Ma374-LAB 10

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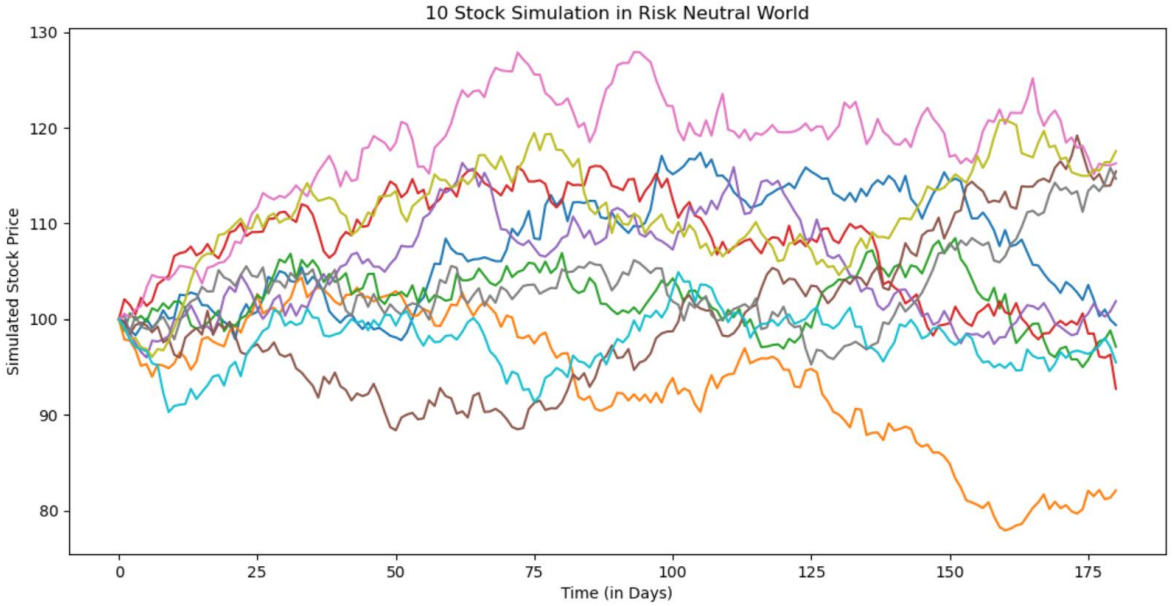
Question 1:

The following parameters have been set:
$\mu = 0.1, \sigma = 0.2, r = 0.05, t = 0, S_0 = 100 \; and \; T = 180 \; days$

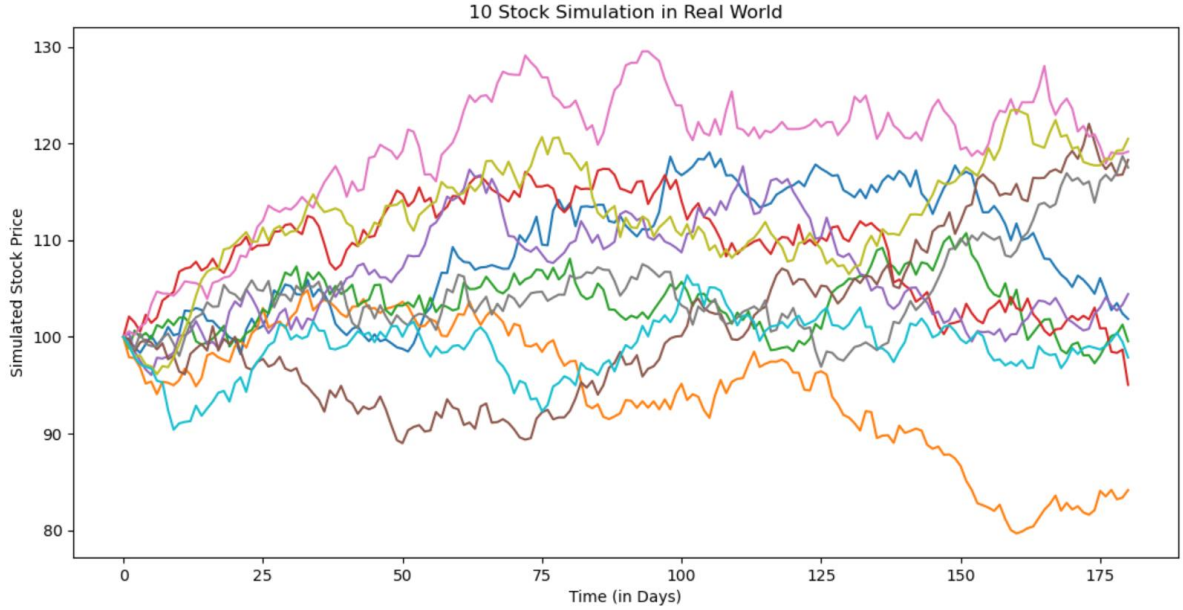
- Stock Price for ten different simulations (using risk neutral GBM equation):

$$S(t_{i+1}) = S(t_i) \exp\left(\left(r - \frac{1}{2}\sigma^2\right)(t_{i+1} - t_i) + \sigma\sqrt{t_{i+1} - t_i}\, Z_{i+1} \right)$$

