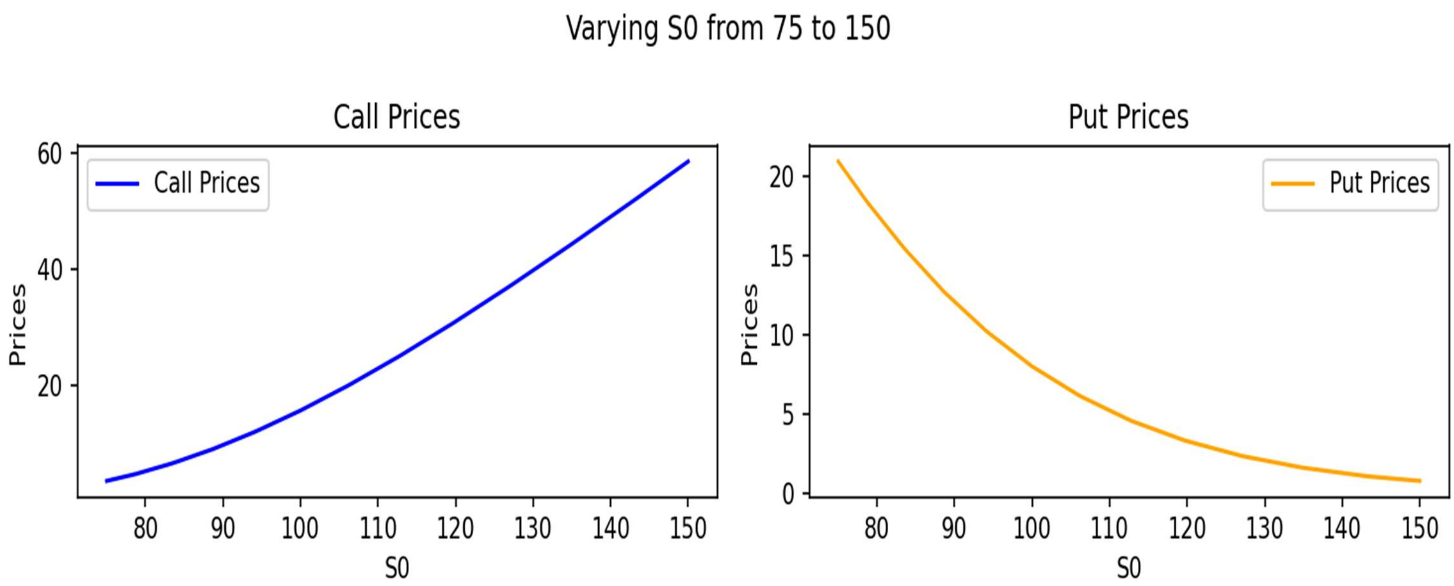
MA 374 Financial Engineering Lab Lab 02

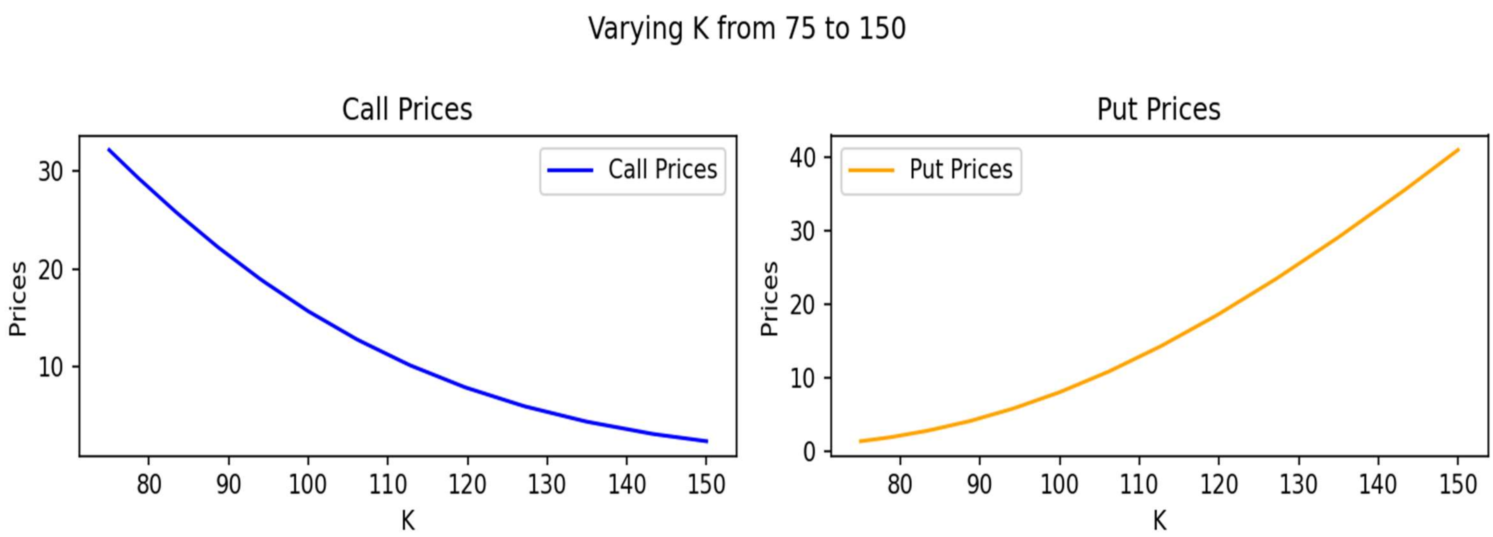
Karan Garg – 210123076

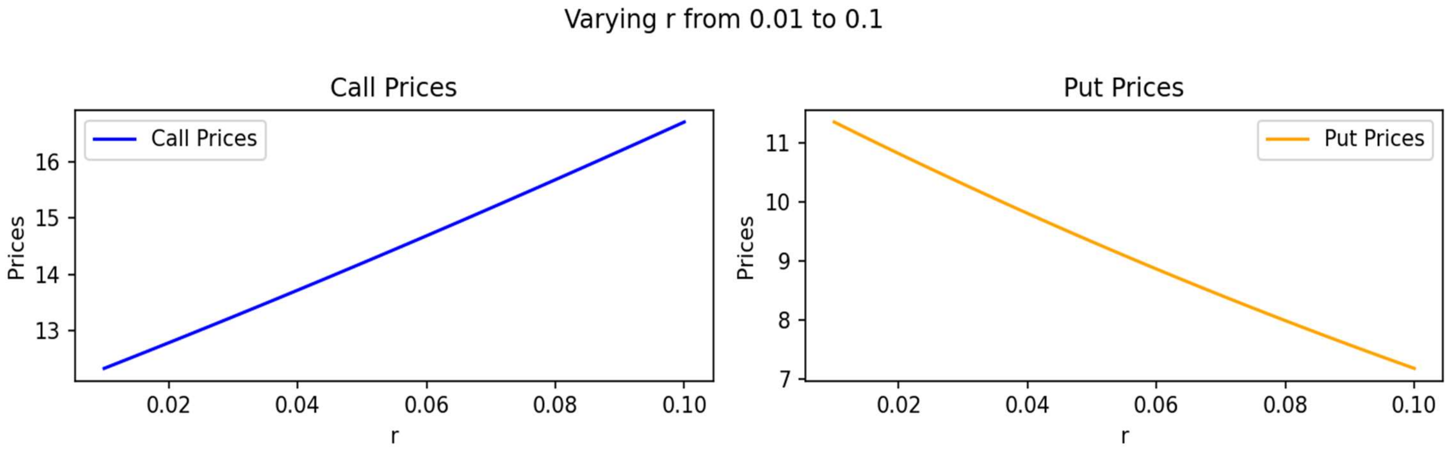
Q1)

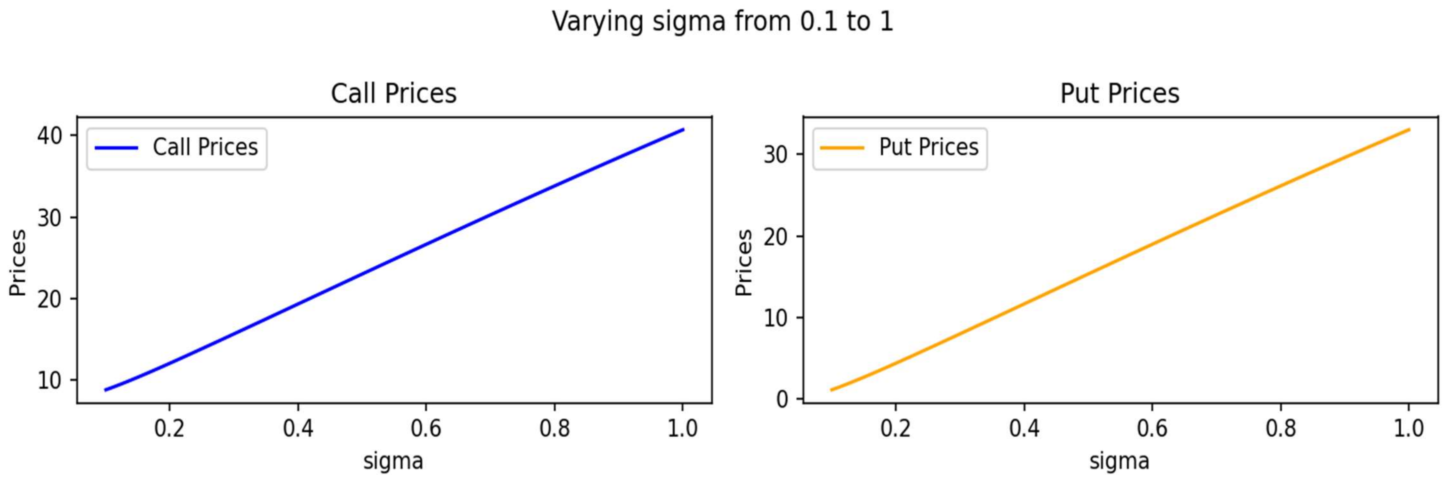
Set 1:

