MF796 Assignment 1

Shi Bo

U56082126

January 25, 2021

1. The area that I am most interest in are big data, machine learning and trading. Machine learning technique and big data provide us with chance to seek for more effective and accurate trading strategies. I suppose when this course ends, I could get deeper understanding with those areas and put them into use to some extent.

2. The main reason is apparent that numerical methods are extremely important and practical in finance world. Also, MF796 focuses on coding for which I can further improve my programming skills and finally utilize these numerical analyses to real world finance problem.

3. R -- well, Python -- well, C++ -- intermediate

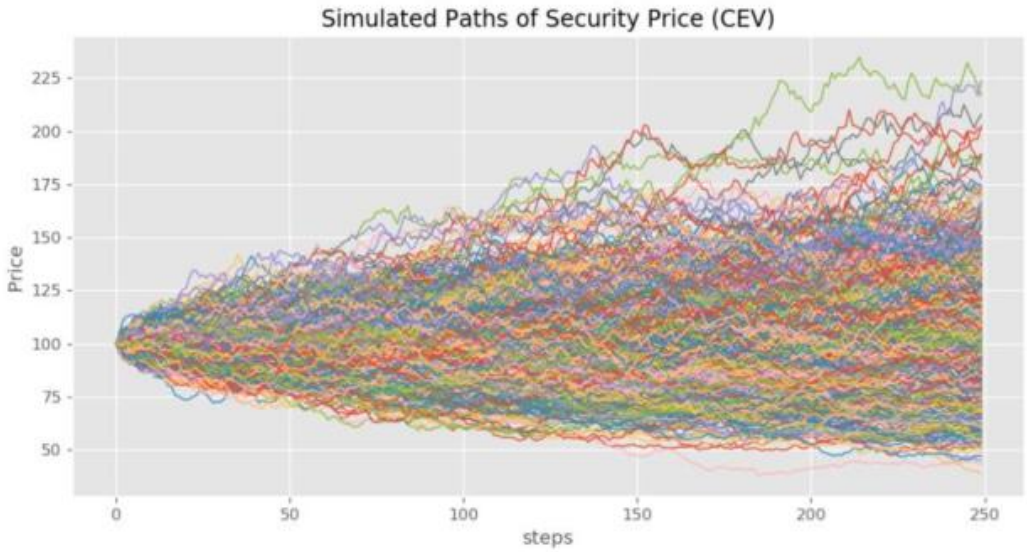
4. There is a common sense that gamma and theta are in an opposite sign. The portfolio decreases in its value if there is no change in S, but increases in value if there is a large positive or negative change in S. So, while gamma is negative, theta is inclined to be positive and the reverse is true: the portfolio increases in value if there is no change in S but decreases in value if there is a large positive or negative change in S. As the absolute value of gamma increases, the sensitivity of the value of the portfolio (Delta) to S increases.

5. (a)

St:	price of underlying asset at time t
r :	risk-free rate; also characterizing the drift term
β :	elasticity parameter of local volatility
σ :	volatility of underlying asset

(b)

Price through simulation is: **9.720327.**



(c) The price of European call option is calculated as **9.9476**, which is very close to the price via simulation method. It supposed to be very close since they are all generated by CEV model, but they cannot be identical due to the randomness in simulation process.

(d) The delta is **0.5497**.

(e) The delta of the call option is **0.5497** and the delta of short position stock is -1 so that in order to construct a delta neutral portfolio, we need to realize the entire delta to be 0. Therefore, share of stock should be 0.5497.

(f) The payoff of the delta neutral portfolio via simulation is **9.778746767836077.**
The profit calculated as:

$$\text{Profit} = \begin{cases} -\Delta(S_T - S_0) + (S_T - K) - c, & S_T > K \\ -\Delta(S_T - S_0) - c, & S_T \leq K \end{cases}$$

This payoff is very close to the price calculated by BS formula earlier, which implies that the profit and lose is almost 0 after taking into account the cost of buying option. When K = 100 = S0, c = 9.9476 and delta = 0.5497. The upper bound of St is **122.09** after calculation and lower bound is **81.90**. So, when St is in **81.9 < St < 122.09** causing money loss, vice versa.

(g) The portfolio delta neutral payoff is **0.9986 with 0.5 beta**. The payoff is much lower. The reason is that lower beta (<1) decreases the sigma of asset price.

(h) The portfolio delta neutral payoff is **16.1067with 0.4 sigma**. The payoff is much higher. The reason is that the higher the volatility the higher the payoff.