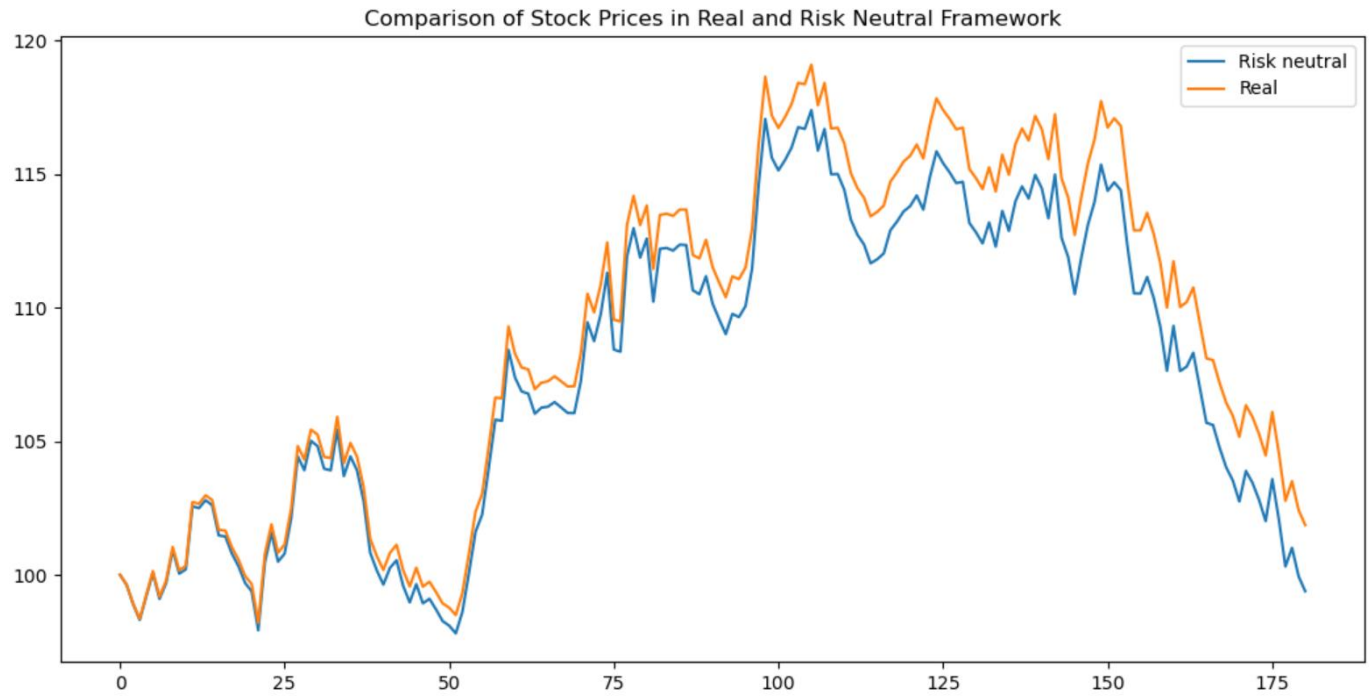


- Stock Price for ten different simulations (using real world GBM equation):

$$S(t_{i+1}) = S(t_i) \exp\left(\left(\mu - \frac{1}{2}\sigma^2\right)(t_{i+1} - t_i) + \sigma\sqrt{t_{i+1} - t_i}\, Z_{i+1} \right)$$



Here, we have compared the stock price values for risk neutral and real world scenarios for one of the simulations.

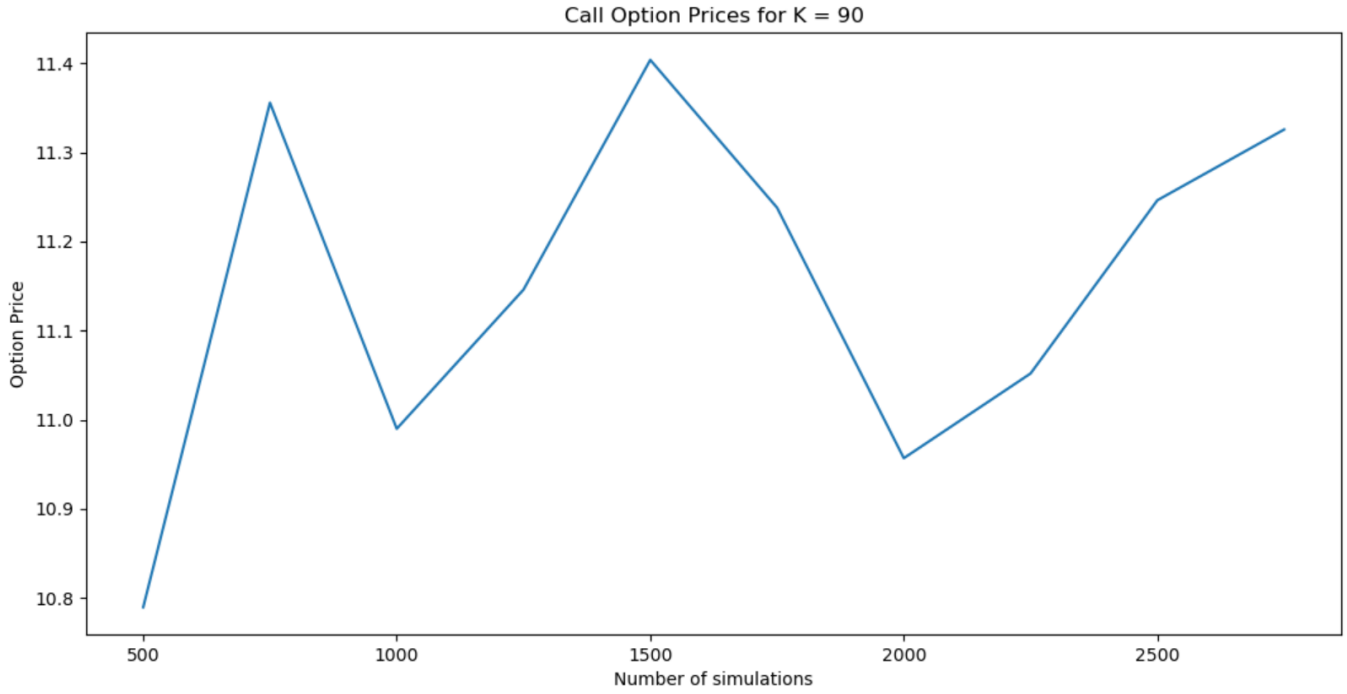


Six month fixed-strike Asian Option Price was calculated for Strike prices 90,105 and 110. To calculate the Asian Option Payoff, arithmetic mean (of the strike prices in the 6-month period) was used. The option price was calculated as follows:

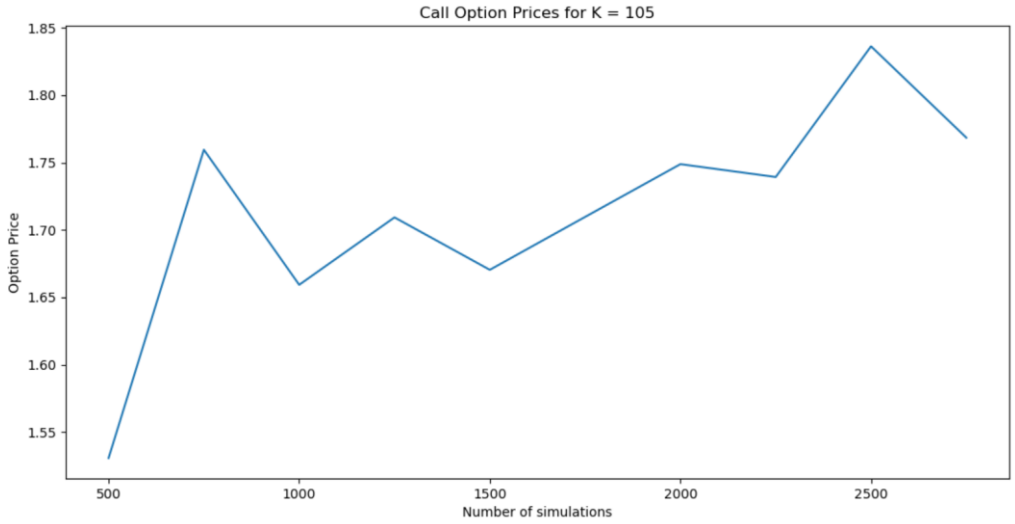
$$H(0) = e^{-rT} \sum_{i=0}^{M} \frac{1}{M} * (Payoff\ of\ Option)$$

The graphical plots of the Option Prices vs Number of Simulations are as follows:

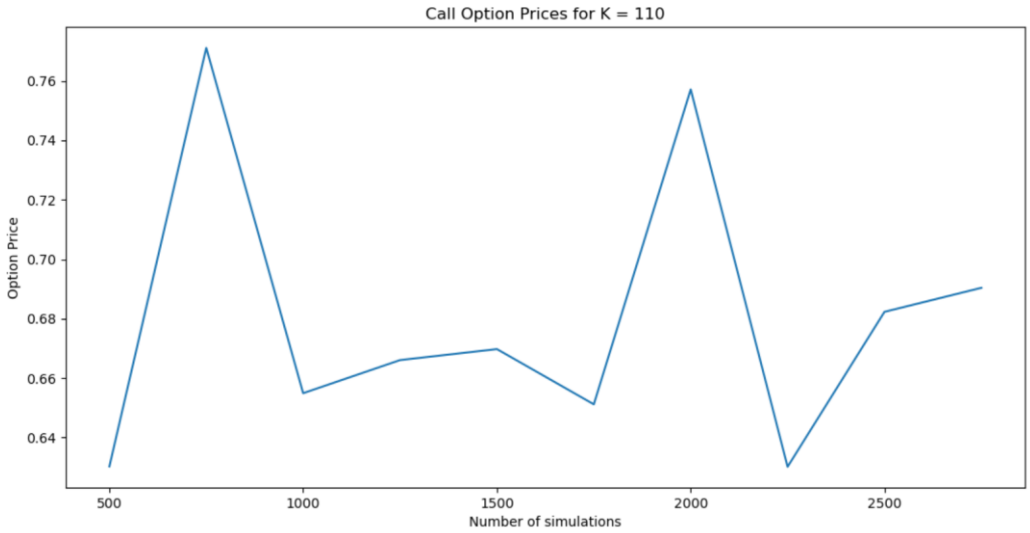
Average Call option price for K = 90 is 11.32566



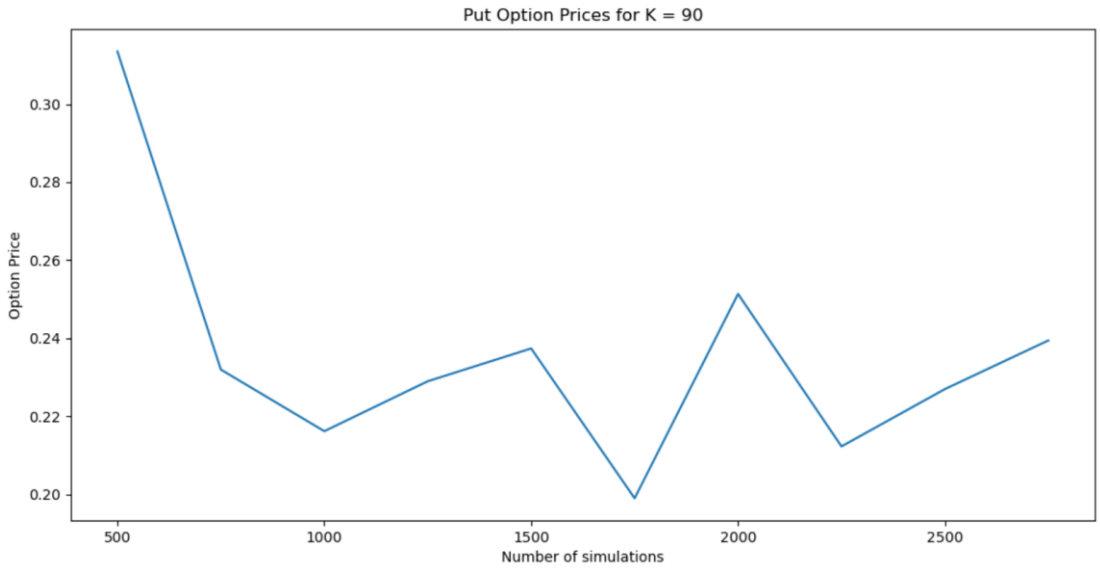
Average Call option price for K = 105 is 1.76843



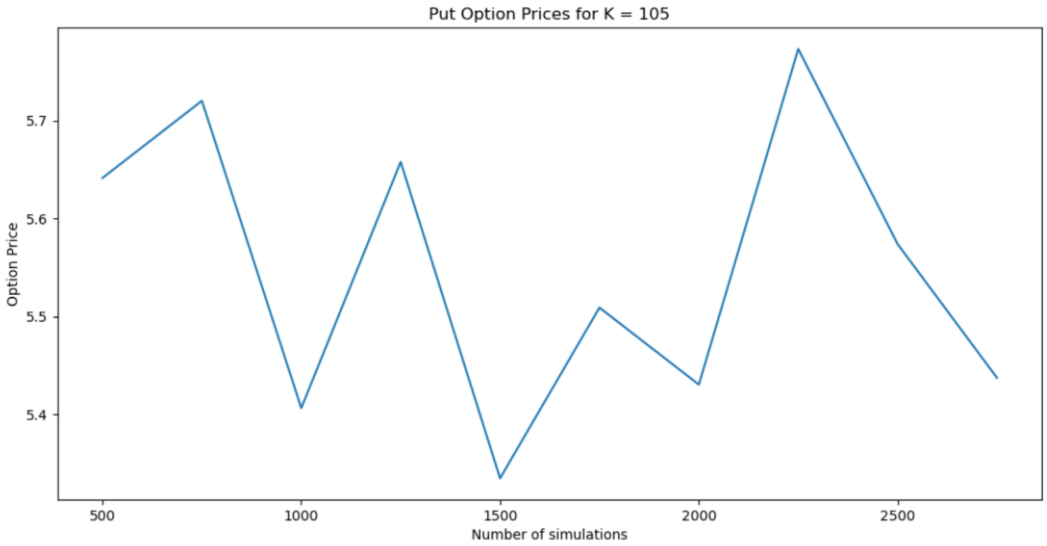
Average Call option price for K = 110 is 0.69037



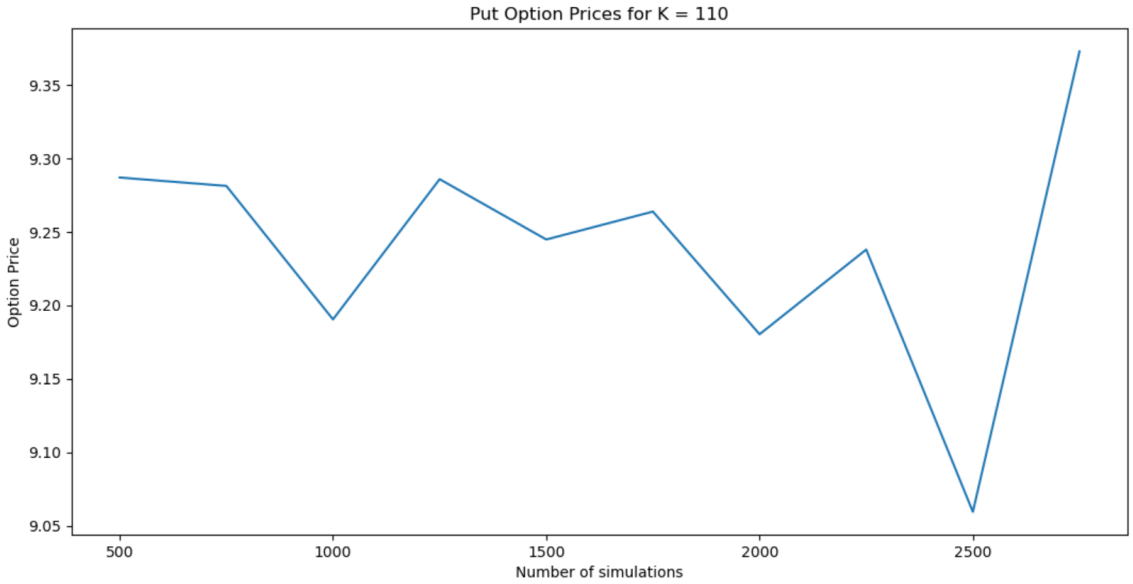
Average Put option price for K = 90 is 0.23942