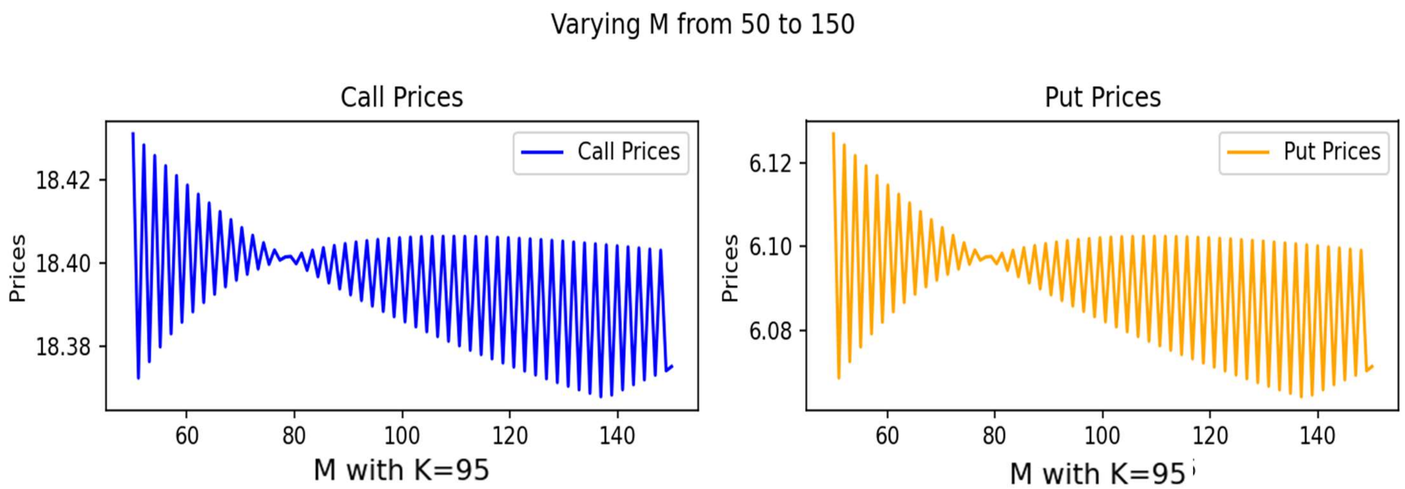
$$u = e^{\sigma\sqrt{\Delta t}}\ ;\ d = e^{-\sigma\sqrt{\Delta t}}.$$

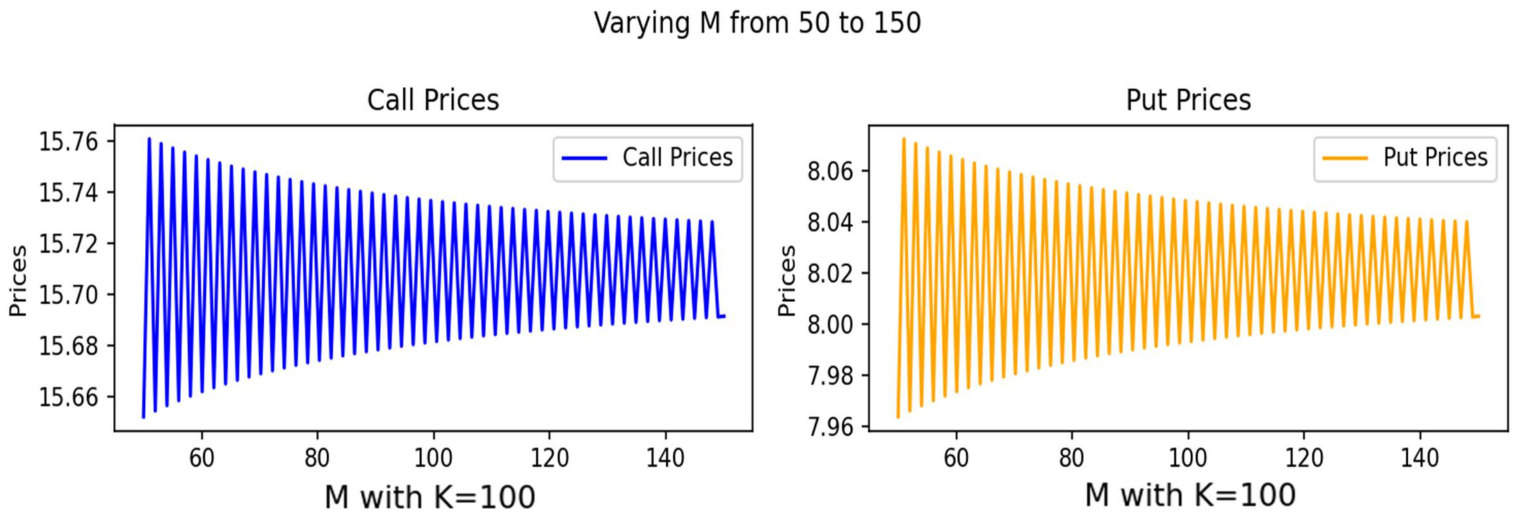


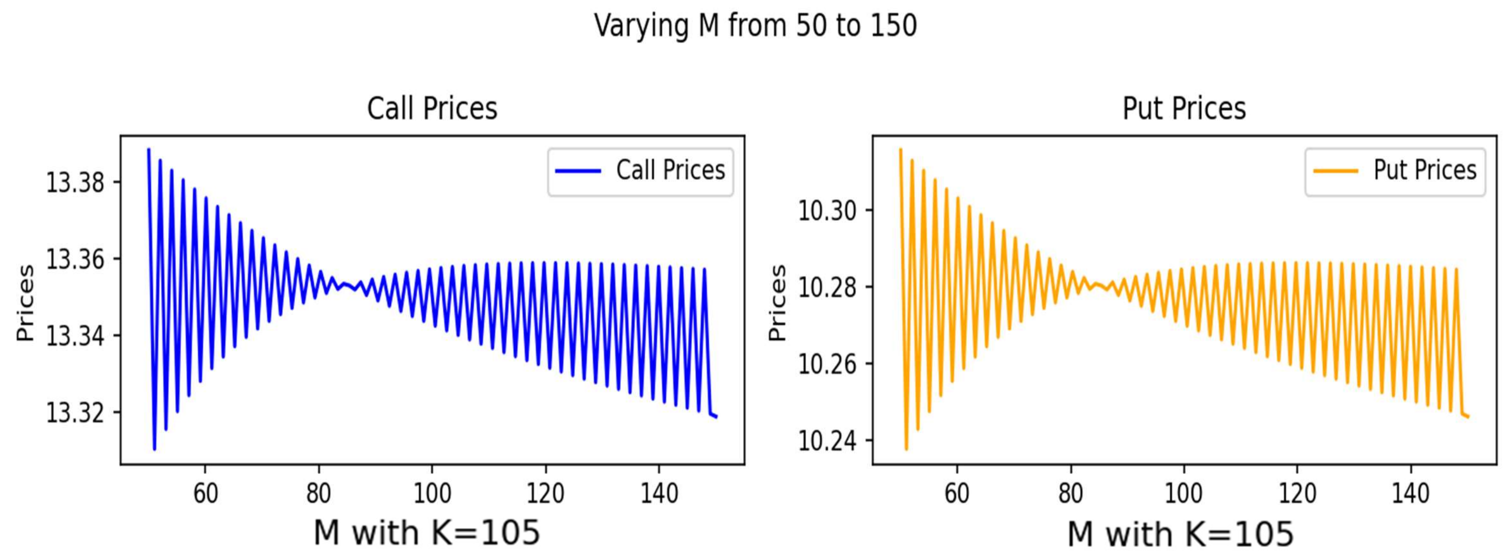



Varying r from 0.01 to 0.1
Call Prices
Call Prices
Prices
r
Put Prices
Put Prices
Prices
r


Varying sigma from 0.1 to 1
Call Prices
Call Prices
Prices
sigma
Put Prices
Put Prices
Prices
sigma

