

Lab 8
Jwalit
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1 QUESTION - 1:

The historical volatility from last one month's data:

***** Historical Volatility of last month for BSE *****

1 WIPRO.BO	0.28602
2 BAJAJ-AUTO.BO	0.253034
3 HDFCBANK.BO	0.15554
4 HEROMOTOCO.BO	0.358761
5 TCS.BO	0.179806
6 INFY.BO	0.271099
7 NESTLEIND.BO	0.236681
8 MARUTI.BO	0.290557
9 RELIANCE.BO	0.243351
10 TATAMOTORS.BO	0.3437
11 BSE Index	0.158524

***** Historical Volatility of last month for NSE *****

SI No Stocks Name Historical Volatility

1 WIPRO.NS	0.259191
2 BAJAJ-AUTO.NS	0.264682
3 HDFCBANK.NS	0.166909
4 HEROMOTOCO.NS	0.35209
5 TCS.NS	0.18165
6 INFY.NS	0.276314
7 NESTLEIND.NS	0.236231
8 MARUTI.NS	0.294158
9 RELIANCE.NS	0.238356
10 TATAMOTORS.NS	0.349414
11 NSE Index	0.157738

2 QUESTION - 2:

Using the final price of the stock price in the data as S_0 , and taking $r = 0.05$, $t = 0$, σ = from the last 1 month's data and various prices of K , the option prices are computed:

***** For stocks - WIPRO.BO *****

Historical volatility for last 1 month = 0.286020315623835

Strike price (K) Call Option Put Option

0.5*S0	126.059	0.00165057
0.6*S0	102.108	0.0473642
0.7*S0	78.5324	0.468021
0.8*S0	56.3925	2.32472
0.9*S0	37.3599	7.28866
1.0*S0	22.7595	16.6847
1.1*S0	12.8028	30.7246
1.2*S0	6.7073	48.6256
1.3*S0	3.30597	69.2208
1.4*S0	1.54861	91.46
1.5*S0	0.695791	114.604

***** For stocks - BAJAJ-AUTO.BO *****

Historical volatility for last 1 month = 0.25303438677643103

Strike price (K) Call Option Put Option

0.5*S0	1306.2	0.00213365
0.6*S0	1057.68	0.135382
0.7*S0	811.115	2.2163
0.8*S0	575.412	15.164
0.9*S0	369.624	58.0274
1.0*S0	212.711	149.765
1.1*S0	109.817	295.521
1.2*S0	51.3471	485.702
1.3*S0	22.03	705.036
1.4*S0	8.79227	940.449
1.5*S0	3.30604	1183.61

***** For stocks - HDFCBANK.BO *****

Historical volatility for last 1 month = 0.15553966425159013

Strike price (K) Call Option Put Option

0.5*S0	539.271	3.90402e-10
0.6*S0	436.614	9.32441e-06
0.7*S0	333.964	0.00628421
0.8*S0	231.726	0.424805
0.9*S0	134.909	6.26446
1.0*S0	59.755	33.7674
1.1*S0	18.9478	95.6168
1.2*S0	4.28852	183.614
1.3*S0	0.716102	282.698
1.4*S0	0.0923057	384.731
1.5*S0	0.00960726	487.305

***** For stocks - HEROMOTOCO.BO *****

Historical volatility for last 1 month = 0.35876095316560974

Strike price (K) Call Option Put Option

0.5*S0	1478.94	0.348222
0.6*S0	1200.6	3.47997
0.7*S0	933.098	17.4437
0.8*S0	690.06	55.8725
0.9*S0	484.931	132.21

1.0*S0	324.707	253.453
1.1*S0	208.244	418.457
1.2*S0	128.704	620.385
1.3*S0	77.1305	850.278
1.4*S0	45.0743	1099.69
1.5*S0	25.8144	1361.9

***** For stocks - TCS.BO *****

Historical volatility for last 1 month = 0.17980621449552703

Strike price (K) Call Option Put Option

Strike price (K)	Call Option	Put Option
0.5*S0	920.995	2.15916e-07
0.6*S0	745.673	0.000472052
0.7*S0	570.422	0.0715462
0.8*S0	396.974	1.94602
0.9*S0	236.68	16.9749
1.0*S0	113.916	69.5329
1.1*S0	43.0232	173.962
1.2*S0	12.8239	319.086
1.3*S0	3.09394	484.678
1.4*S0	0.623608	657.53
1.5*S0	0.108311	832.337

***** For stocks - INFY.BO *****

Historical volatility for last 1 month = 0.27109896165658315

Strike price (K) Call Option Put Option

Strike price (K)	Call Option	Put Option
0.5*S0	315.182	0.0017519
0.6*S0	255.252	0.0695031
0.7*S0	196.028	0.844335
0.8*S0	139.969	4.78336
0.9*S0	91.4716	16.2846
1.0*S0	54.3809	39.1923
1.1*S0	29.5066	74.3163
1.2*S0	14.7442	119.552
1.3*S0	6.86251	171.669
1.4*S0	3.00964	227.814
1.5*S0	1.25698	286.06

***** For stocks - NESTLEIND.BO *****

Historical volatility for last 1 month = 0.23668108599521595

Strike price (K) Call Option Put Option

Strike price (K)	Call Option	Put Option
0.5*S0	5503.09	0.00236676
0.6*S0	4455.76	0.252398
0.7*S0	3413.67	5.73956
0.8*S0	2408.63	48.2785
0.9*S0	1522.42	209.646
1.0*S0	847.916	582.72
1.1*S0	415.583	1197.96
1.2*S0	180.997	2010.96
1.3*S0	71.1031	2948.64
1.4*S0	25.6038	3950.72
1.5*S0	8.58046	4981.27

***** For stocks - MARUTI.BO *****

Historical volatility for last 1 month = 0.29055723796828214

Strike price (K) Call Option Put Option

0.5*S0	3761.34	0.0624402
0.6*S0	3046.92	1.63927
0.7*S0	2344.58	15.3031
0.8*S0	1686.57	73.3002
0.9*S0	1121.88	224.616
1.0*S0	688.256	506.998
1.1*S0	391.131	925.879
1.2*S0	207.639	1458.39
1.3*S0	103.986	2070.74
1.4*S0	49.6062	2732.37
1.5*S0	22.7419	3421.51

***** For stocks - RELIANCE.BO *****

Historical volatility for last 1 month = 0.24335114679176587

Strike price (K) Call Option Put Option

0.5*S0	571.507	0.000436405
0.6*S0	462.751	0.0371912
0.7*S0	354.654	0.733932
0.8*S0	250.775	5.64814
0.9*S0	159.565	23.231
1.0*S0	90.1009	62.5597
1.1*S0	45.1471	126.399
1.2*S0	20.2691	210.314
1.3*S0	8.26969	307.108
1.4*S0	3.11262	410.744
1.5*S0	1.09617	517.521

***** For stocks - TATAMOTORS.BO *****

Historical volatility for last 1 month = 0.34369983443720353

Strike price (K) Call Option Put Option

0.5*S0	87.5214	0.0128947
0.6*S0	71.0024	0.152189
0.7*S0	55.0417	0.849737
0.8*S0	40.4543	2.92068
0.9*S0	28.1123	7.23692
1.0*S0	18.5098	14.2928
1.1*S0	11.6081	24.0493
1.2*S0	6.97985	36.0794
1.3*S0	4.0514	49.8092
1.4*S0	2.28448	64.7006
1.5*S0	1.25842	80.3328

***** For stocks - BSE Index *****

Historical volatility for last 1 month = 0.1585237368520172

Strike price (K) Call Option Put Option

0.5*S0	18483.7	3.12957e-08
0.6*S0	14965.1	0.000524672
0.7*S0	11446.8	0.283614
0.8*S0	7944.7	16.7657
0.9*S0	4638.31	228.978
1.0*S0	2077.32	1186.59
1.1*S0	675.147	3303.01
1.2*S0	159.014	6305.47
1.3*S0	28.0205	9693.08
1.4*S0	3.85727	13187.5
1.5*S0	0.43296	16702.7

***** For stocks - WIPRO.NS *****

Historical volatility for last 1 month = 0.25919139780584455

Strike price (K) Call Option Put Option

0.5*S0	125.677	0.000319881
0.6*S0	101.77	0.0171081
0.7*S0	78.0797	0.251291
0.8*S0	55.51	1.60559
0.9*S0	35.8703	5.88991
1.0*S0	20.8811	14.8247
1.1*S0	10.9736	28.8412
1.2*S0	5.25512	47.0468
1.3*S0	2.322	68.0377
1.4*S0	0.958924	90.5986
1.5*S0	0.374579	113.938