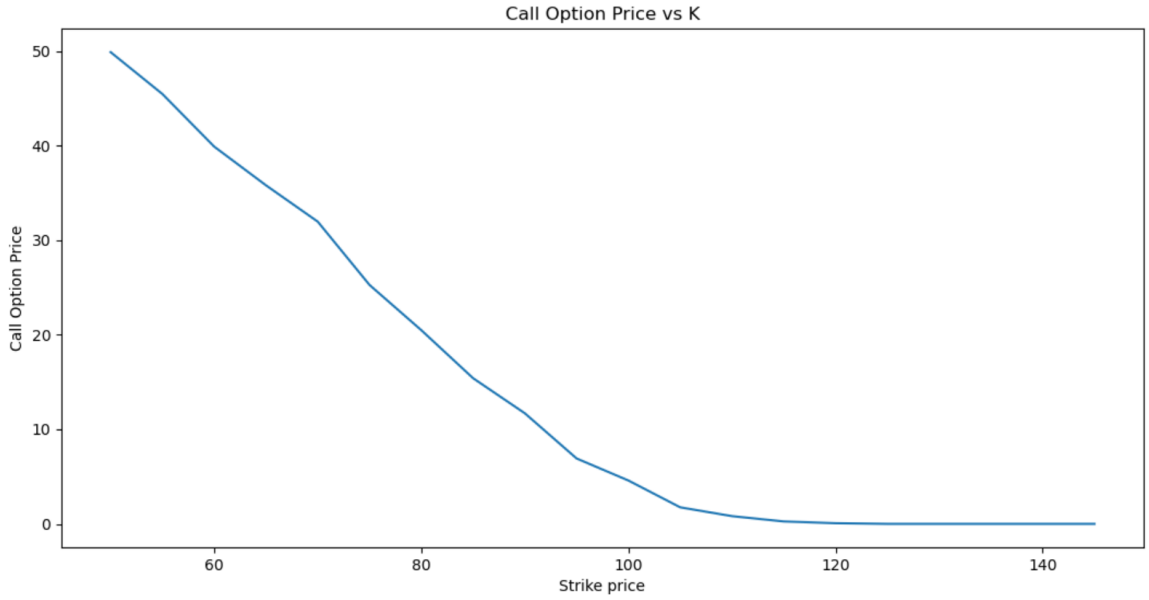
Average Put option price for K = 105 is 5.43707