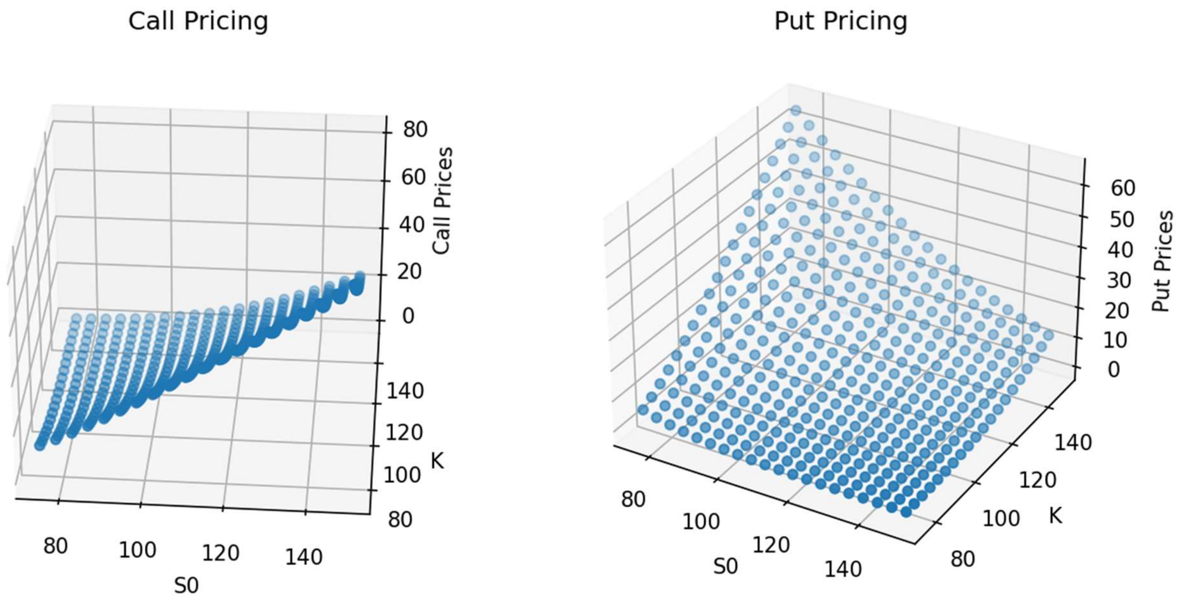

Varying M from 50 to 150
Call Prices
Call Prices
Prices
M with K=95
Put Prices
Put Prices
Prices
M with K=95


Varying M from 50 to 150
Call Prices
Call Prices
15.76
15.74
15.72
15.70
15.68
15.66
Prices
60
80
100
120
140
M with K=100
Put Prices
Put Prices
8.06
8.04
8.02
8.00
7.98
7.96
Prices
60
80
100
120
140
M with K=100

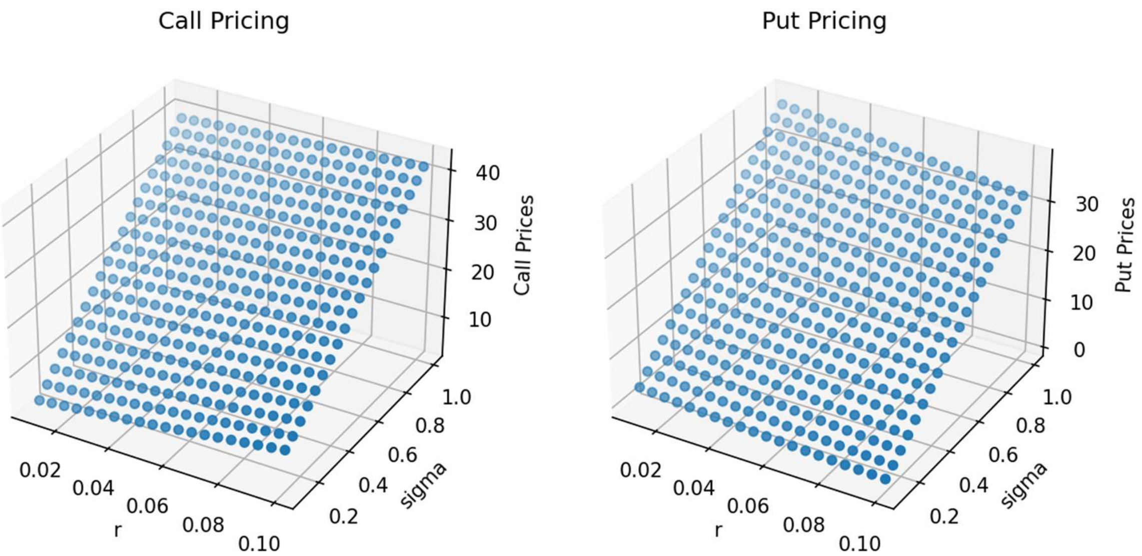

Varying M from 50 to 150
Call Prices
Call Prices
13.38
13.36
13.34
13.32
Prices
60
80
100
120
140
M with K=105
Put Prices
Put Prices
10.30
10.28
10.26
10.24
Prices
60
80
100
120
140
M with K=105

3d plots:

Varying S0 from 75 to 150 and K from 75 to 150

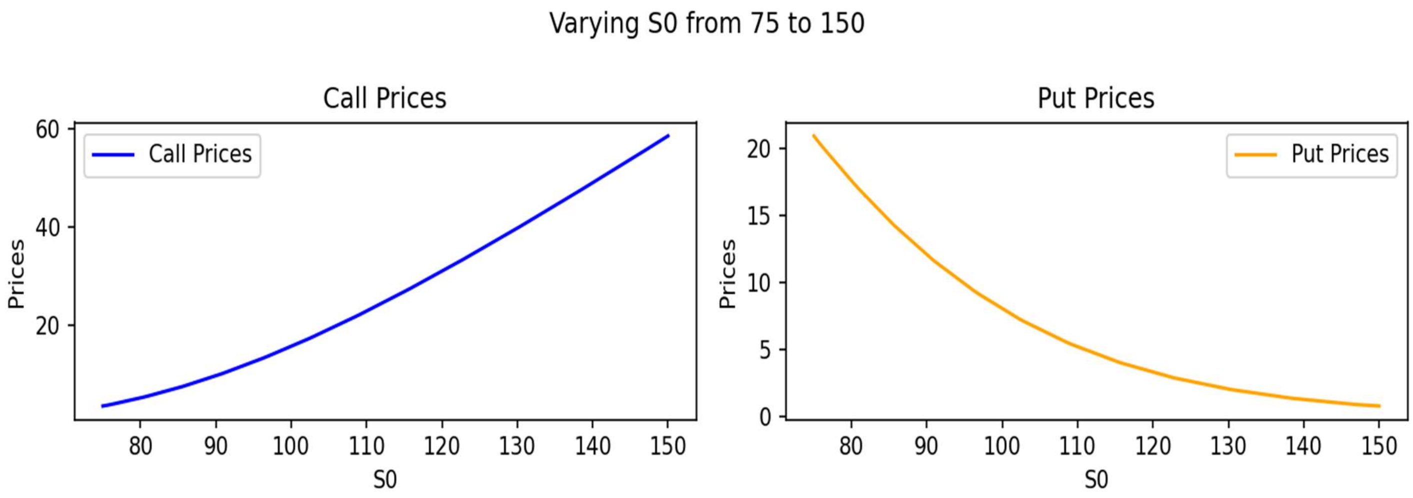


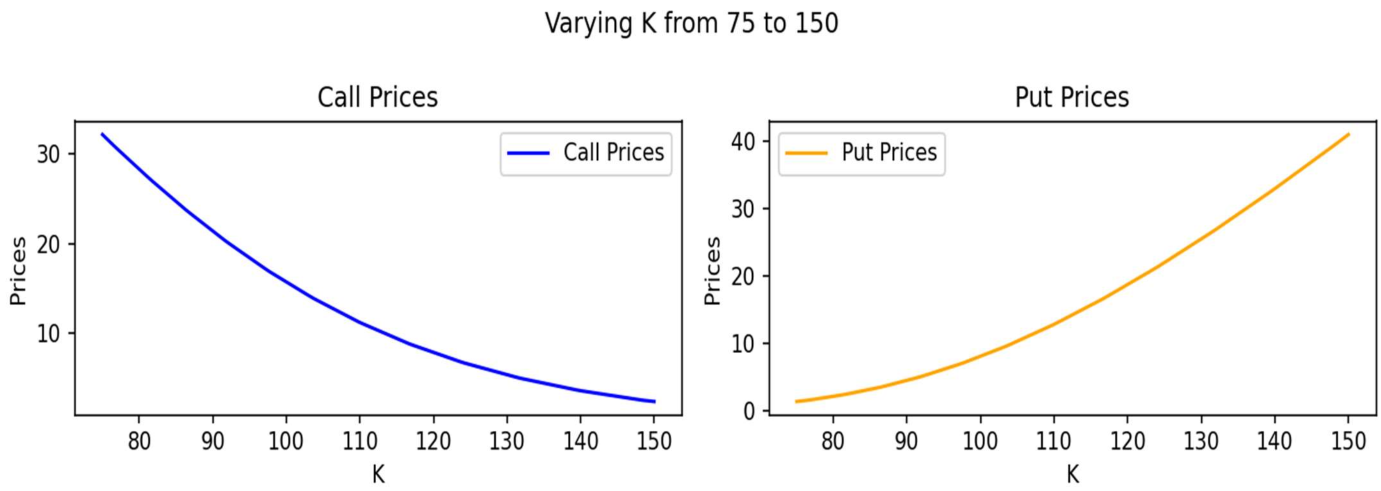
Varying r from 0.01 to 0.1 and sigma from 0.1 to 1

