Computational Finance Problem Set 4
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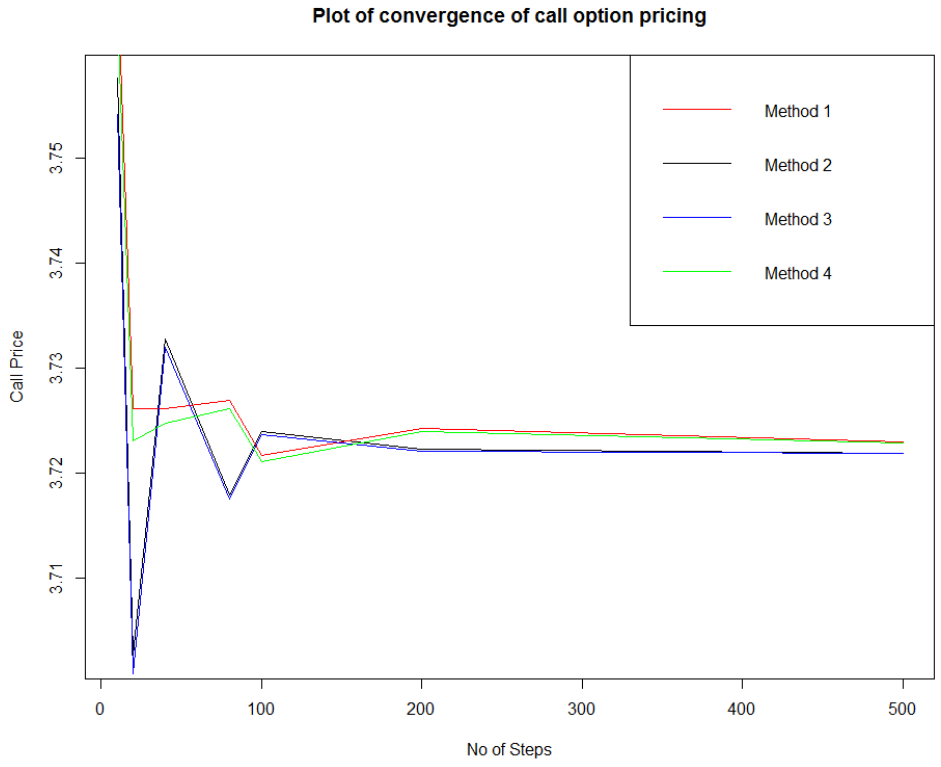
QUESTION 1

All the prices for the 4 types and various values of N are

N	10	20	40	80	100	200	500
Method1	3.76994	3.72614	3.72615	3.72688	3.72163	3.72428	3.72297
Method2	3.75763	3.70258	3.73276	3.71787	3.72394	3.72224	3.72191
Method3	3.75416	3.7008	3.73197	3.71745	3.72364	3.72209	3.72185
Method4	3.76389	3.72307	3.72474	3.72614	3.72103	3.72398	3.72285

The convergence price which can be decided by Black Scholes price using S0=32, K=30, r = 5%, σ = 24%, time = 0.5 years is **3.72244**

All the 4 methods converge towards the Black Scholes price



QUESTION 2

All necessary information (stock and call option prices) were retrieved out of yahoo finance.

The current price (April end of month) for the Google stock is **916.44**

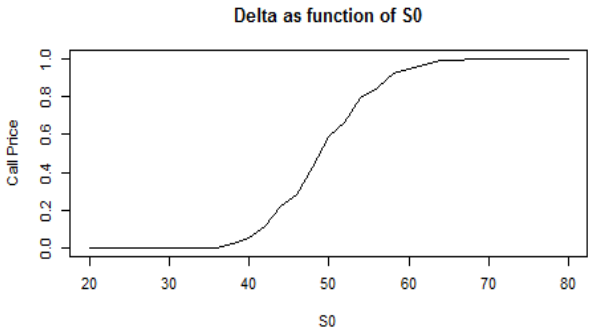
For the historical volatility, we can first retrieve past 61 months' prices (not including current month), from which we can calculate the past 60 returns. We can convert this to annual data and calculate the annual standard deviation of these annual data. Time to maturity of the option was set as *0.75 (9 months) – (8/252),* as the expiry of the January option is on that date.