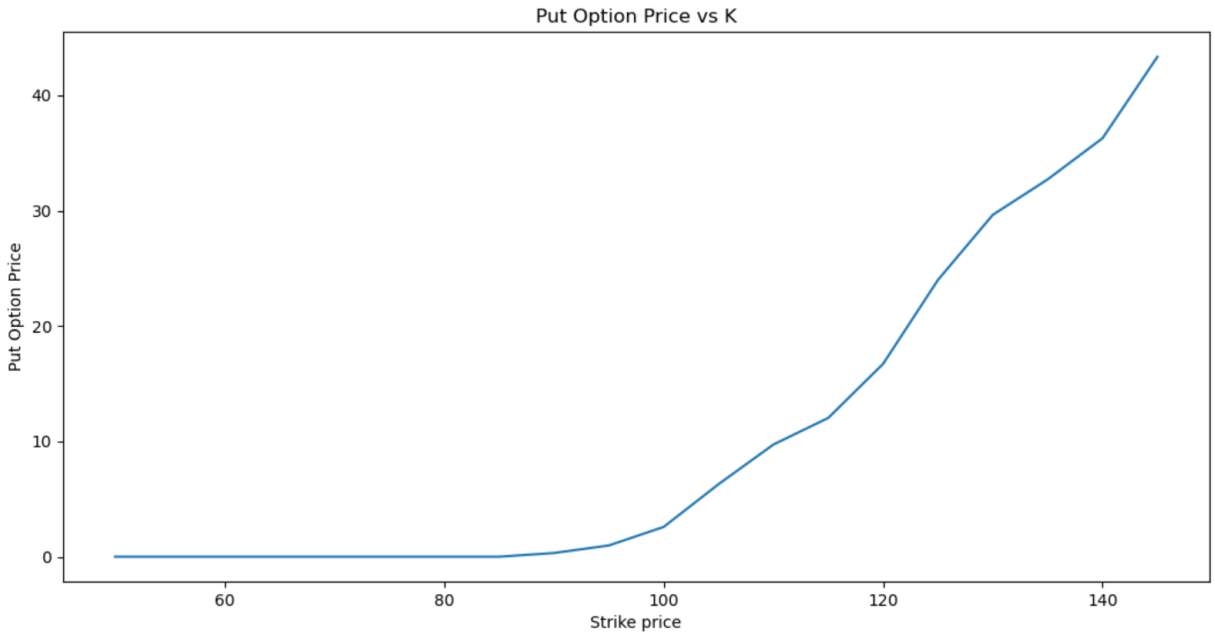


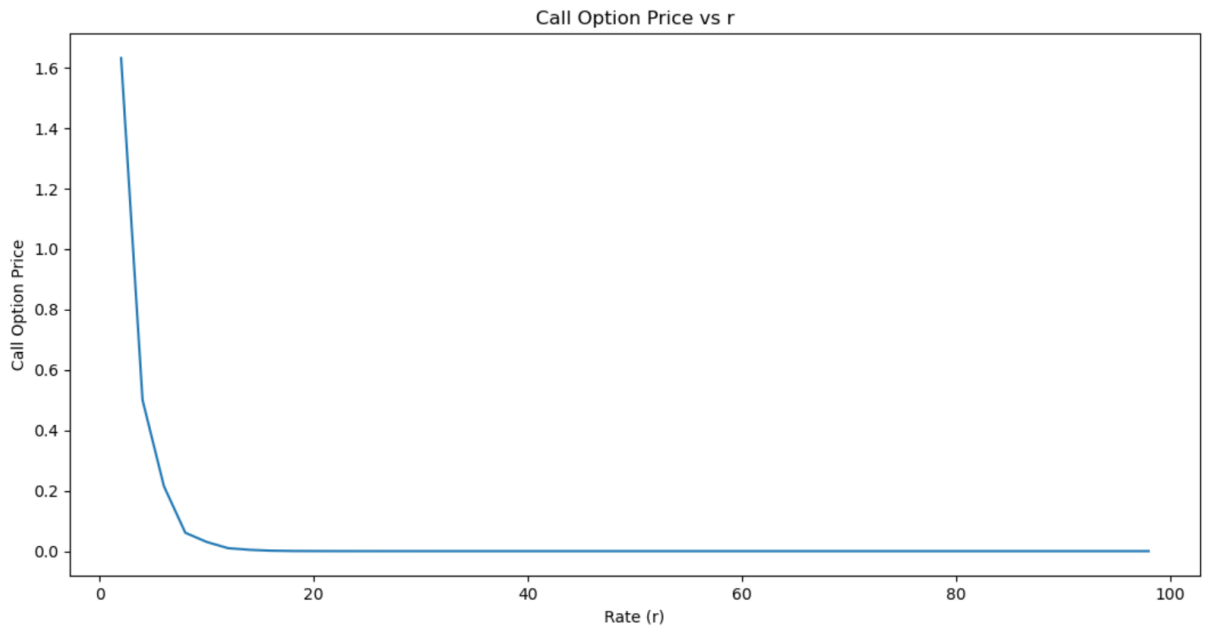
Average Put option price for K = 110 is 9.37288

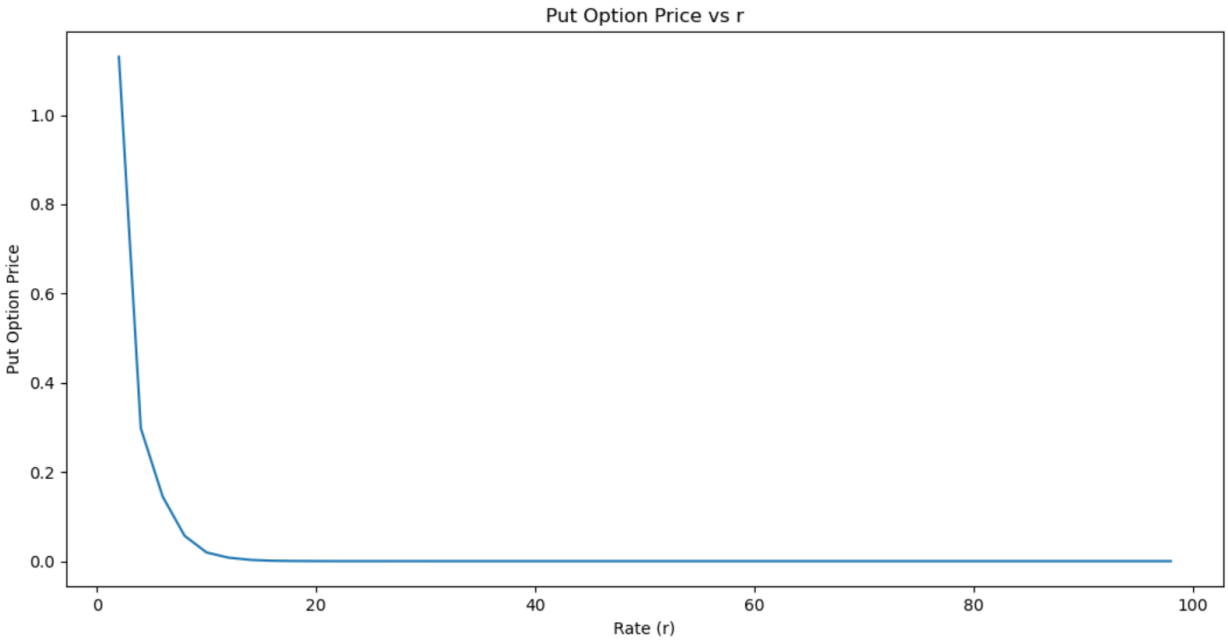


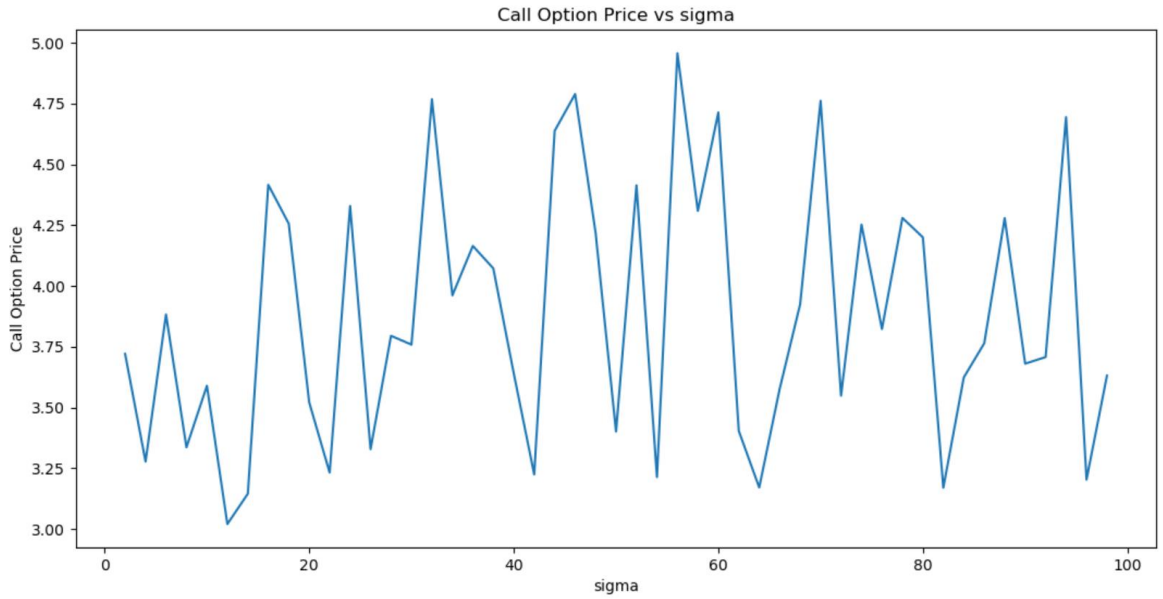
Sensitivity analysis of the option prices was done (on the model parameters T, K, r, sigma).