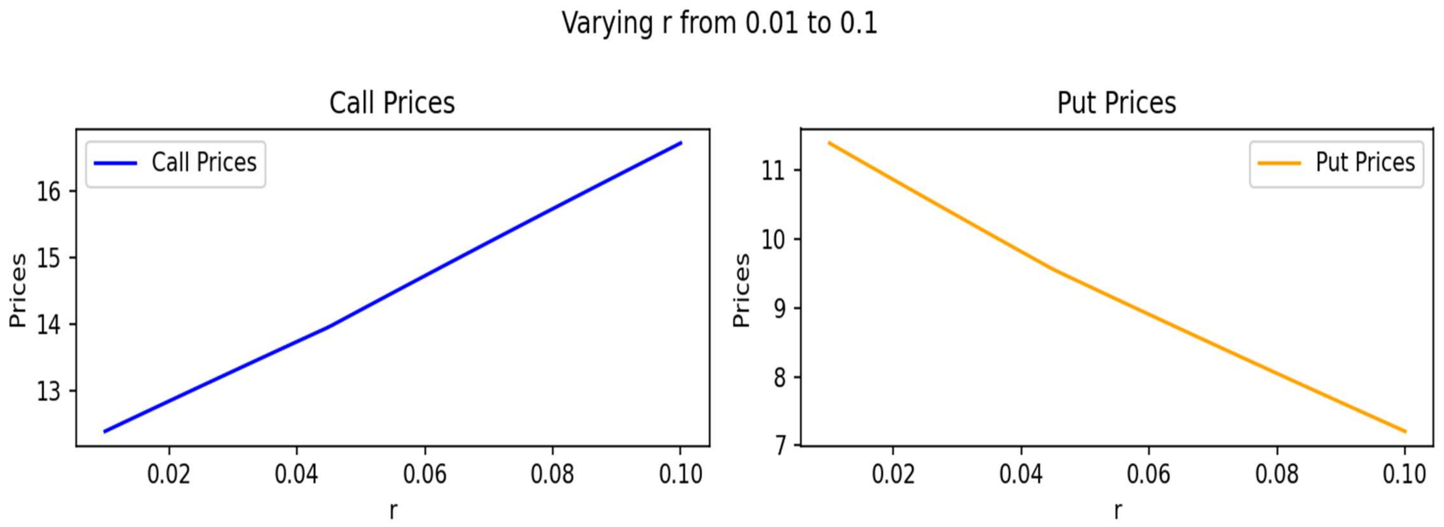


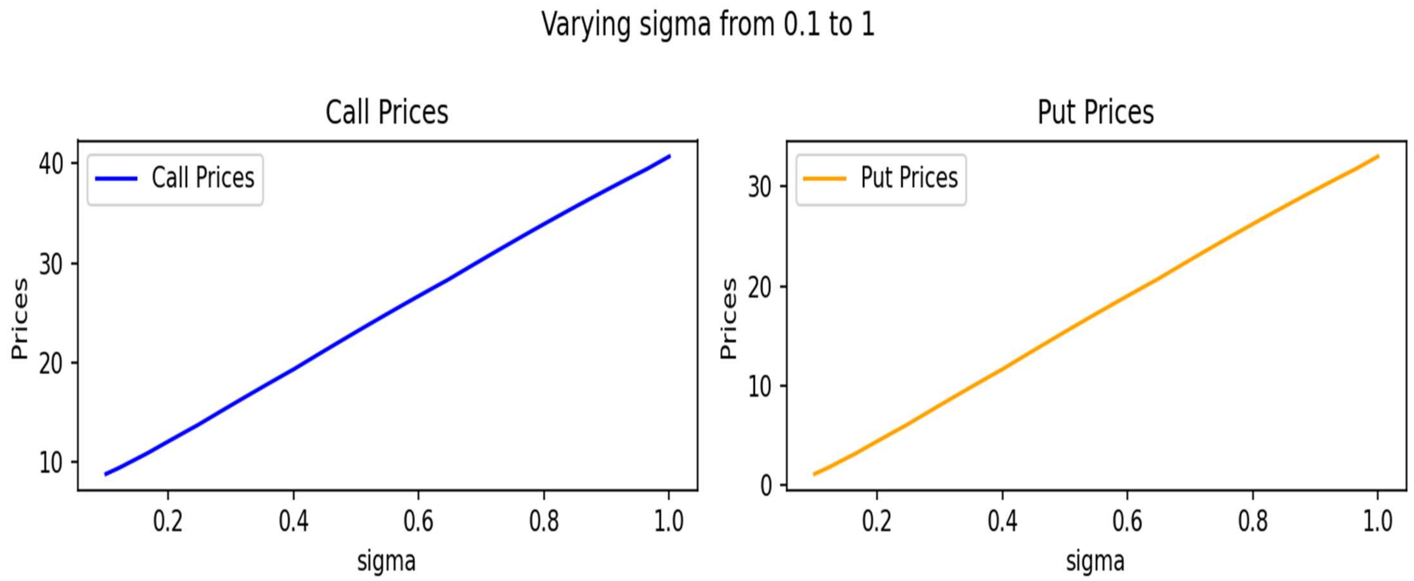
Set 2

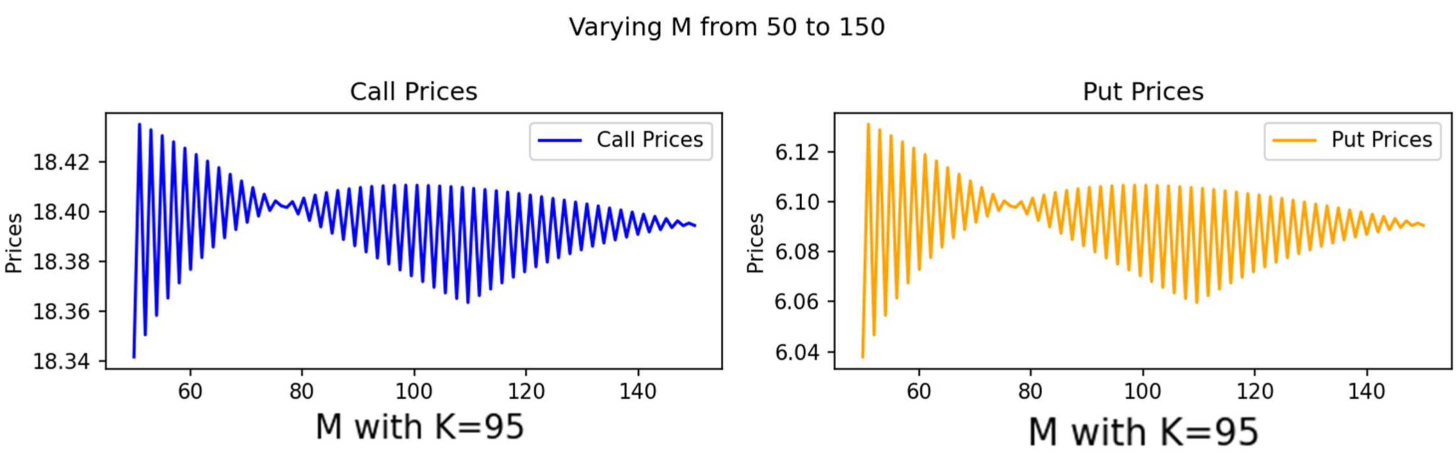
$$u = e^{\sigma\sqrt{\Delta t} + \left(r - \frac{1}{2}\sigma^2\right)\Delta t} \; ; \; d = e^{-\sigma\sqrt{\Delta t} + \left(r - \frac{1}{2}\sigma^2\right)\Delta t}$$