***** For stocks - BAJAJ-AUTO.NS *****

Historical volatility for last 1 month = 0.2646819256693279

Strike price (K) Call Option Put Option

0.5*S0	1303.29	0.00481208
0.6*S0	1055.41	0.223152
0.7*S0	810.089	2.9938
0.8*S0	577.061	18.0626
0.9*S0	374.851	63.9485
1.0*S0	220.38	157.574
1.1*S0	117.579	302.87
1.2*S0	57.4553	490.842
1.3*S0	26.0227	707.506
1.4*S0	11.0589	940.638
1.5*S0	4.45991	1182.14

***** For stocks - HDFCBANK.NS *****

Historical volatility for last 1 month = 0.16690948948038967

Strike price (K) Call Option Put Option

0.5*S0	539.269	7.90216e-09
0.6*S0	436.613	5.41087e-05
0.7*S0	333.973	0.0167329
0.8*S0	232.004	0.703896
0.9*S0	136.55	7.90597

1.0*S0	63.0042	37.0167
1.1*S0	21.8336	98.5024
1.2*S0	5.69501	185.02
1.3*S0	1.15101	283.132
1.4*S0	0.187232	384.825
1.5*S0	0.0254504	487.32

***** For stocks - HEROMOTOCO.NS *****

Historical volatility for last 1 month = 0.3520900194104773

Strike price (K) Call Option Put Option

Strike price (K)	Call Option	Put Option
0.5*S0	1475.35	0.284049
0.6*S0	1197.32	3.048
0.7*S0	929.476	16.0003
0.8*S0	685.502	52.8233
0.9*S0	479.375	127.494
1.0*S0	318.652	247.567
1.1*S0	202.394	412.107
1.2*S0	123.618	614.128
1.3*S0	73.0722	844.379
1.4*S0	42.0529	1094.16
1.5*S0	23.6859	1356.59

***** For stocks - TCS.NS *****

Historical volatility for last 1 month = 0.18165036953378472

Strike price (K) Call Option Put Option

Strike price (K)	Call Option	Put Option
0.5*S0	921.145	3.06824e-07
0.6*S0	745.795	0.000580947
0.7*S0	570.524	0.0804772
0.8*S0	397.164	2.0715
0.9*S0	237.239	17.4974
1.0*S0	114.839	70.4485
1.1*S0	43.8612	174.822
1.2*S0	13.2993	319.611
1.3*S0	3.28172	484.944
1.4*S0	0.679659	657.693
1.5*S0	0.121759	832.486

***** For stocks - INFY.NS *****

Historical volatility for last 1 month = 0.27631403459319437

Strike price (K) Call Option Put Option

Strike price (K)	Call Option	Put Option
0.5*S0	314.87	0.00239496
0.6*S0	255.013	0.0843503
0.7*S0	195.94	0.94987
0.8*S0	140.179	5.12803
0.9*S0	92.0529	16.9404
1.0*S0	55.2083	40.0347
1.1*S0	30.3499	75.1152
1.2*S0	15.4292	120.133
1.3*S0	7.33334	171.976
1.4*S0	3.29467	227.877
1.5*S0	1.41338	285.934

***** For stocks - NESTLEIND.NS *****

Historical volatility for last 1 month = 0.23623130253003924

Strike price (K) Call Option Put Option

0.5*S0	5514.25	0.00227782
0.6*S0	4464.79	0.246782
0.7*S0	3420.51	5.66814
0.8*S0	2413.12	47.9769
0.9*S0	1524.57	209.131
1.0*S0	848.307	582.573
1.1*S0	415.135	1199.1
1.2*S0	180.419	2014.09
1.3*S0	70.6879	2954.06
1.4*S0	25.3752	3958.45
1.5*S0	8.47426	4991.25

***** For stocks - MARUTI.NS *****

Historical volatility for last 1 month = 0.29415801174853734

Strike price (K) Call Option Put Option

0.5*S0	3758.8	0.0748089
0.6*S0	3045.04	1.83532
0.7*S0	2344.09	16.4067
0.8*S0	1688.61	76.4359
0.9*S0	1126.81	230.155
1.0*S0	695.054	513.92
1.1*S0	398.111	932.494
1.2*S0	213.5	1463.4
1.3*S0	108.233	2073.65
1.4*S0	52.3563	2733.29
1.5*S0	24.3748	3420.83

***** For stocks - RELIANCE.NS *****

Historical volatility for last 1 month = 0.23835616618536623

Strike price (K) Call Option Put Option

0.5*S0	565.984	0.000282341
0.6*S0	458.27	0.0284114
0.7*S0	351.123	0.622801
0.8*S0	247.878	5.11963
0.9*S0	156.939	21.9224
1.0*S0	87.7149	60.4399
1.1*S0	43.2356	123.702
1.2*S0	18.9782	207.187
1.3*S0	7.52859	303.479
1.4*S0	2.74219	406.434
1.5*S0	0.93084	512.365

***** For stocks - TATAMOTORS.NS *****

Historical volatility for last 1 month = 0.3494139705247439

Strike price (K) Call Option Put Option

0.6*S0	71.0424	0.171385
0.7*S0	55.1249	0.917135
0.8*S0	40.6108	3.06613
0.9*S0	28.3428	7.46133
1.0*S0	18.7838	14.5655
1.1*S0	11.8832	24.3281
1.2*S0	7.22253	36.3306
1.3*S0	4.24512	50.0163
1.4*S0	2.42755	64.8619
1.5*S0	1.35785	80.4554

***** For stocks - NSE Index *****

Historical volatility for last 1 month = 0.15773797914236246

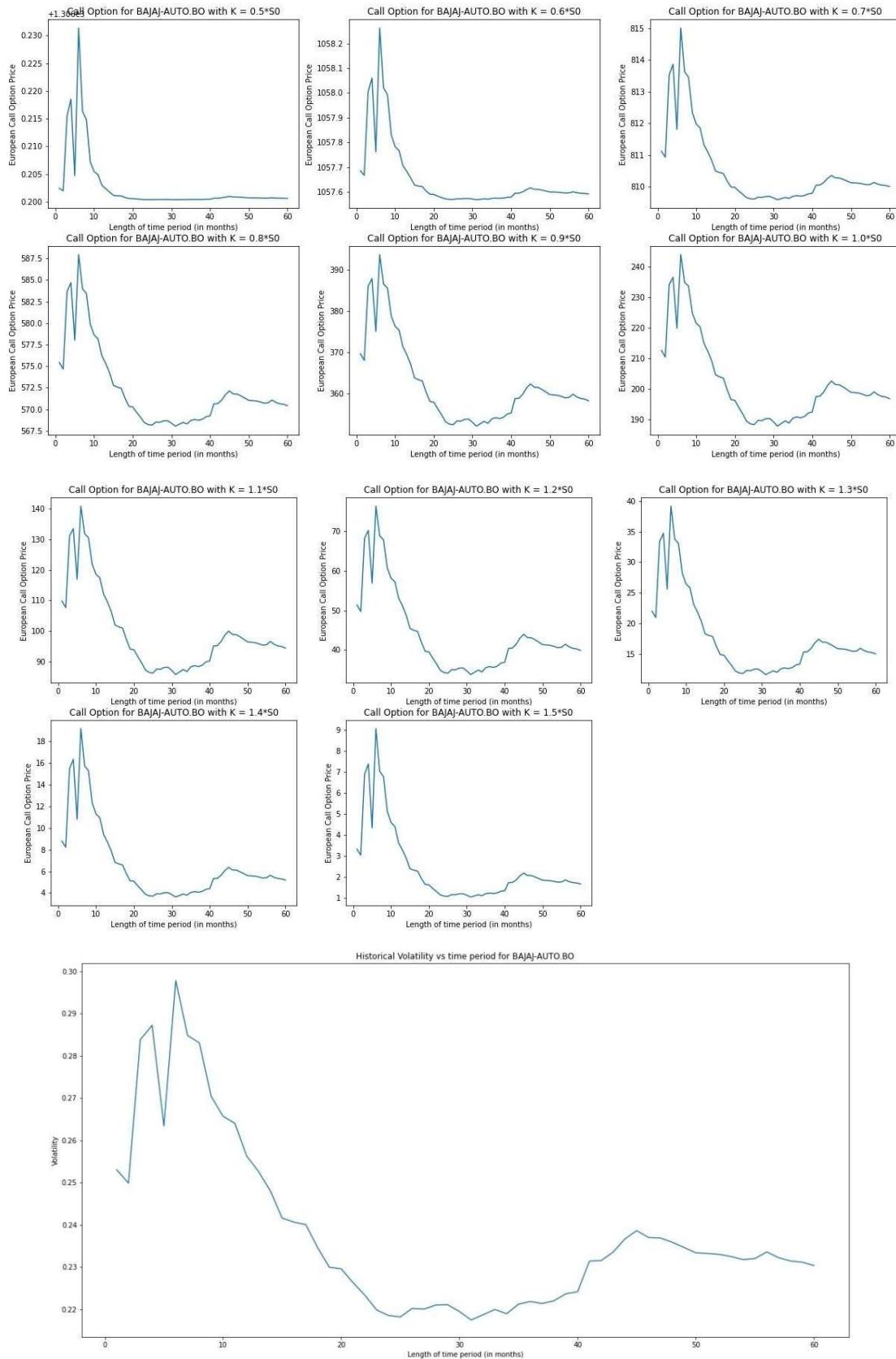
Strike price (K)	Call Option	Put Option
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0.5*S0	5564.02	7.566e-09
0.6*S0	4504.84	0.000138964
0.7*S0	3445.74	0.0795143
0.8*S0	2391.35	4.86593
0.9*S0	1395.09	67.7862
1.0*S0	623.006	354.874
1.1*S0	201.191	992.236
1.2*S0	46.9004	1897.12
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1.4*S0	1.10311	3969.68
1.5*S0	0.12143	5027.87