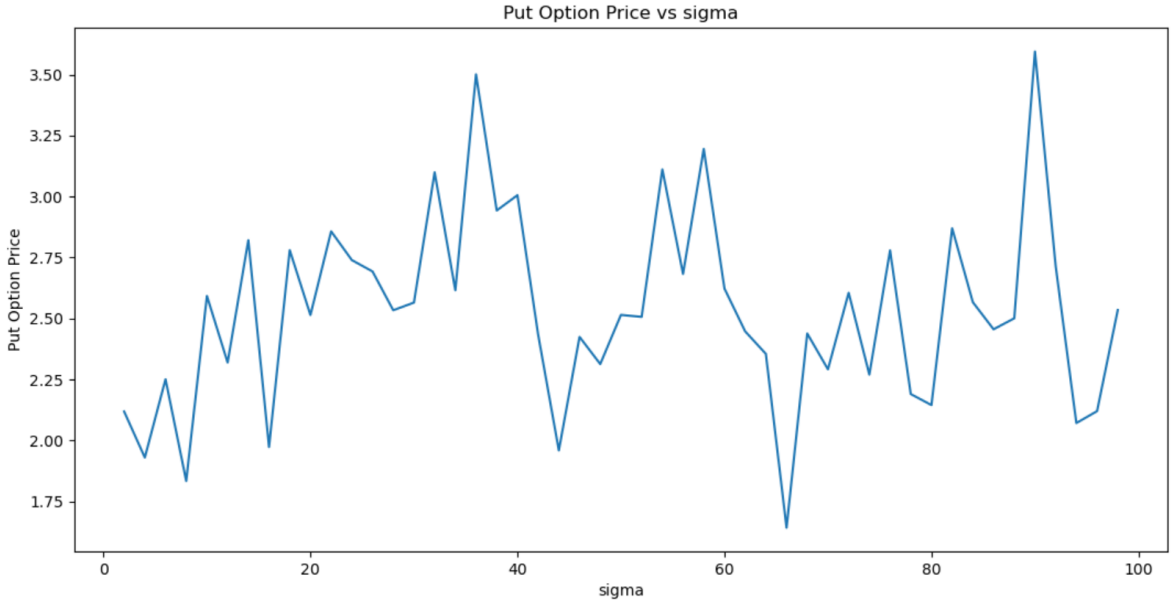


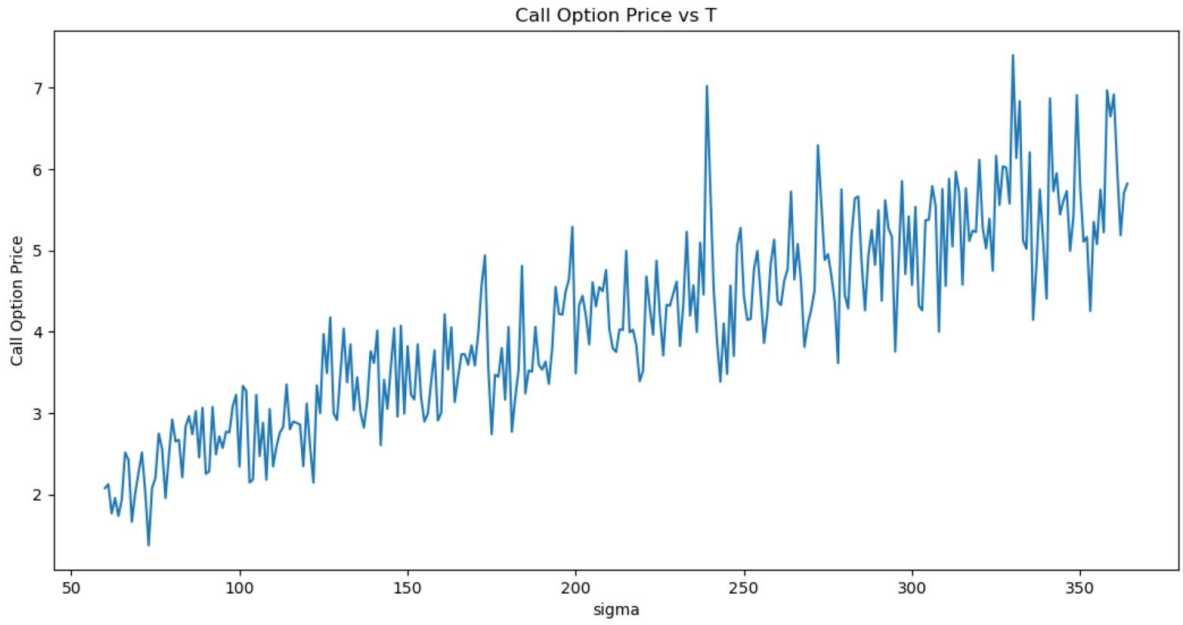

Put Option Price vs K
Put Option Price
Strike price
0
10
20
30
40
60
80
100
120
140

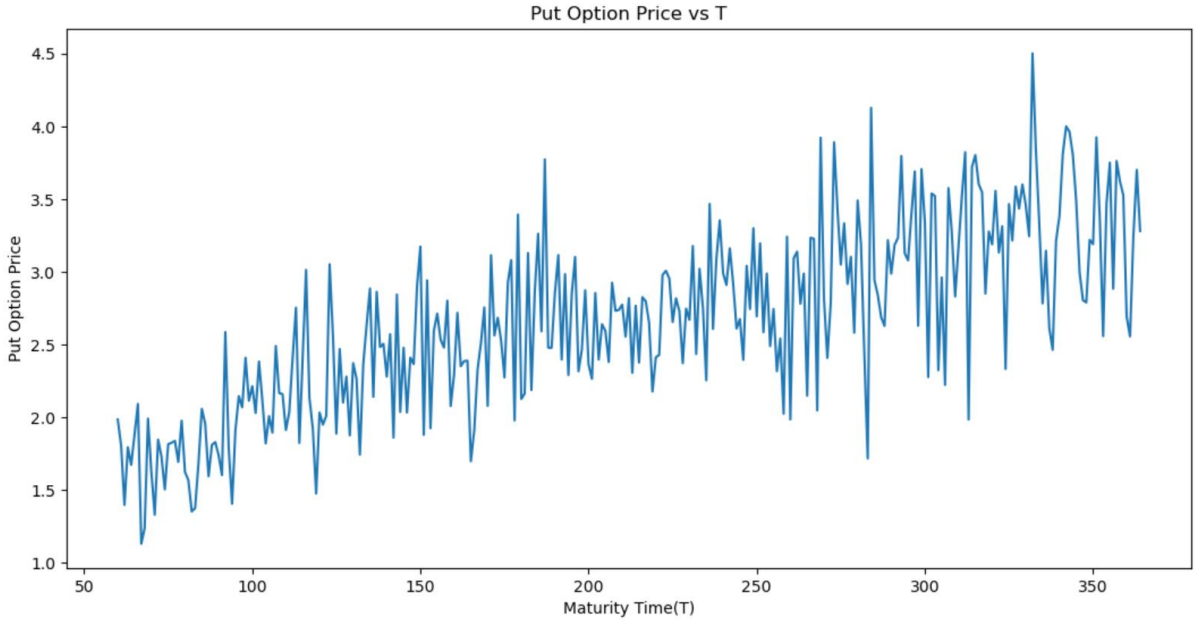

Call Option Price vs r
Call Option Price
Rate (r)
0.0
0.2
0.4
0.6
0.8
1.0
1.2
1.4
1.6
0
20
40
60
80
100


Put Option Price vs r
Put Option Price
Rate (r)
0.0
0.2
0.4
0.6
0.8
1.0
0
20
40
60
80
100