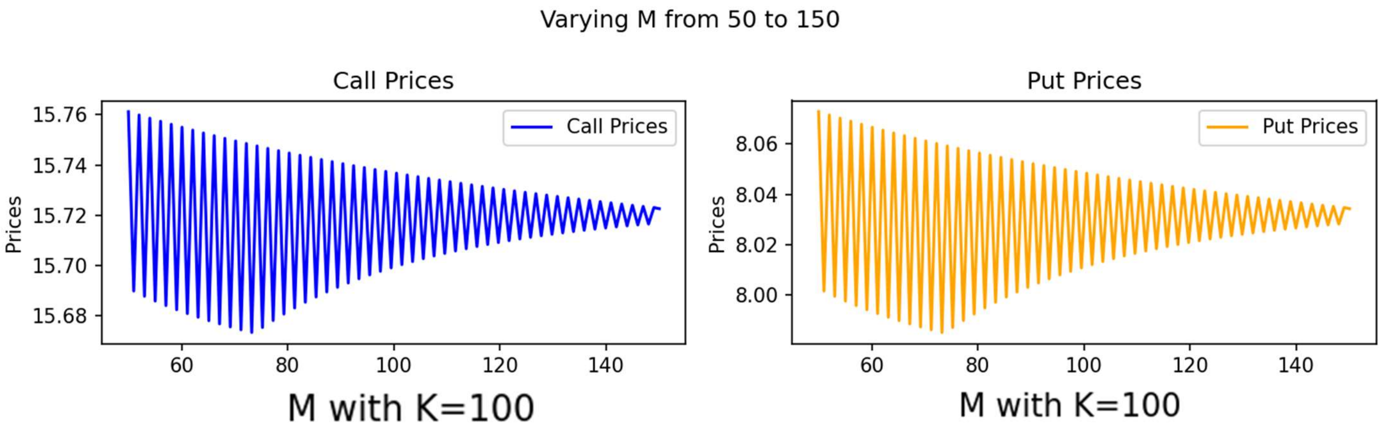


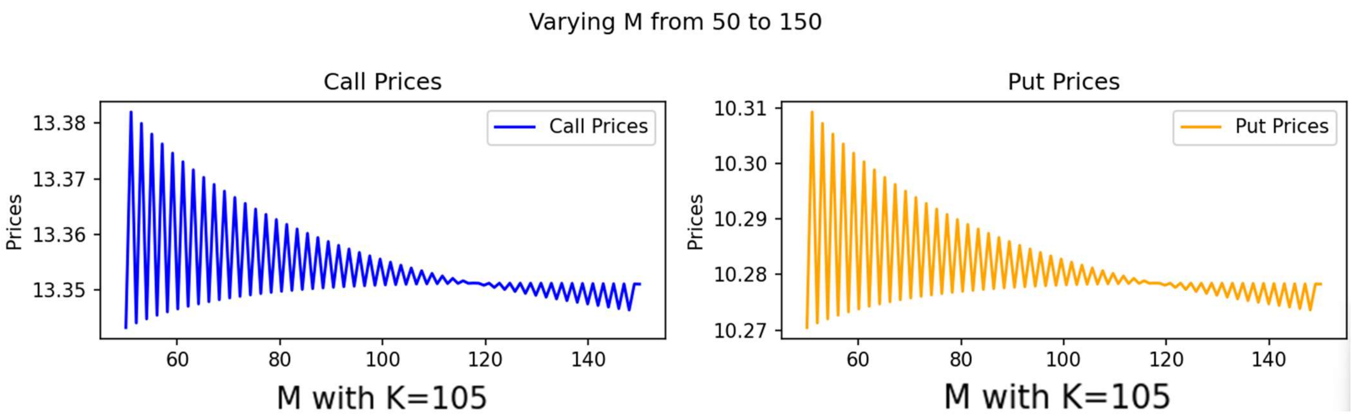



Varying r from 0.01 to 0.1
Call Prices
Put Prices
Prices
r

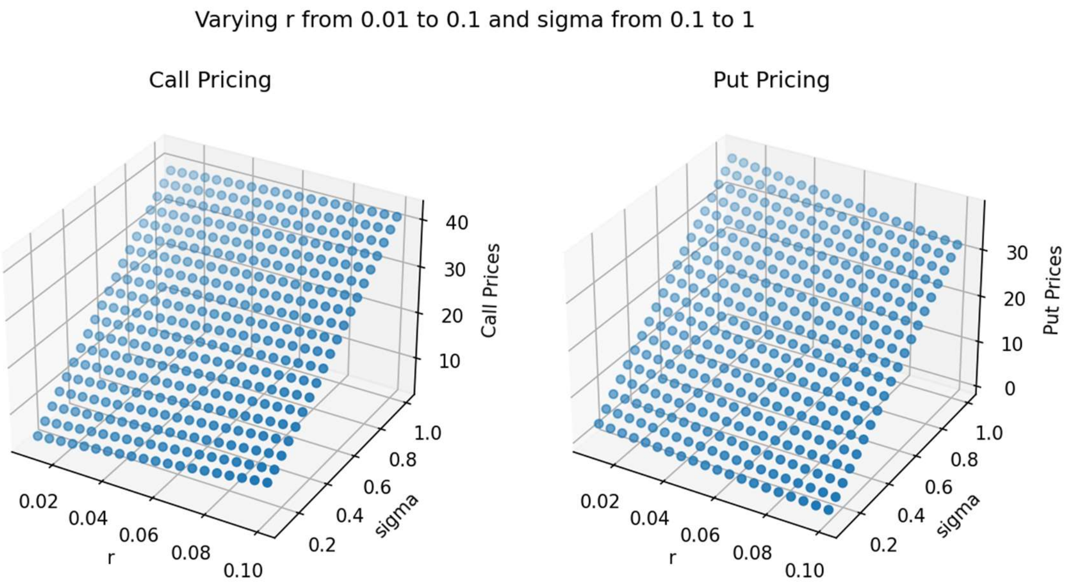

Varying sigma from 0.1 to 1
Call Prices
Put Prices
Prices
sigma


Varying M from 50 to 150
Call Prices
Put Prices
Prices
M with K=95

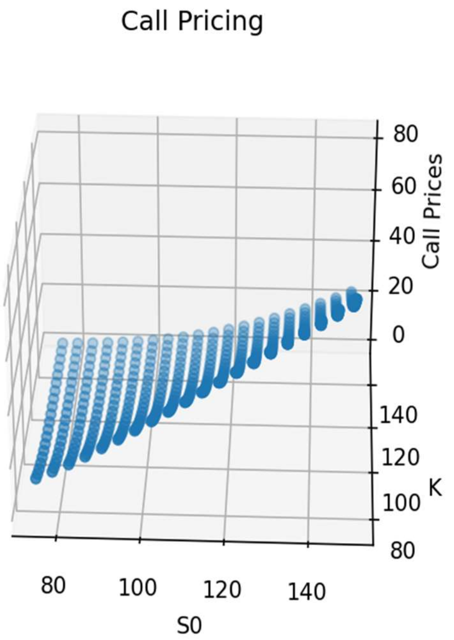

Varying M from 50 to 150
Call Prices
Call Prices
Prices
15.76
15.74
15.72
15.70
15.68
60
80
100
120
140
M with K=100
Put Prices
Put Prices
Prices
8.06
8.04
8.02
8.00
60
80
100
120
140
M with K=100

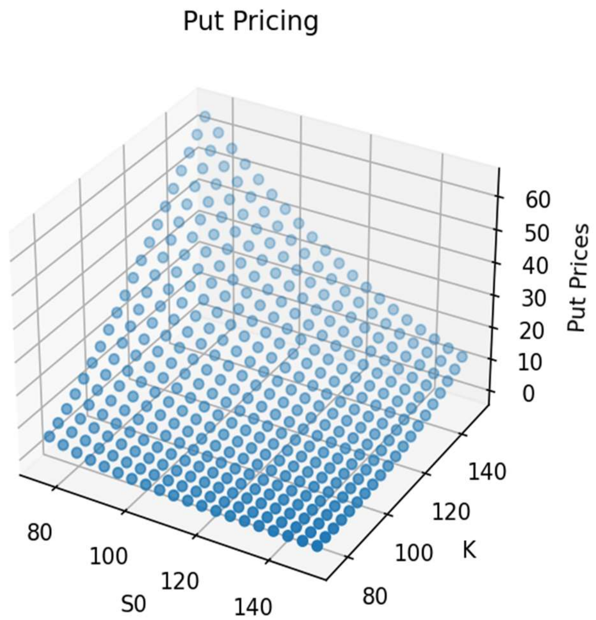

Varying M from 50 to 150
Call Prices
Call Prices
Prices
13.38
13.37
13.36
13.35
60
80
100
120
140
M with K=105
Put Prices
Put Prices
Prices
10.31
10.30
10.29
10.28
10.27
60
80
100
120
140
M with K=105

3D Plots


Varying r from 0.01 to 0.1 and sigma from 0.1 to 1
Call Pricing
Call Prices
40
30
20
10
0.02
0.04
0.06
0.08
0.10
r
0.2
0.4
0.6
0.8
1.0
sigma
Put Pricing
Put Prices
30
20
10
0
0.02
0.04
0.06
0.08
0.10
r
0.2
0.4
0.6
0.8
1.0
sigma

Varying S0 from 75 to 150 and K from 75 to 150





Observation:

We can see in both the cases, the pricing of European option is highly oscillatory when varying with respect to M for different K values, means pricing varies highly with respect to number of steps in binomial pricing.

The 3D plots give us more clarity in how pricing is affected and how it is dependent on S0, K and r, sigma.

Lower the sigma and r and higher is pricing for call options, while pricing of put options are inversely affected

The plots are in accordance to all implication by the formulae.

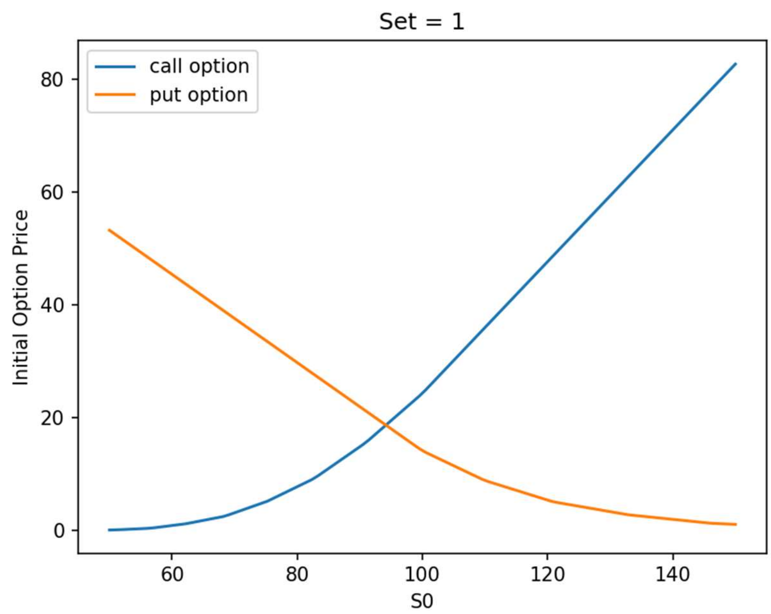
Q2)