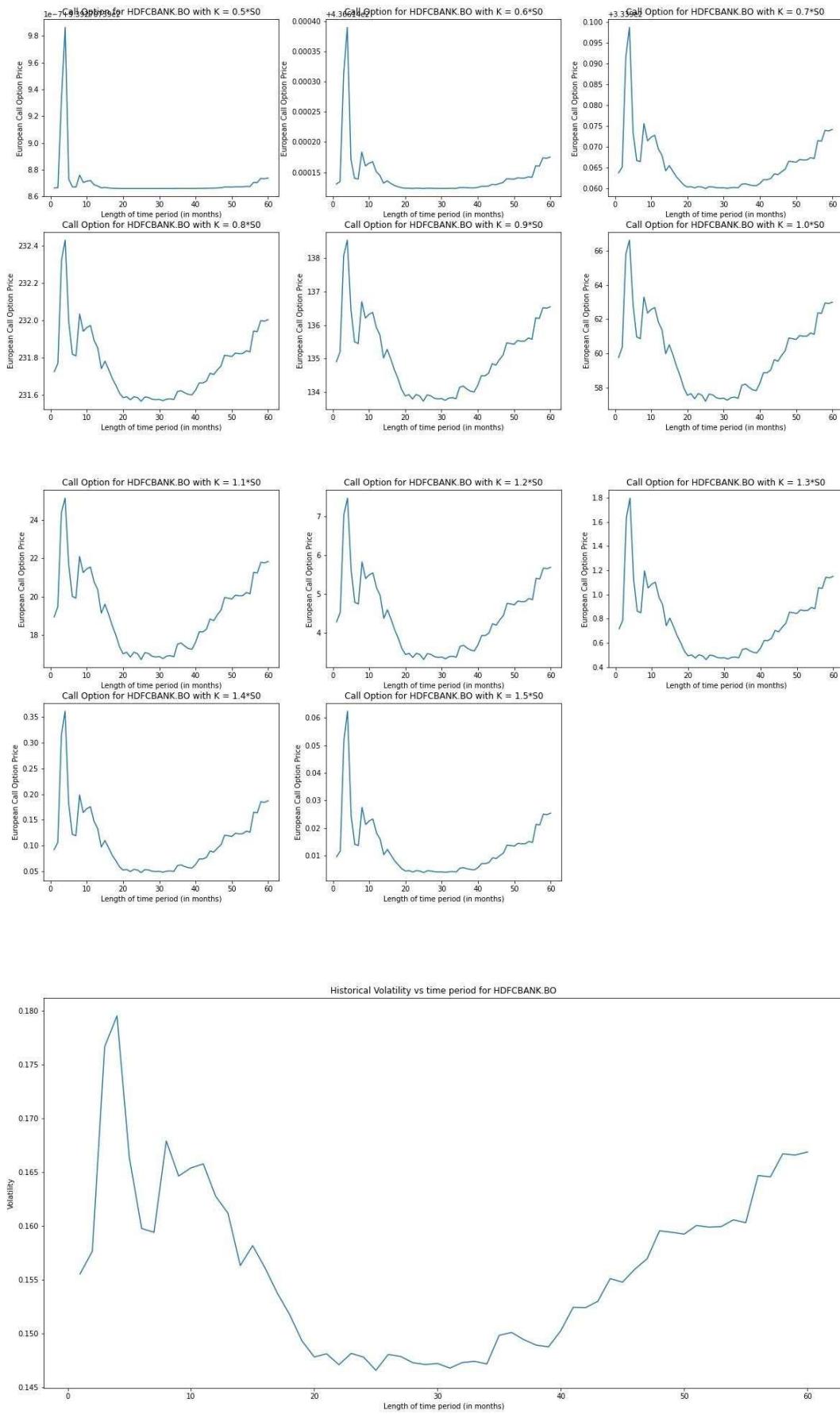
3 QUESTION – 3 :

i. Plots for Call Option and Volatility - stocks in bsedata1:

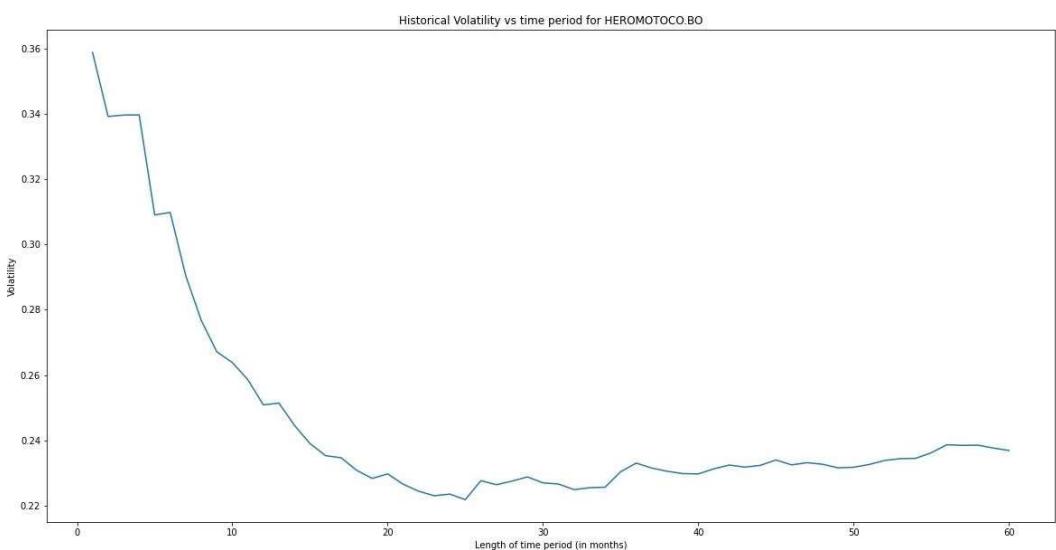
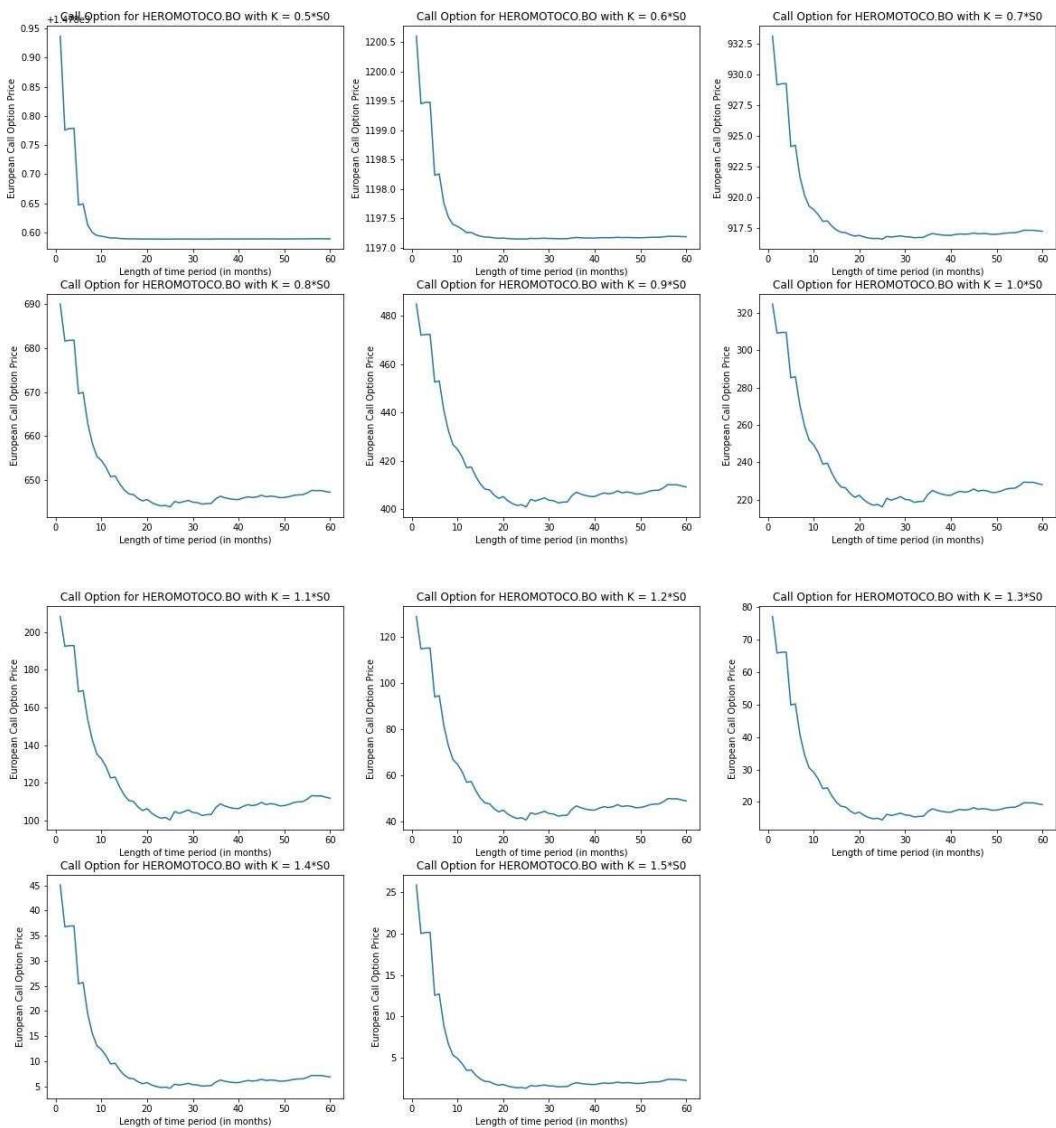
i) BAJA-AUTO.BO