Call Option Price vs sigma
Call Option Price
sigma
5.00
4.75
4.50
4.25
4.00
3.75
3.50
3.25
3.00
0
20
40
60
80
100


Put Option Price vs sigma
Put Option Price
sigma
3.50
3.25
3.00
2.75
2.50
2.25
2.00
1.75
0
20
40
60
80
100


Call Option Price vs T
Call Option Price
sigma
7
6
5
4
3
2
50
100
150
200
250
300
350

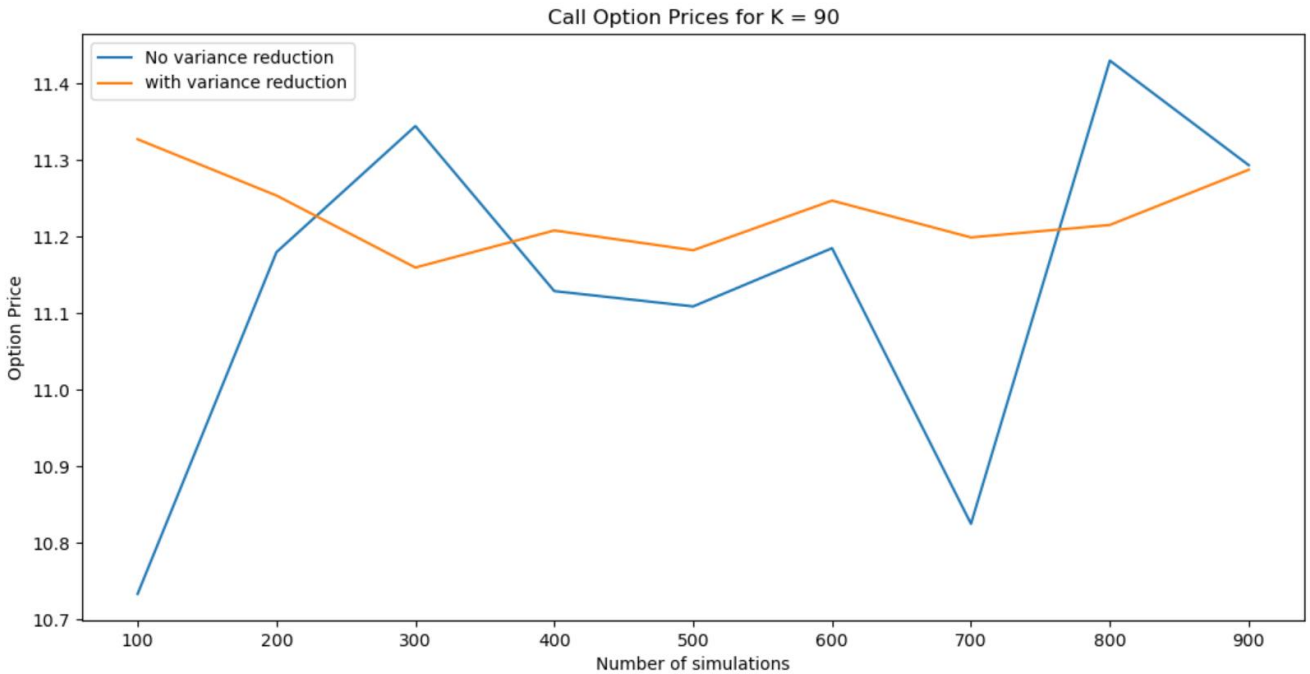


Question 2:

Variance reduction techniques was done using antithetic variables. The reduction in variance is evident from the following graphs:

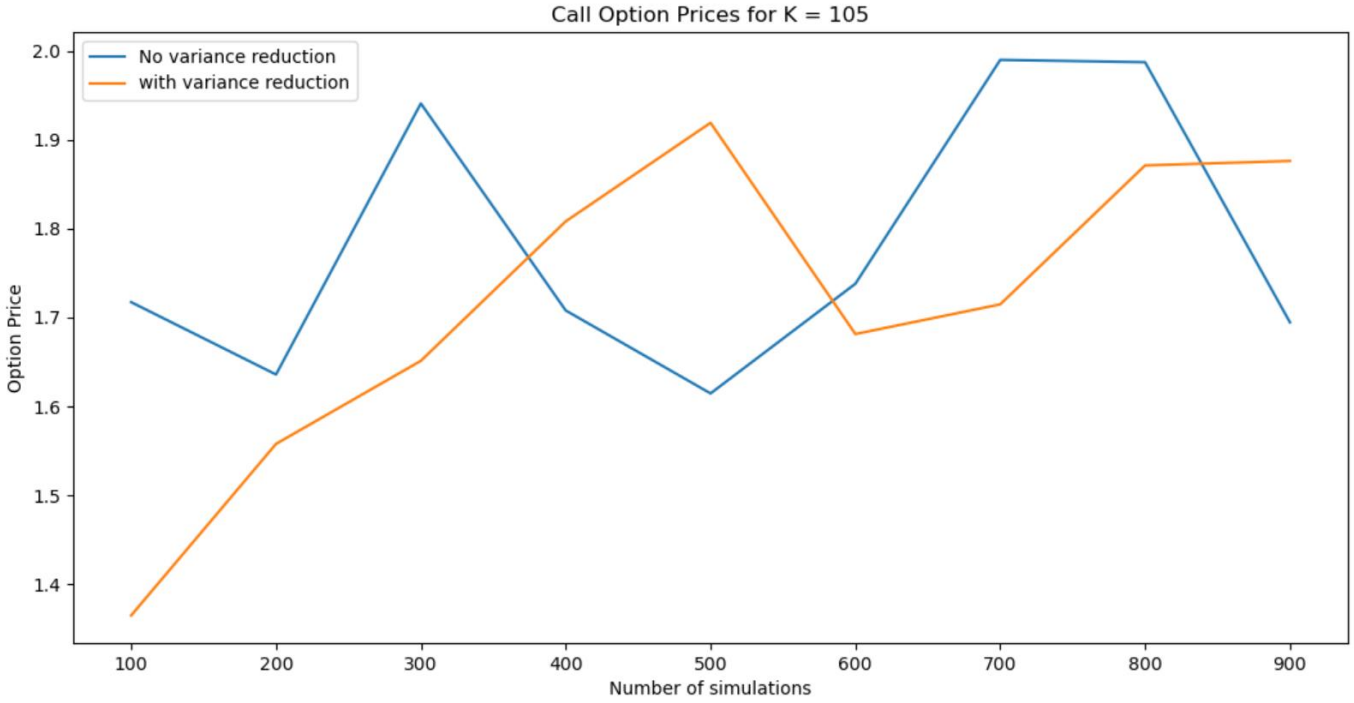
Variance of Call option price without variance reduction for K = 90 is 0.0465