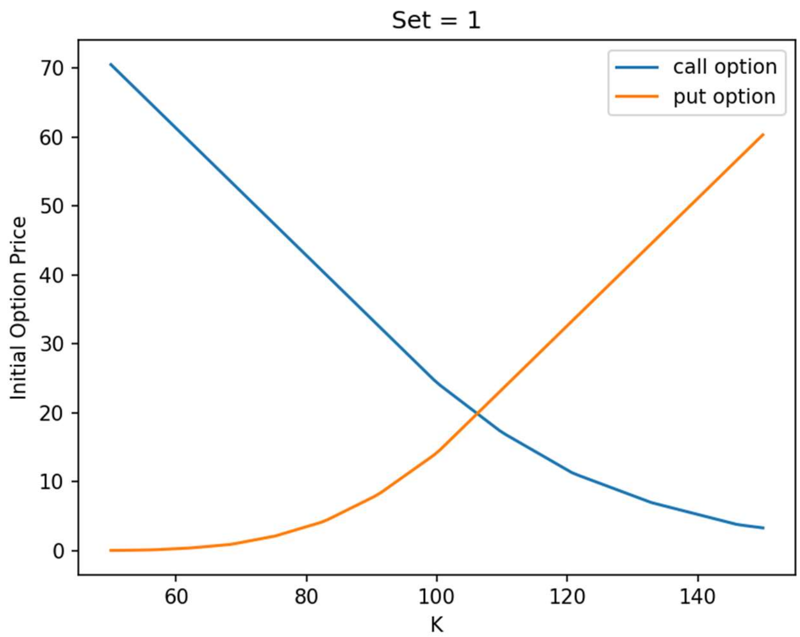
I chose I am taking the loopback option as the path dependent option, i.e, the payoff will depend on the maximum price(in case of call option) and minimum price(in case of put option) of the stock since the contract has been issued.

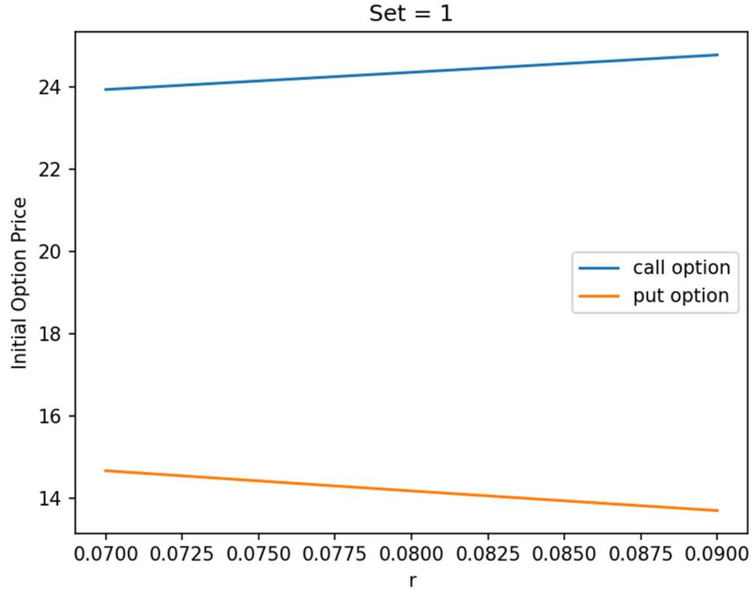
Set-1

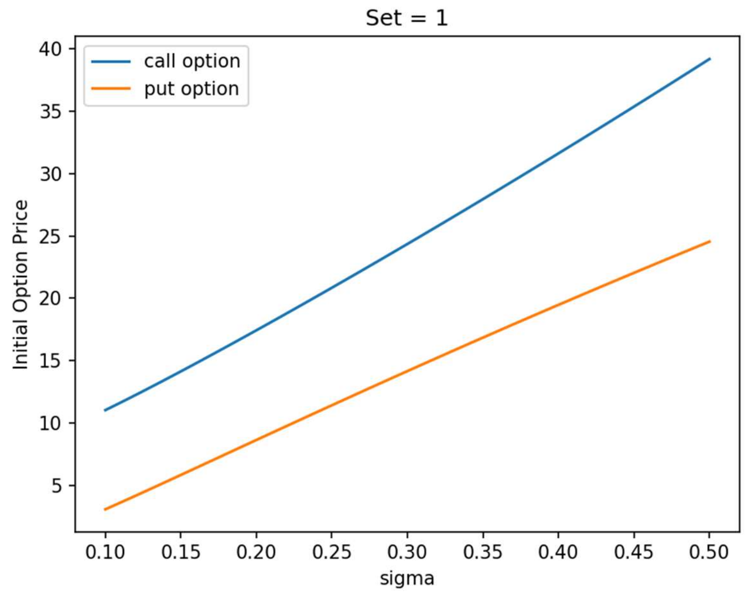
initial call option value: (24.3500260950029, 14.169167660723982)

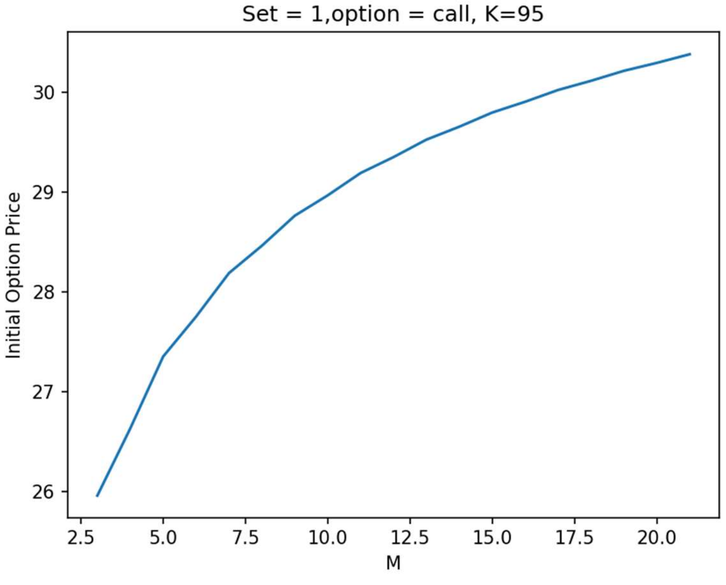
initial put option value: (24.3500260950029, 14.169167660723982)

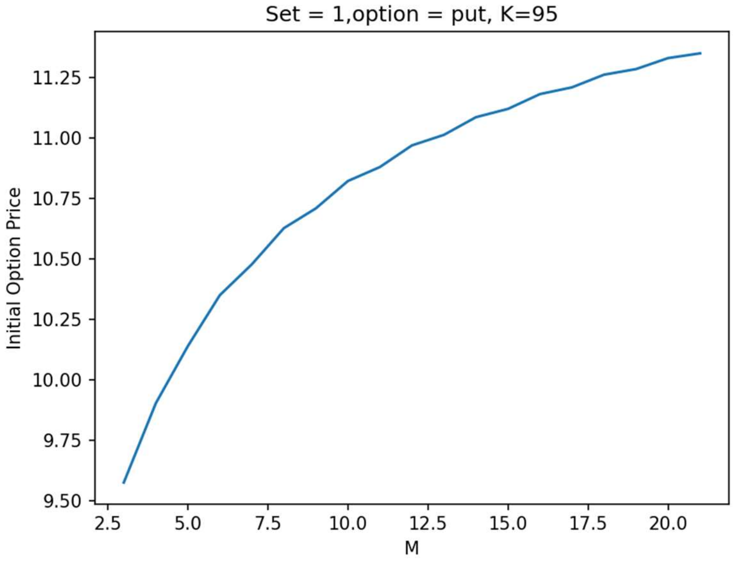


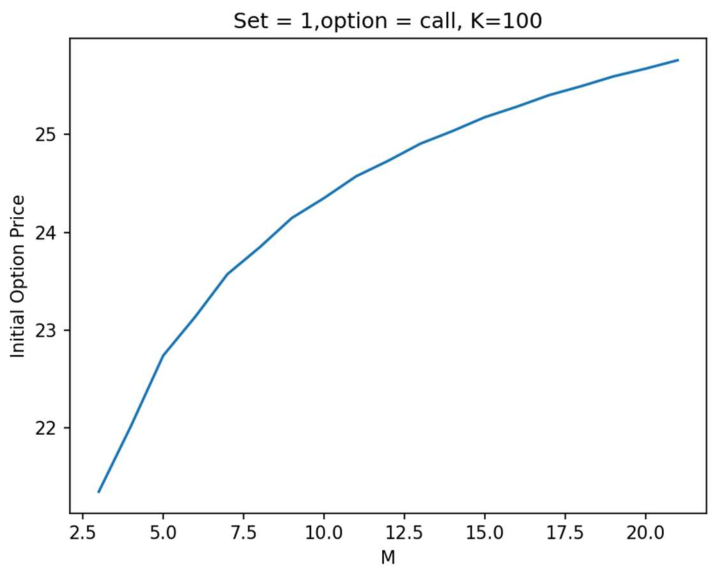


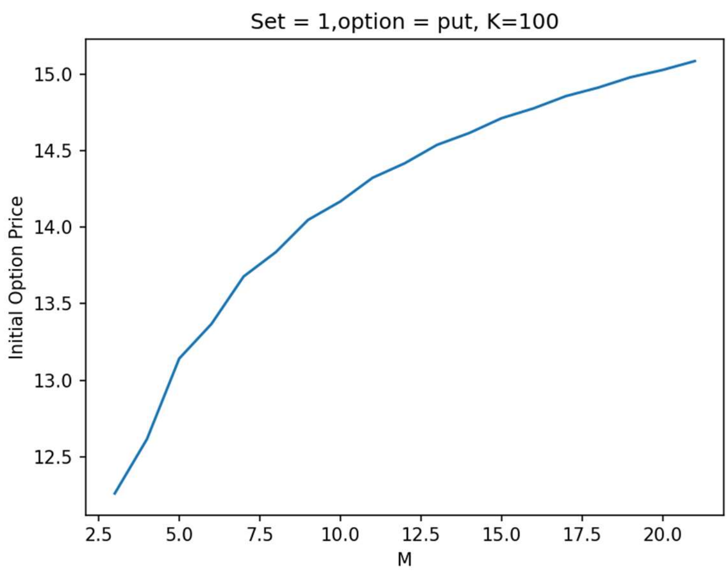

Set = 1
Initial Option Price
r
call option
put option
24
22
20
18
16
14
0.0700
0.0725
0.0750
0.0775
0.0800
0.0825
0.0850
0.0875
0.0900