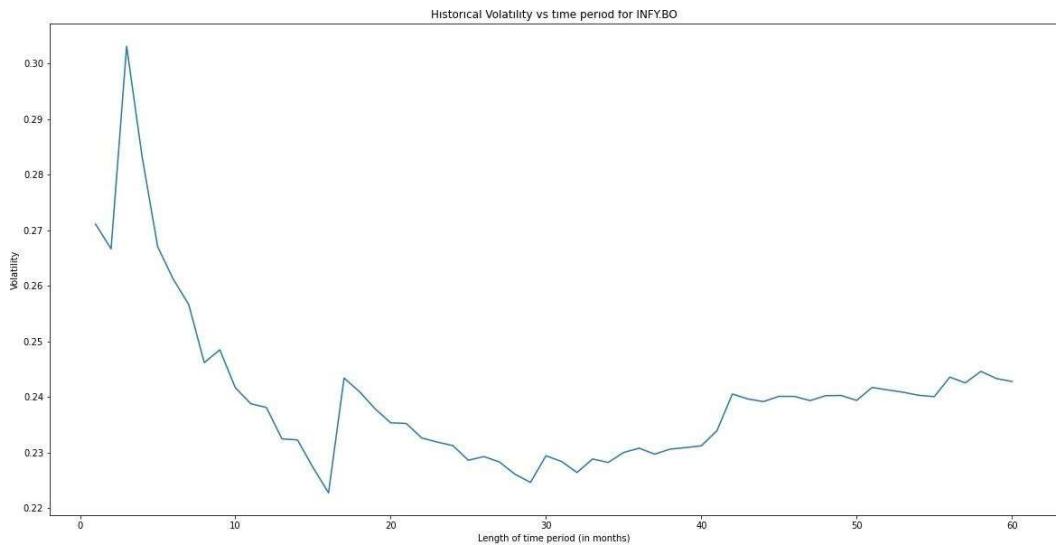
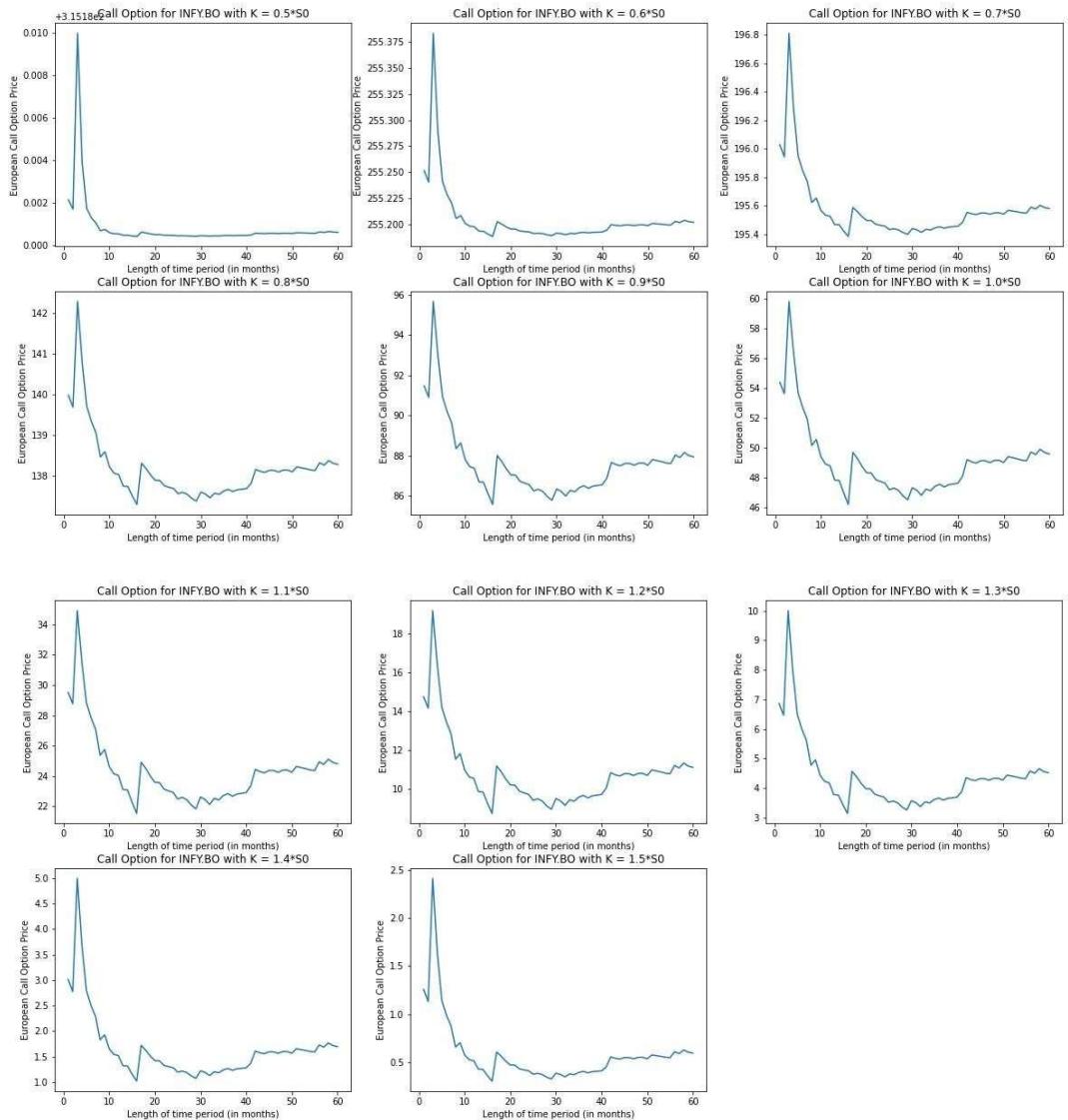
ii) HDFCBANK.BO