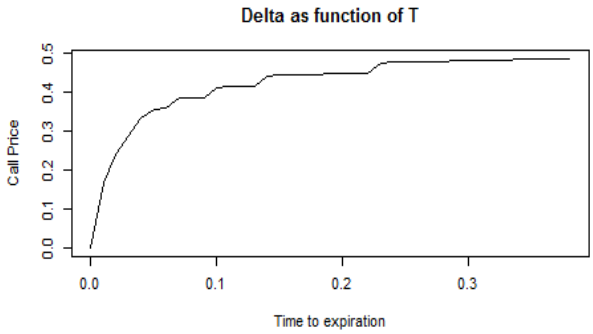
The annual historical volatility = **22.9348%**

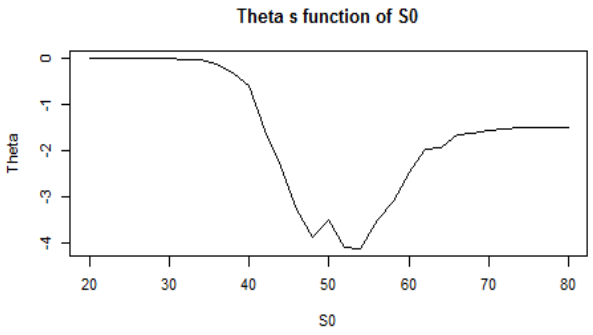
The price based on the historical volatility = $**40.9548**

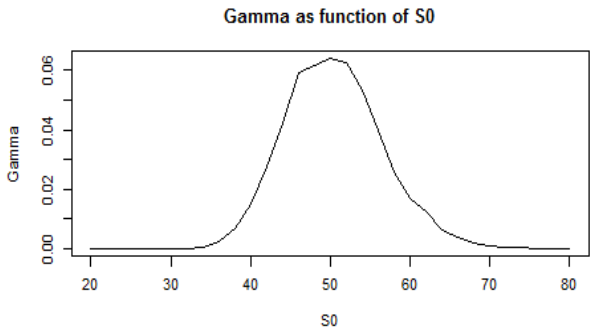
The implied volatility which makes call price equal to the market price of $23.9 (Google call option with current stock price = 916.44, strike = 1000) is **15.93%** (Calculated by making the price equal to the market call price = $23.63).

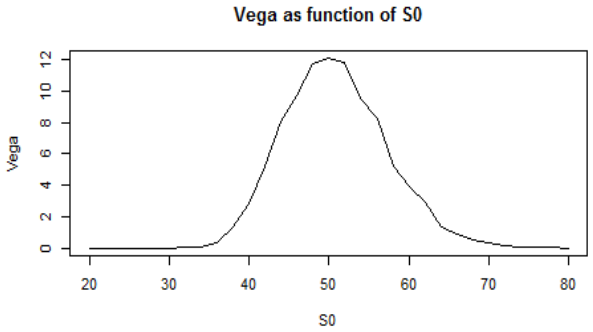
QUESTION 3

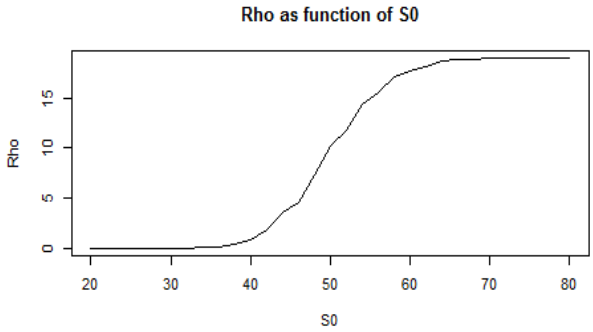

Delta as function of S0
Call Price
0.0
0.2
0.4
0.6
0.8
1.0
20
30
40
50
60
70
80
S0


Delta as function of T
Call Price
0.0
0.1
0.2
0.3
0.4
0.5
0.0
0.1
0.2
0.3
Time to expiration