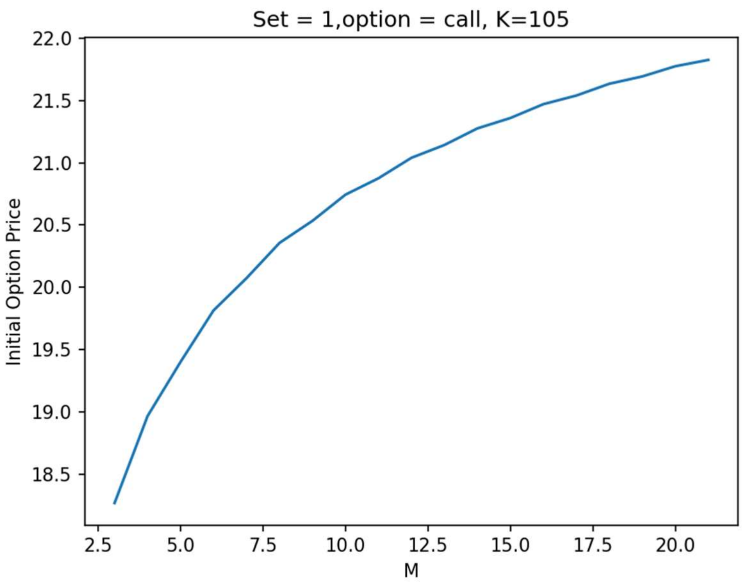

Set = 1
call option
put option
Initial Option Price
sigma
40
35
30
25
20
15
10
5
0.10
0.15
0.20
0.25
0.30
0.35
0.40
0.45
0.50

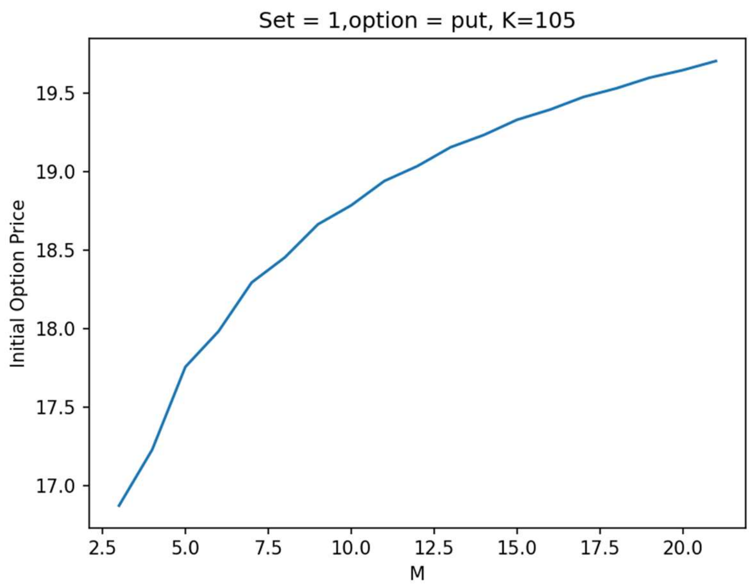

Set = 1,option = call, K=95
Initial Option Price
M
30
29
28
27
26
2.5
5.0
7.5
10.0
12.5
15.0
17.5
20.0


Set = 1,option = put, K=95
Initial Option Price
M
11.25
11.00
10.75
10.50
10.25
10.00
9.75
9.50
2.5
5.0
7.5
10.0
12.5
15.0
17.5
20.0


Set = 1,option = call, K=100
Initial Option Price
M
22
23
24
25
2.5
5.0
7.5
10.0
12.5
15.0
17.5
20.0


Set = 1,option = put, K=100
Initial Option Price
M
12.5
13.0
13.5
14.0
14.5
15.0
2.5
5.0
7.5
10.0
12.5
15.0
17.5
20.0

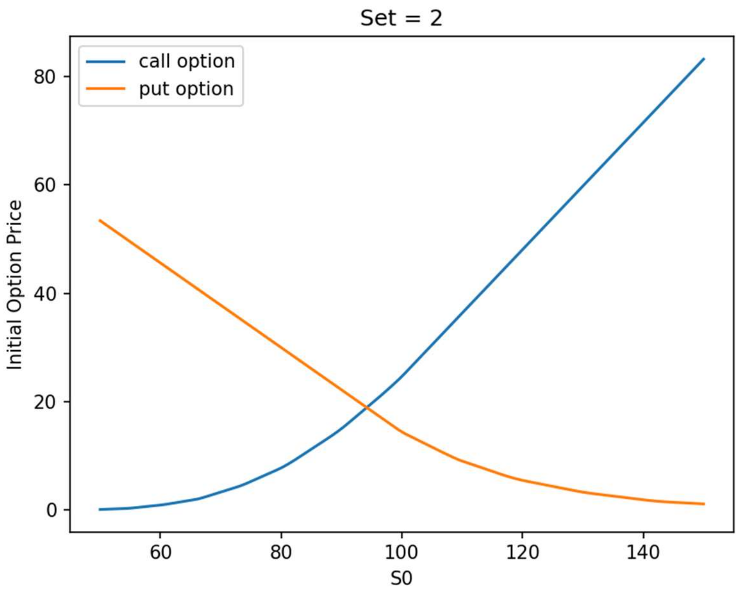

Set = 1,option = call, K=105
Initial Option Price
M
18.5
19.0
19.5
20.0
20.5
21.0
21.5
22.0
2.5
5.0
7.5
10.0
12.5
15.0
17.5
20.0

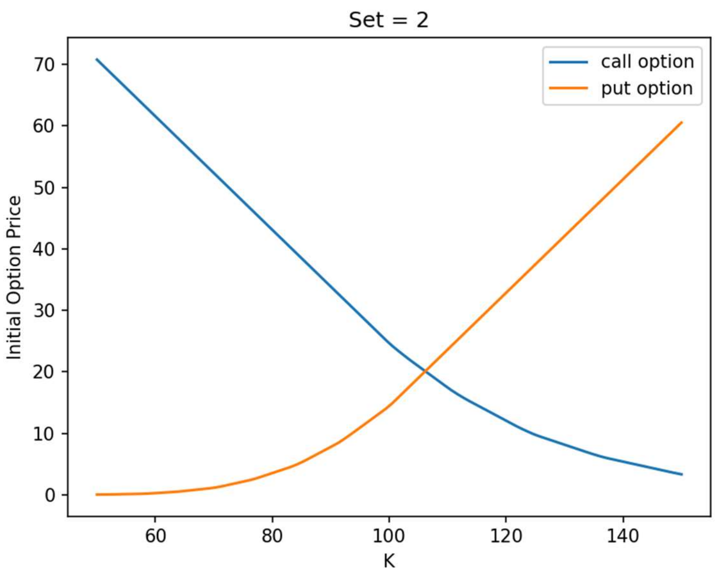

Set = 1,option = put, K=105
Initial Option Price
M
17.0
17.5
18.0
18.5
19.0
19.5
2.5
5.0
7.5
10.0
12.5
15.0
17.5
20.0

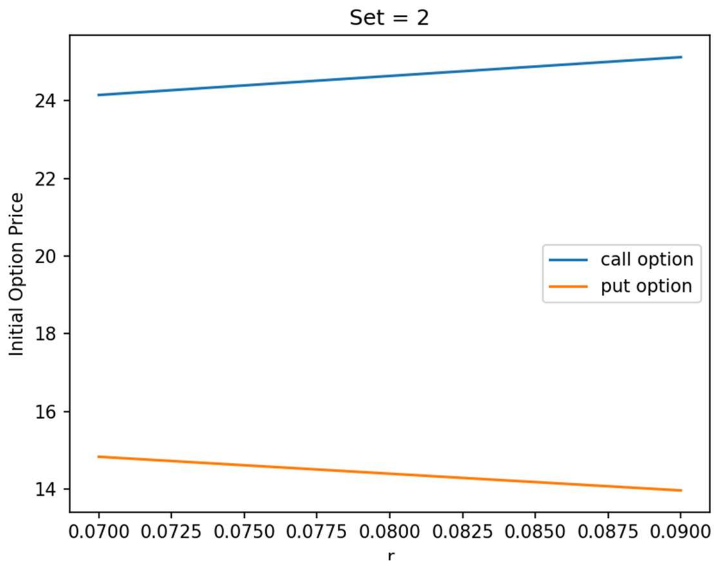
Set-2

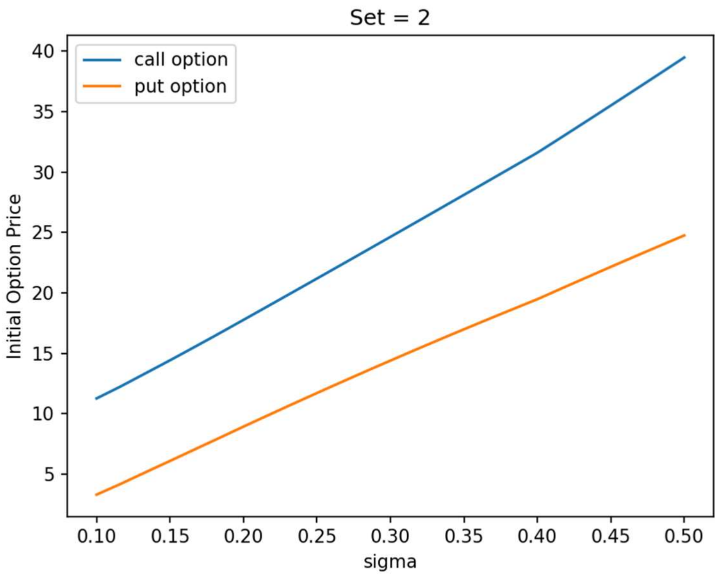
initial call option value: (24.638705853114136, 14.394557152706502)