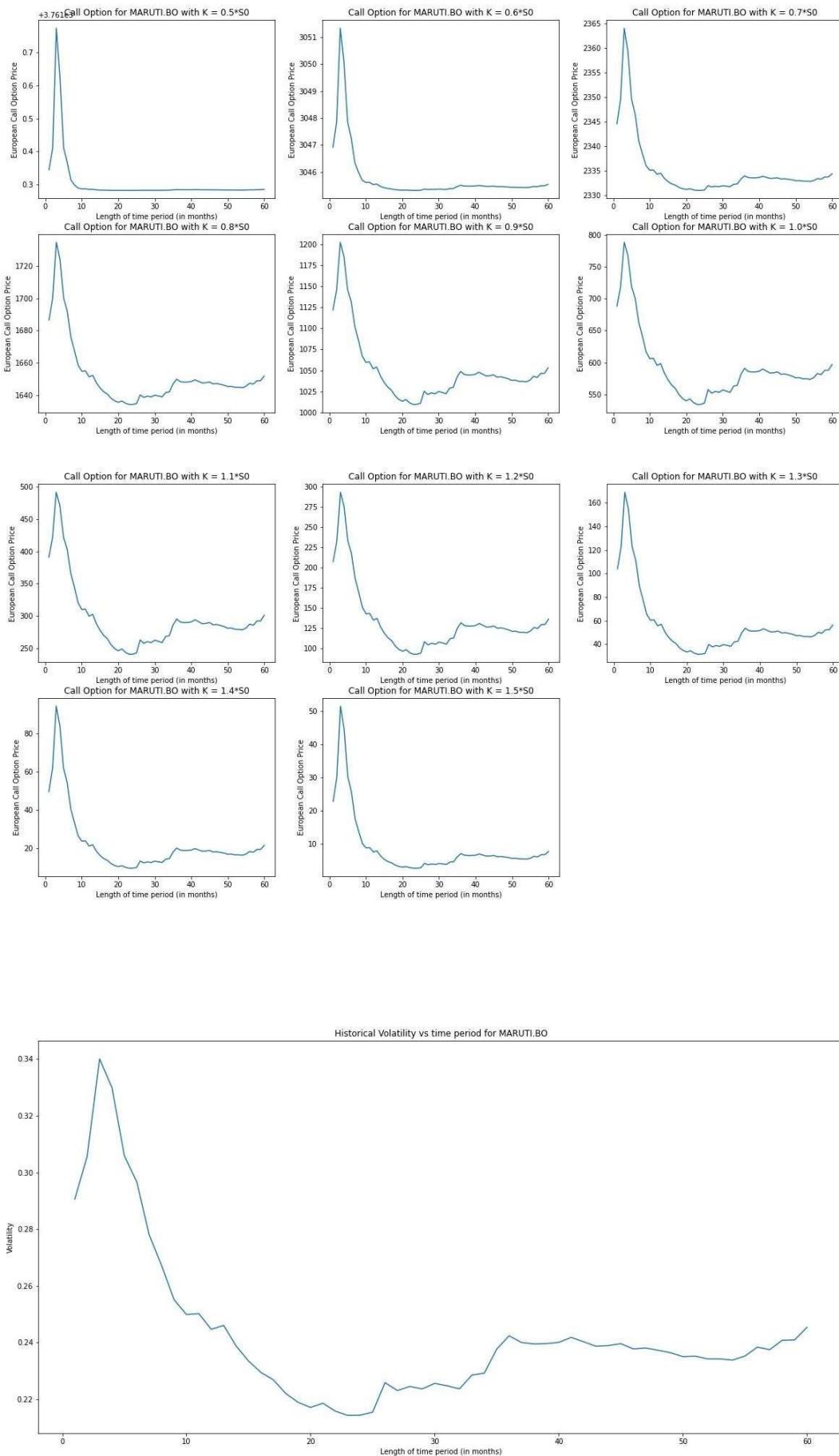
iii) HEROMOTOCO.BO



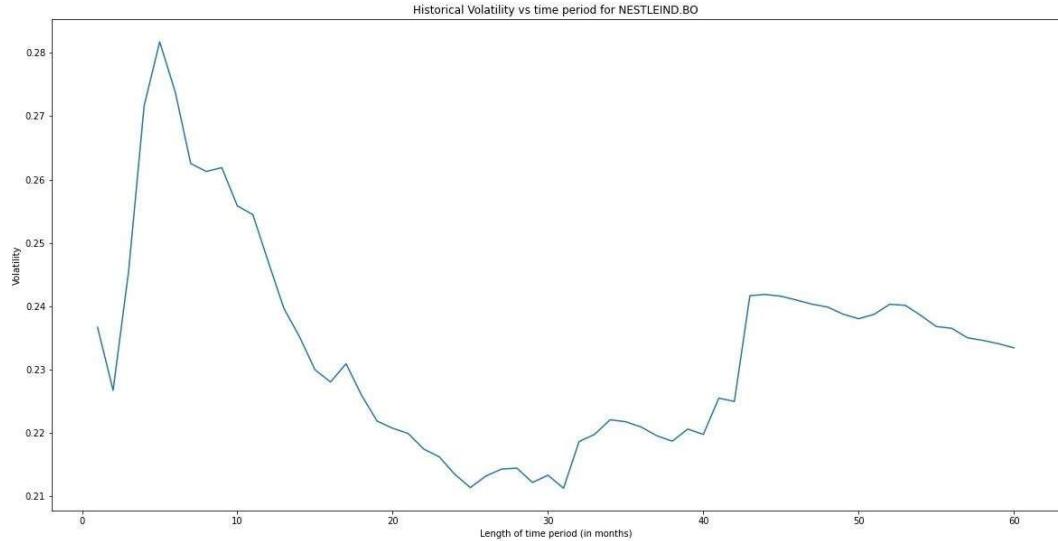
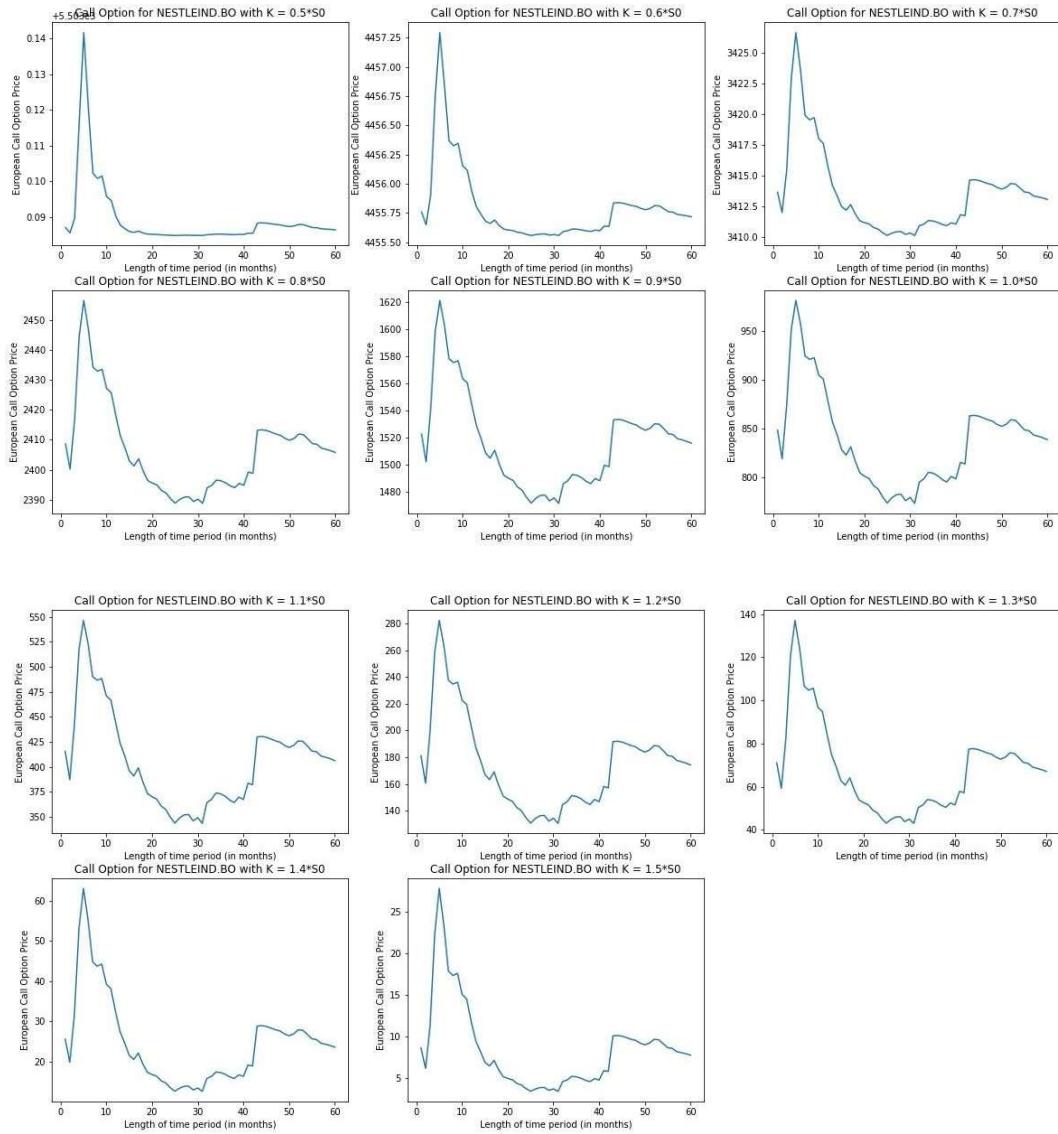
iv) INFY.BO



