Assignment 3

Question 1: (50 points)

(1) Download option prices of ticker ˆVIX for all expiration dates and name it VIX.options

(2) Download the current price (last quote price) for ˆVIX

(3) For calls and puts of VIX.options at each expiration calculate the average of Bid and Ask. Create a new column named ‘Price‘ to contain the result.

(4) For calls and puts of VIX.options at each expiration, add a column of InTheMoney, which takes value TRUE when it is in-the-money, and FALSE otherwise. Compare it to ITM column to check your results.

(*Hint.* A call option is in-the-money when its strike is less than the current price of underlying. A put option is in-the-money if its strike is greater than the current price of underlying. And the current price of underlying is the last quote price from 1.2)

(5) For calls and puts of VIX at each expiration, delete all the fields except Strike, Bid, Ask, Price, and In-The-Money, and save them in .csv files with the format "VIXdata2021-09-26Exp2021-10-08puts.csv", here 2021-09-26 should be replaced by the date you download the data, and 2021-10-08 should be replaced by the date of expiration.

(*Hint.* You may generate many .csv files, besides your .pdf report, please submit one of the .csv file.)

Question 2: (50 points)

We can approximate put option price by replacing the mean with sample mean, then the put option can be approximated by:

$$p(S_0, K, T, \sigma, r) = e^{-rT} E^Q[(K - S(T))_+] \approx e^{-rT} \frac{1}{m} \sum_{j=1}^{m} (K - S^{(j)}(T))_+$$

(1) Using Monte-Carlo Simulation to estimate the put option price using $S0 = 100, K = 100, T = 1, \sigma = 0.2, r = 0.05$, you can use number of steps n = 252 and number of paths m = 10000

(2) Implement Black-Scholes formula for pricing the put option

$$p(S_0, K, T, \sigma, r) = e^{-rT} E^Q[(K - S(T))_+] = -S_0 N(-d_1) + e^{-rT} K N(-d_2)$$

Check the difference between the Black-Scholes price and the Monte-Carlo price.