 40797 = USD 39389.
When you incur option cost, you are actually paying out of your portfolio.

(a) For your no limit setting portfolio from Q2, on any date throughout the two years, you are allowed to decide your favored frequency, and buy or sell any quantity of options **as long as** that option has a trading record on that date based on the data file. (Again, similar to Q4, assuming that you can successfully buy the instrument of any quantity at the last transacted prices. E.g., if your strategy decide to buy one call at 4:00PM, you may use the price at 3:58PM as the market price.) **Clearly explain your strategy**: what is the intuition? why do you design it in such a way.

(b) Simulate, present, and evaluate your portfolio's performance with your strategy (highlight the annualized return and Sharpe ratio, you can also choose to plot the portfolio value curve).