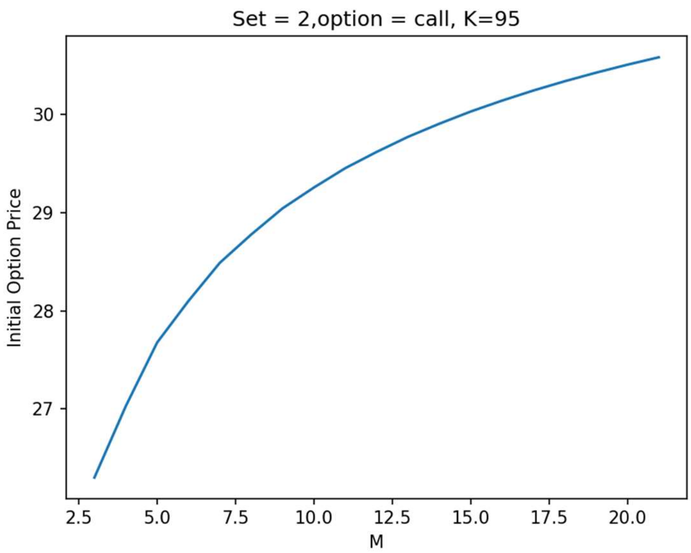
initial put option value: (24.638705853114136, 14.394557152706502)

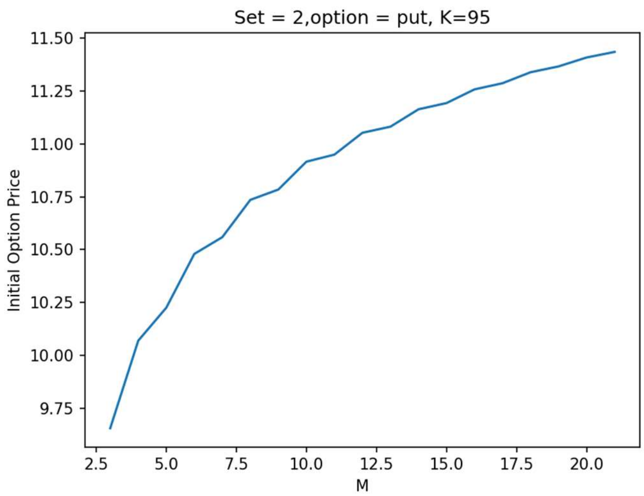


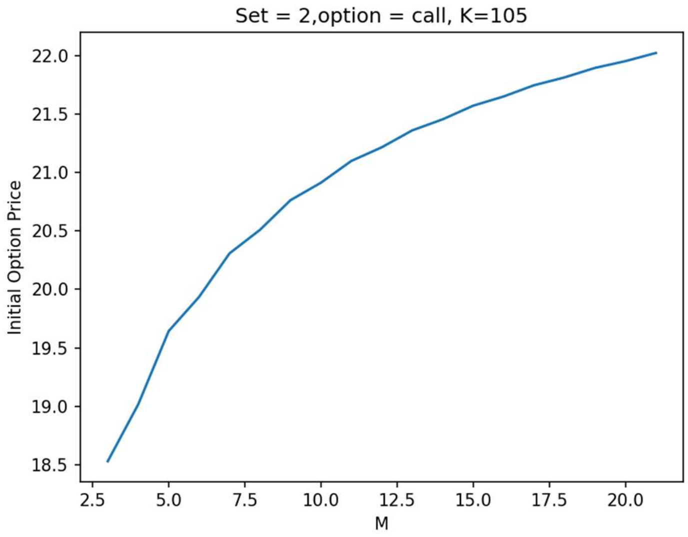


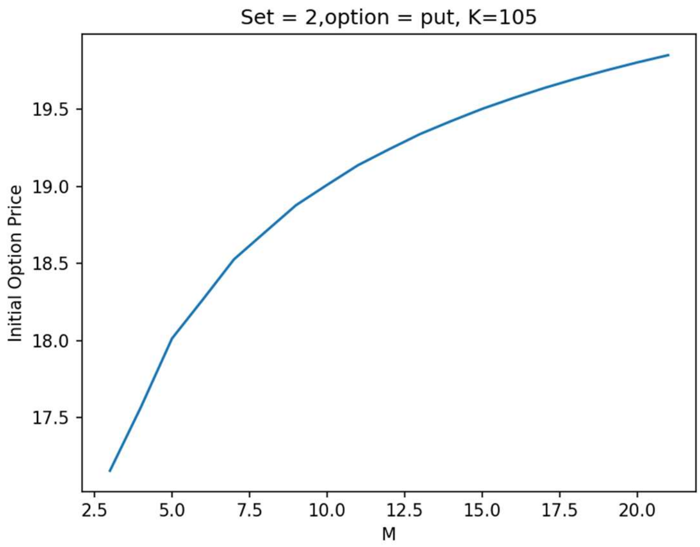

Set = 2
Initial Option Price
r
call option
put option

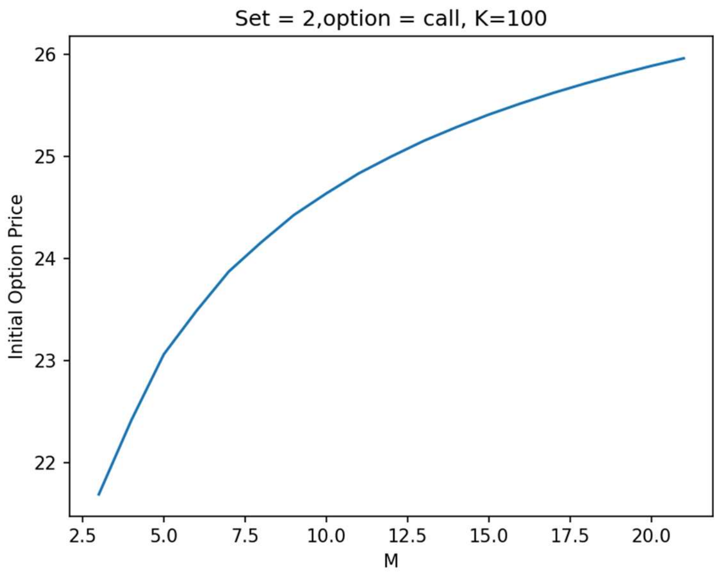

Set = 2
Initial Option Price
sigma
call option
put option

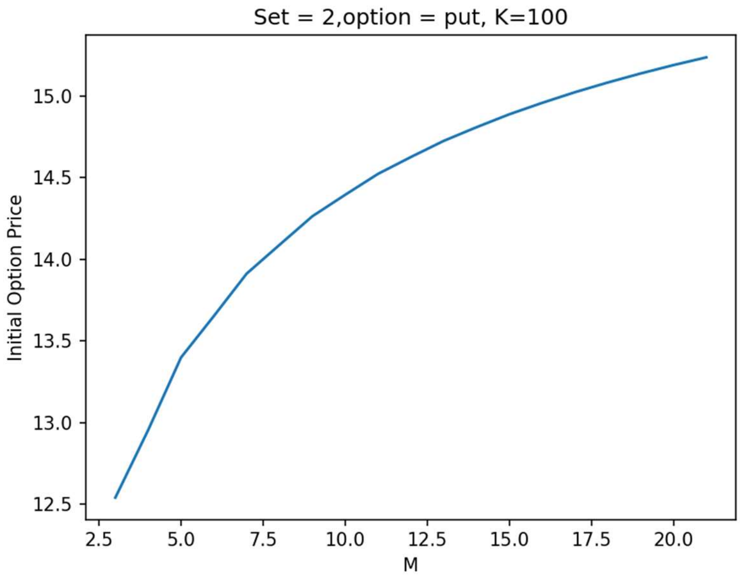

Set = 2,option = call, K=95
Initial Option Price
M


Set = 2,option = put, K=95
Initial Option Price
M









Observations:

Observations In the case of the put option, the payoff is (-min(S)+K) + and in case of call option it is (max(S)-K)+, where min and max are chosen over the timeline of the stock, making it path dependent.

The pricing is far less oscillatory when varying M, when compared to European options.