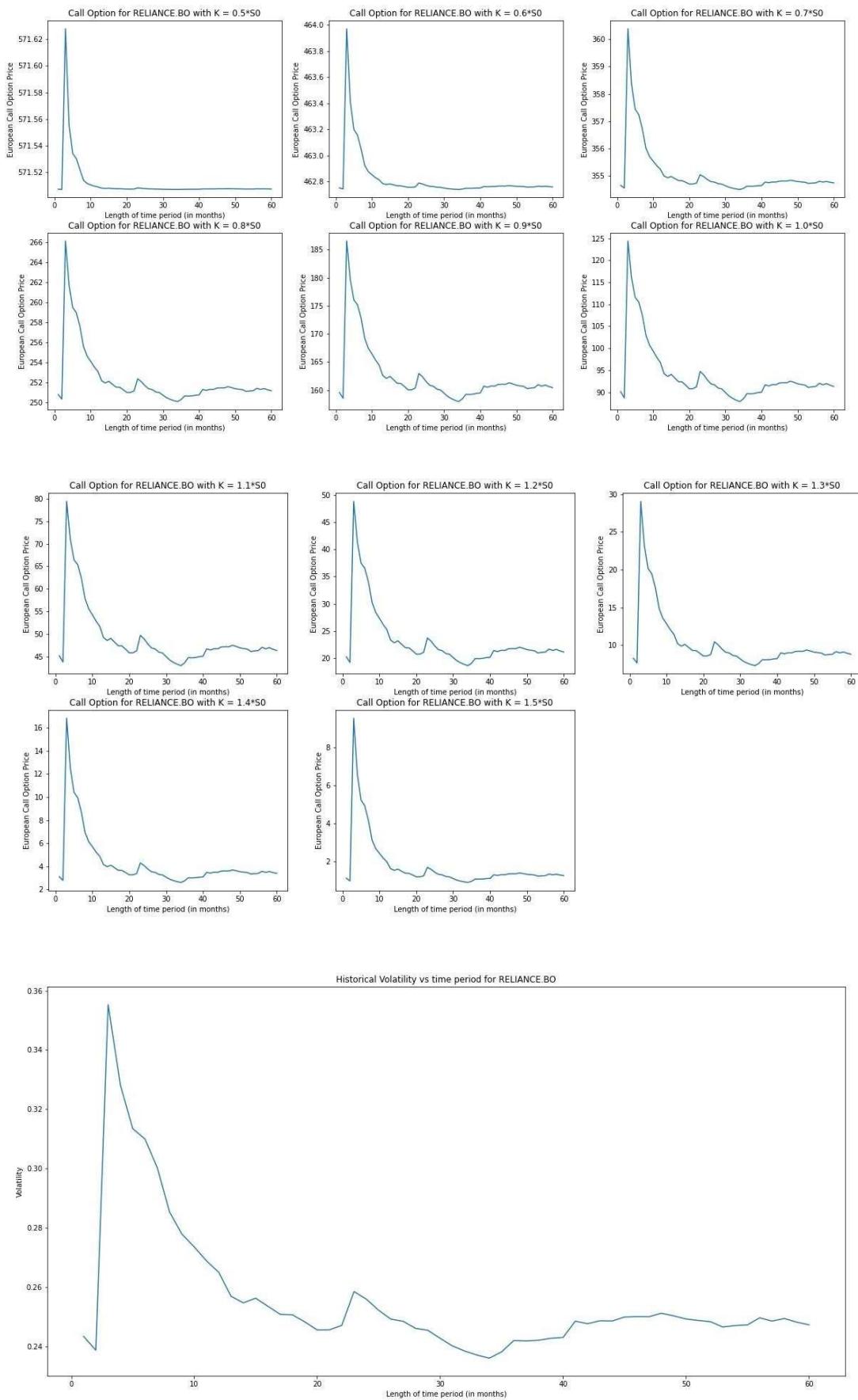
v) MARUTI.BO



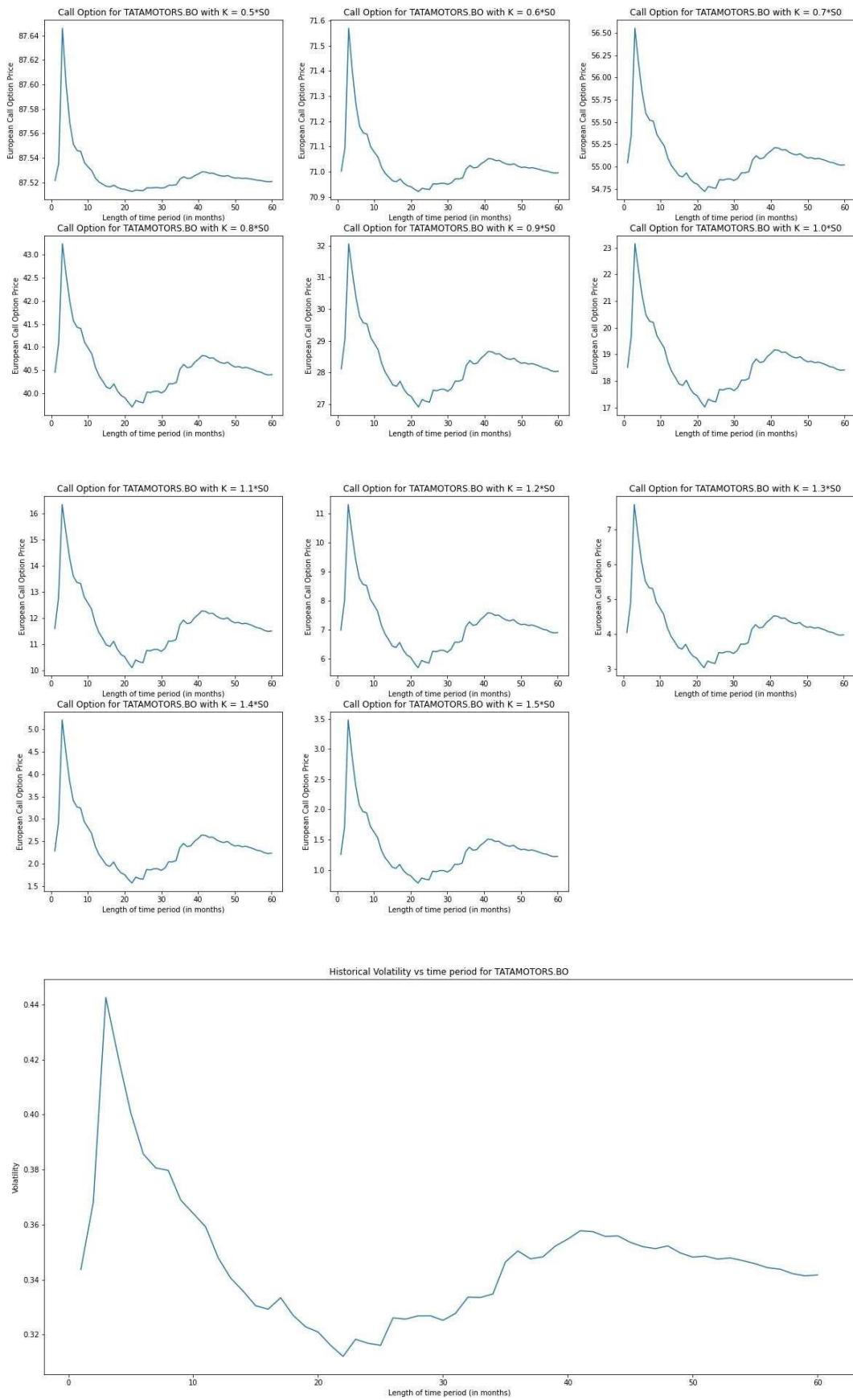
vi) NESTLEIND.BO



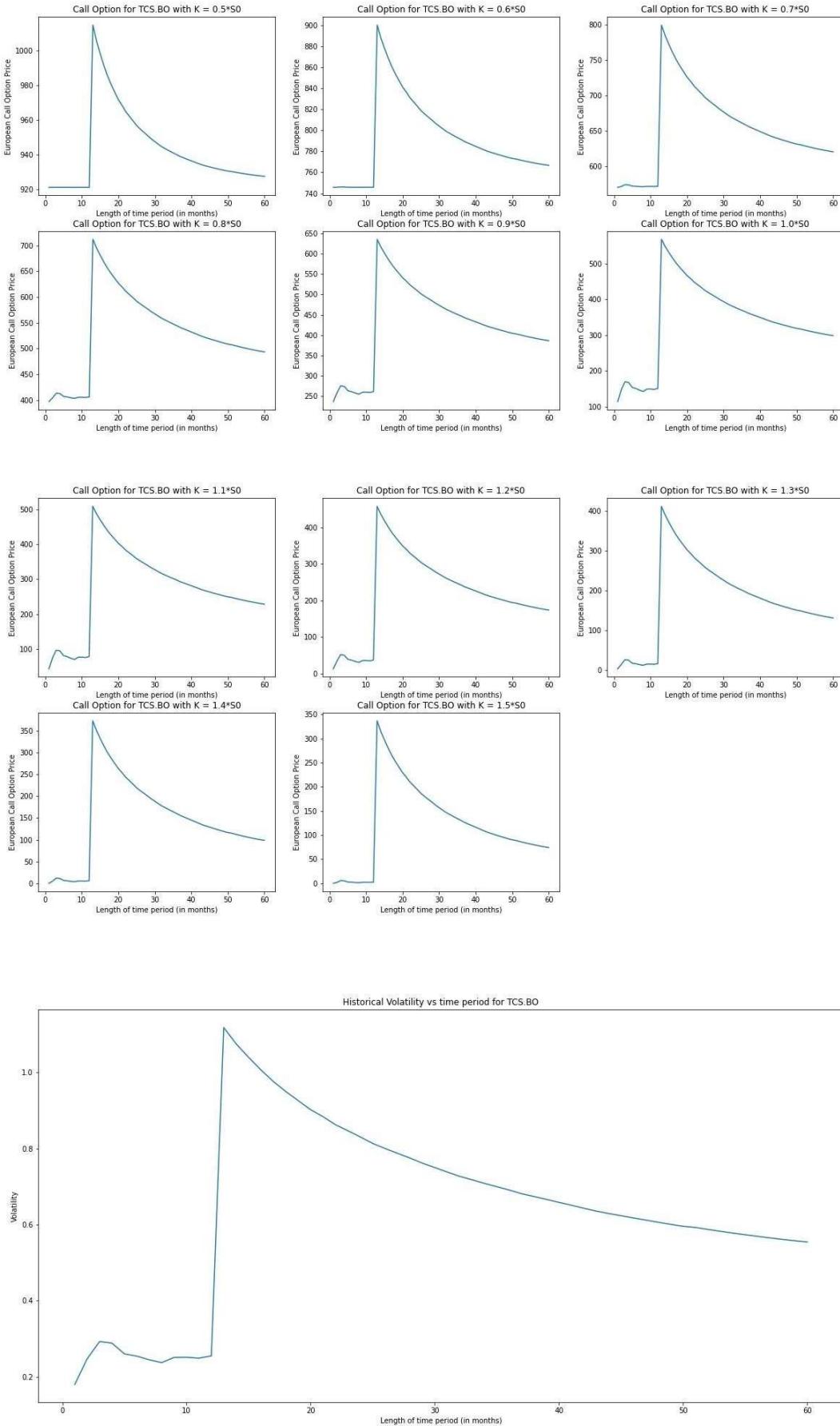