Theta s function of S0
Theta
0
-1
-2
-3
-4
20
30
40
50
60
70
80
S0


Gamma as function of S0
Gamma
0.00
0.02
0.04
0.06
20
30
40
50
60
70
80
S0

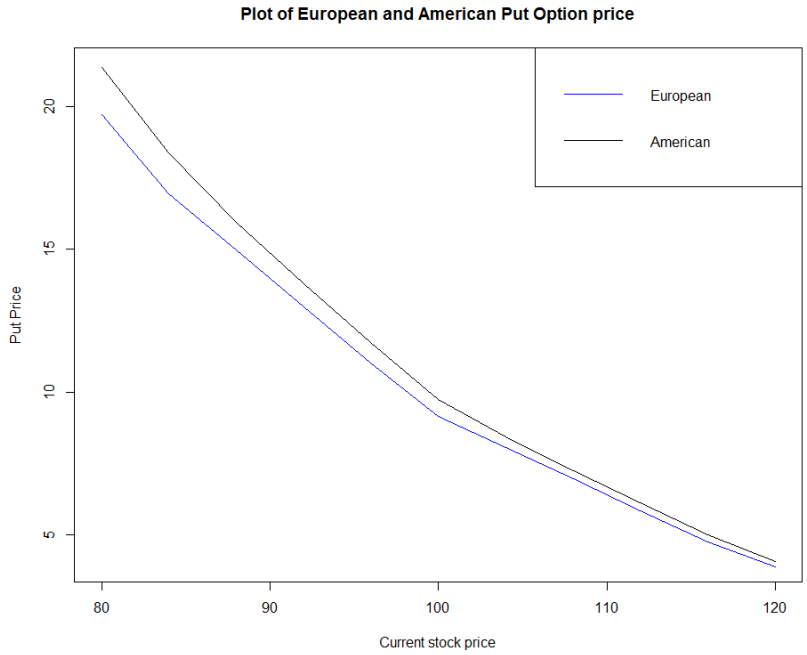

Vega as function of S0
Vega
0
2
4
6
8
10
12
20
30
40
50
60
70
80
S0


Rho as function of S0
Rho
0
5
10
15
20
30
40
50
60
70
80
S0

QUESTION 4

Prices of European and American call are as below

Stock price	80	84	88	92	96	100	104	108	112	116	120
European	19.71	16.93	14.97	13.0	11.03	9.17	8.06	6.95	5.84	4.74	3.9
American	21.35	18.37	15.94	13.8	11.72	9.75	8.43	7.25	6.11	5.0	4.06



The American put is more expensive than the European put. The difference reduces as the stock price increases. This is because of time value of money. If we get the strike early on, we can invest it at risk free rate and get the time value return on it.

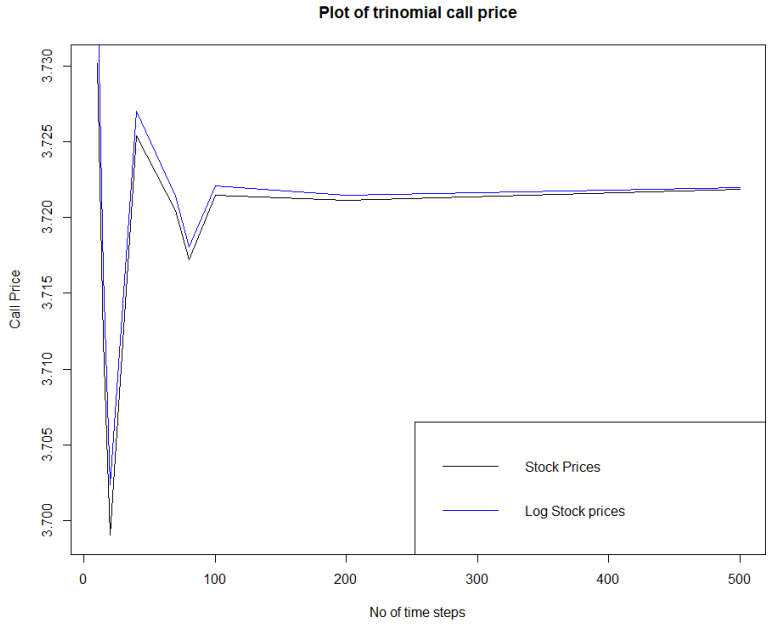
QUESTION 5

The Trinomial returns for the call option is

Intervals	**10**	**15**	**20**	**40**	**70**	**80**	**100**	**200**	**500**
Stock Price	3.730	3.712	3.7	3.725	3.72	3.717	3.721	3.721	3.722
Log normal stock prices	3.736	3.716	3.702	3.727	3.721	3.718	3.722	3.721	3.722

For the log normal prices, we need to build the stock prices in log terms. While calculating the call prices, we need to exponentiate the stock prices and then use that to subtract the strike and get the call prices.

The convergence price which can be decided by Black Scholes price using S0=32, K=30, r = 5%, σ = 24%, time = 0.5 years is = **3.72244**



QUESTION 6

Price of call option for Halton sequenes (b1=2, b2=7) using S0=32, K=30, r = 5%, σ = 24%, time = 0.5 years is **3.73656.**

The convergence price which can be decided by Black Scholes price using S0=32, K=30, r = 5%, σ = 24%, time = 0.5 years is = **3.72244**