Variance of Call option price with variance reduction for K = 90 is 0.0025



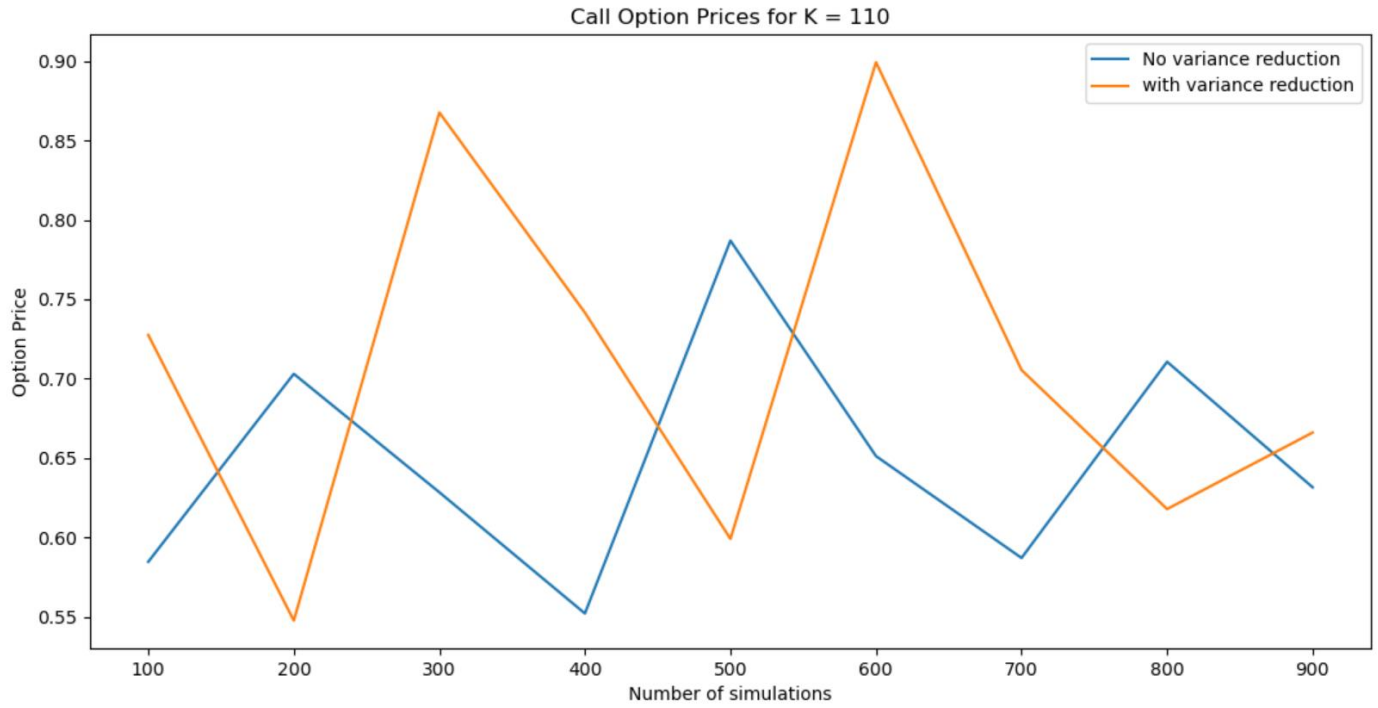
Variance of Call option price without variance reduction for K = 105 is 0.01992

Variance of Call option price with variance reduction for K = 105 is 0.02815



Variance of Call option price without variance reduction for K = 110 is 0.00487

Variance of Call option price with variance reduction for K = 110 is 0.01234

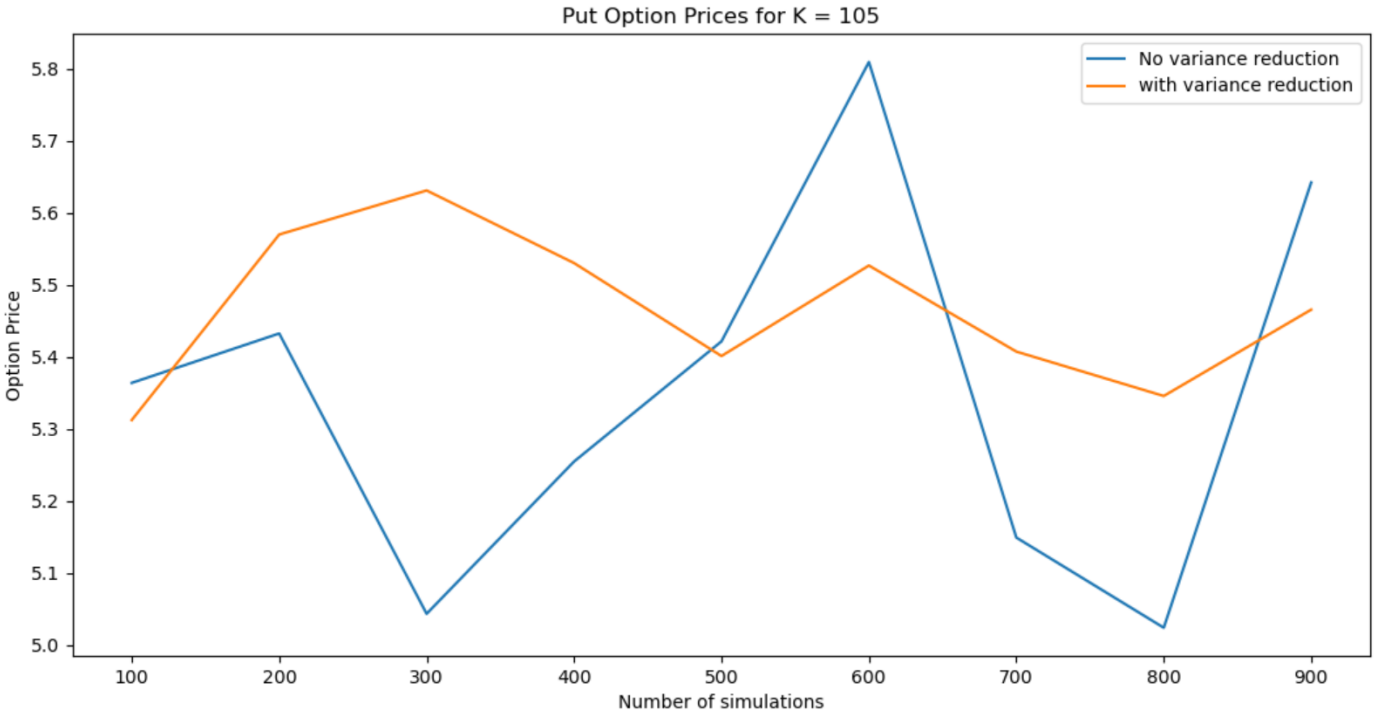


Variance of Put option price without variance reduction for K = 90 is 0.00298

Variance of Put option price with variance reduction for K = 90 is 0.00066

Variance of Put option price without variance reduction for K = 105 is 0.0619

Variance of Put option price with variance reduction for K = 105 is 0.01016



Variance of Put option price without variance reduction for K = 110 is 0.09944

Variance of Put option price with variance reduction for K = 110 is 0.00177