vii) RELIANCE.BO



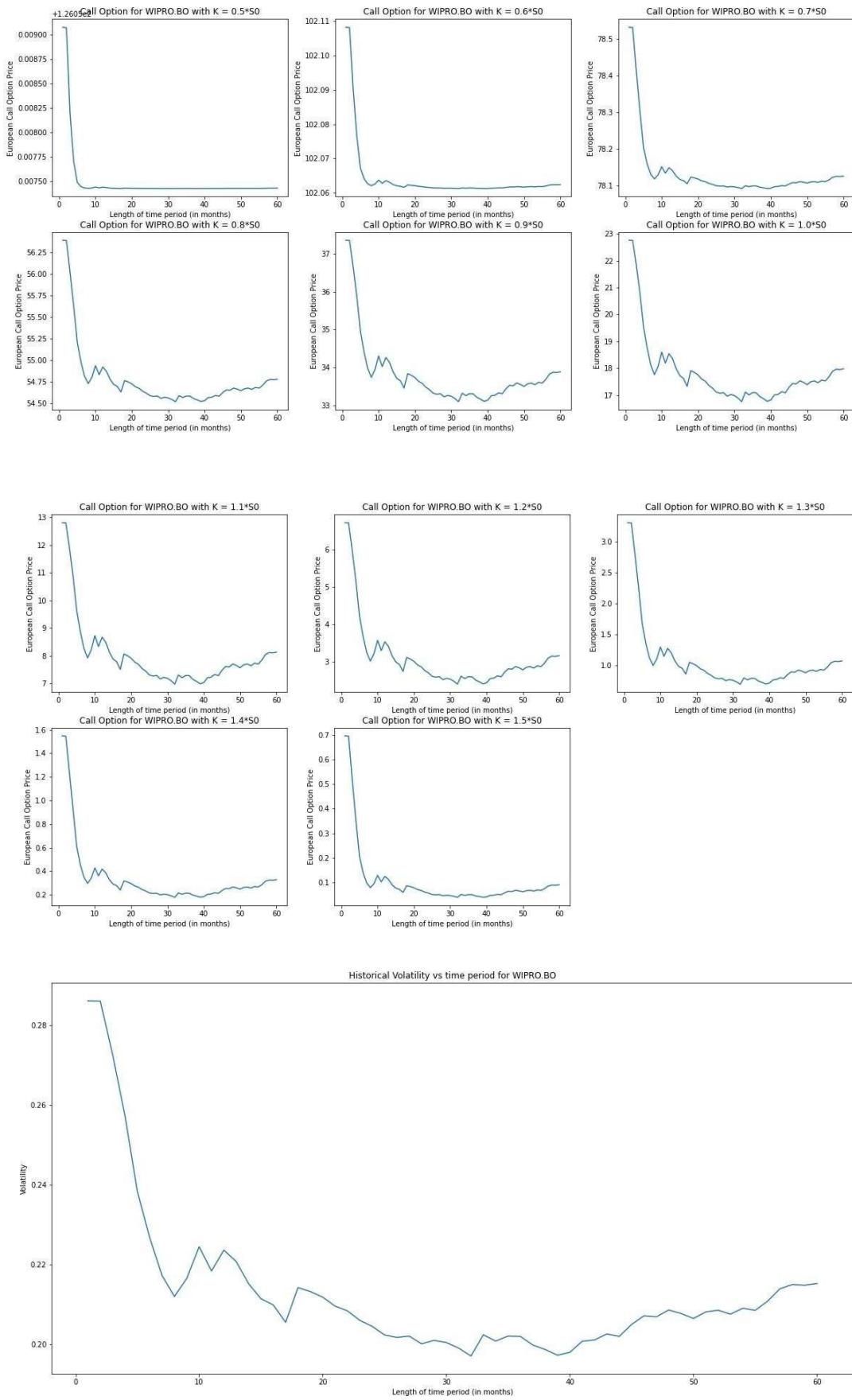
viii) TATAMOTORS.BO



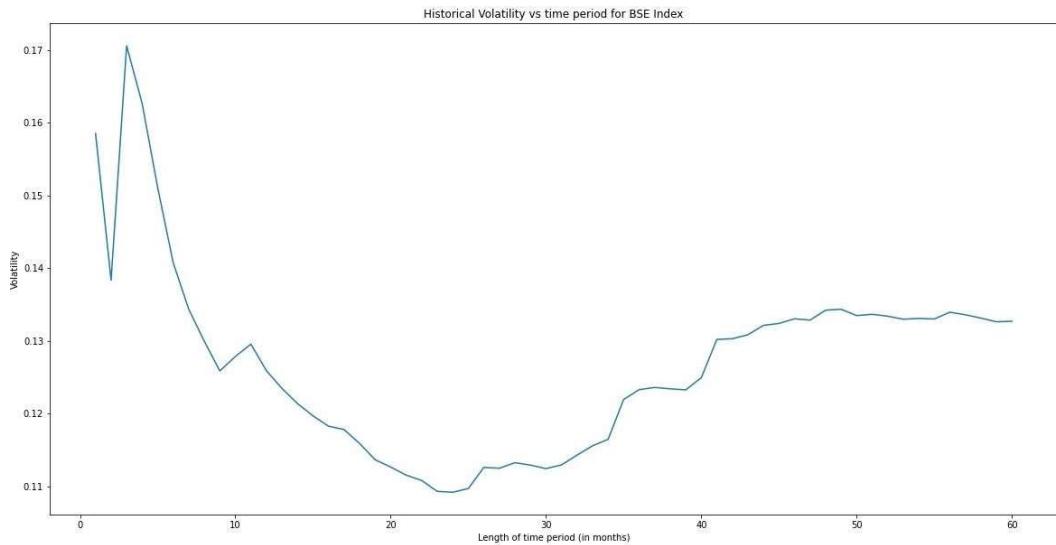
