

Project 5 Mathematics 512

Instructor: Ricardo Mancera Fall 2024

Due date: Monday November 11th

1.

Consider the stock TSLA.

a) Estimate the historical volatility σ using the closing prices of the past 6 months. (you may find this data at yahoo.finance.com or at many other websites).

b) Use the binomial tree approach to estimate the price of a Dec 2024 European call option, where $r = 0.05$
 $S_0 = \text{current price}$, $K = S_0 + \$20$

c) Investigate the convergence rate of the binomial method as a function of the number of partitions of your time to expiration. Draw a graph.

d) Use the binomial tree approach to estimate the price of a Dec 2024 American put option, where $r = 0.05$
 $S_0 = \text{current price}$, $K = S_0 + \$20$

e) Use B-S formula to calculate the price of a Jun 2024 European call option, where $r = 0.05$, $S_0 = \text{current price}$, $K = S_0 + \$20$. Use the put-call parity relation to calculate the price of a corresponding put option. Calculate the Delta, Gamma, Vega, Rho of this option at the start of the option's life.

f) Use a simple Monte Carlo method to estimate the price of a Dec. 2024 European call option, where $r = 0.05$
 $S_0 = \text{current price}$, $K = S_0 + \$20$. Compare your answer with parts b) and e)

g) Use a Monte Carlo method with Antithetic variates to estimate the price of a Dec. 2024 European call option, where $r = 0.05$, $S_0 = \text{current price}$, $K = S_0 + \$20$.

h) Use a Monte Carlo method with Control variables to estimate the price of a Dec. 2024 European call option, where $r = 0.05$, $S_0 = \text{current price}$, $K = S_0 + \$20$. Compare f), g), h)

i) Estimate the implied volatility for the problem in part e). How does it compare with the historical volatility?