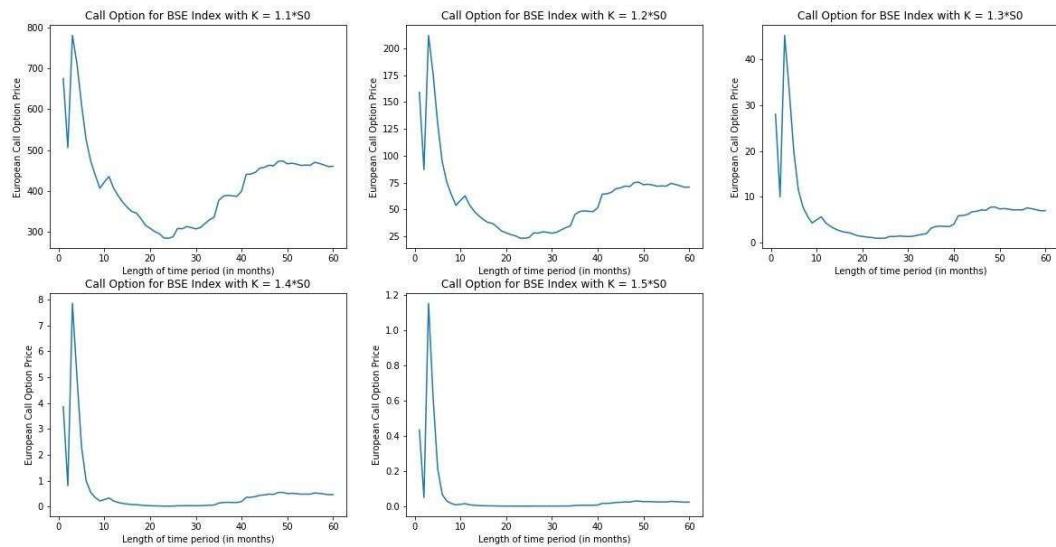
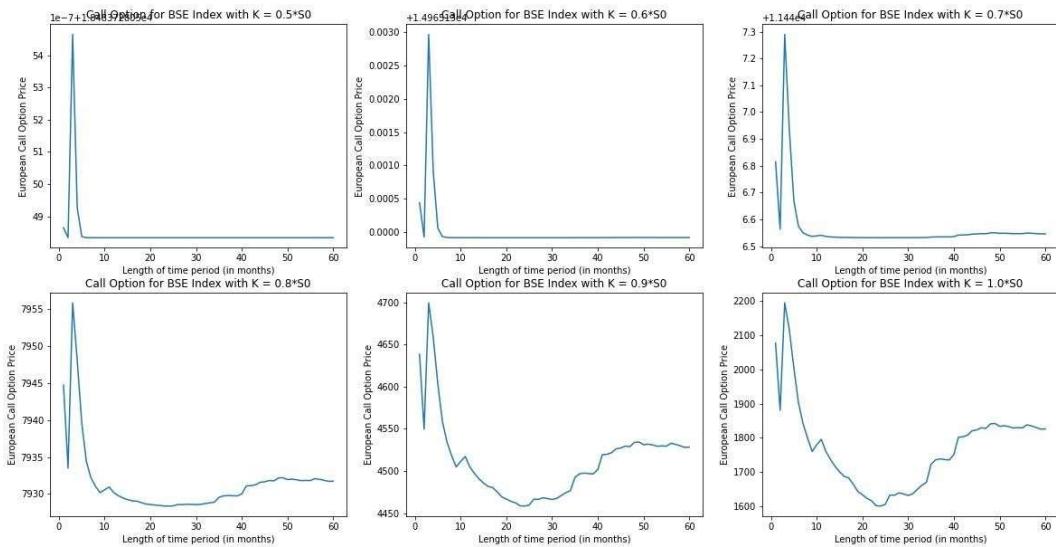
ix) TCS.BO



x) WIPRO.BO

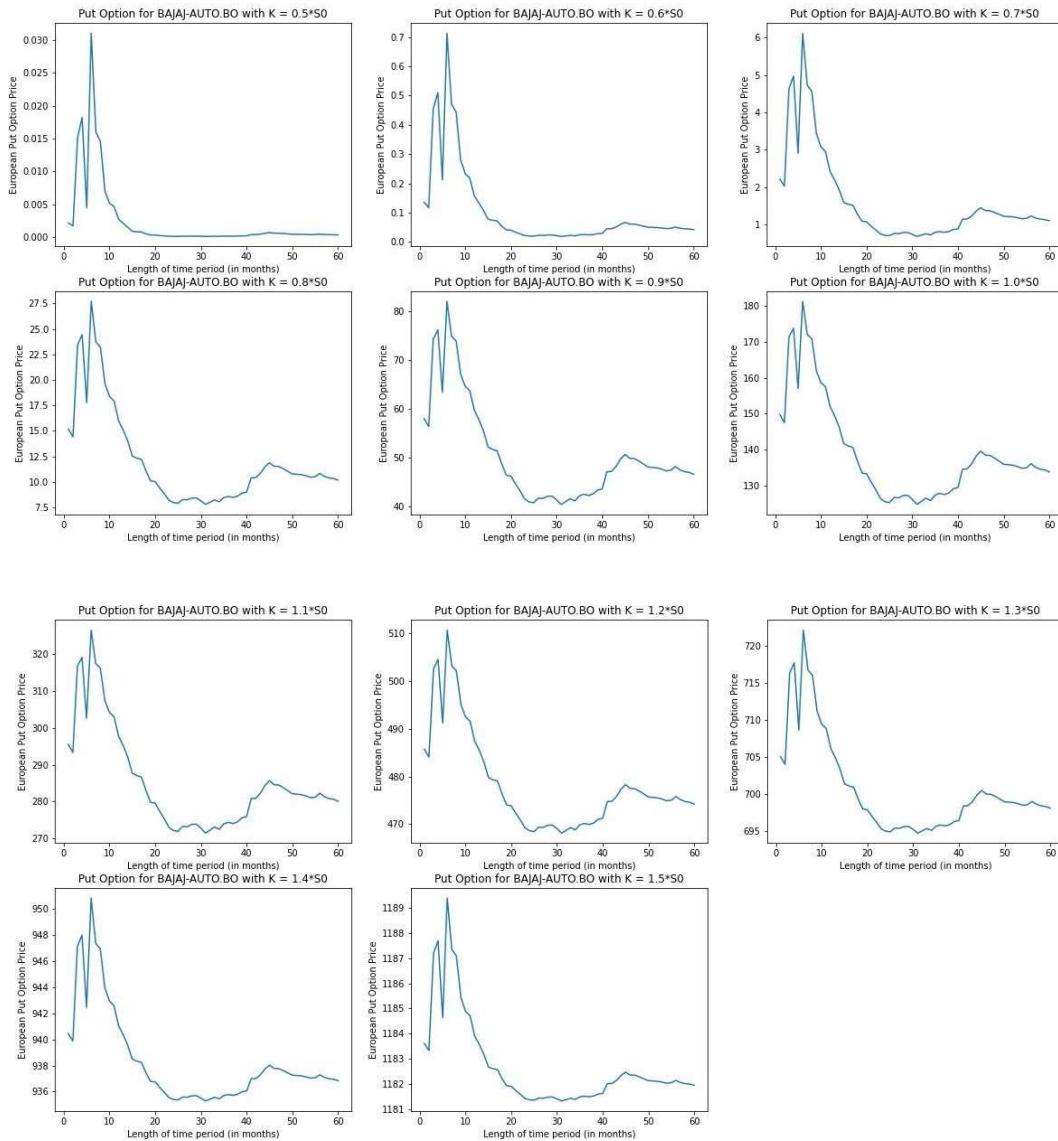


xi) BSE Index

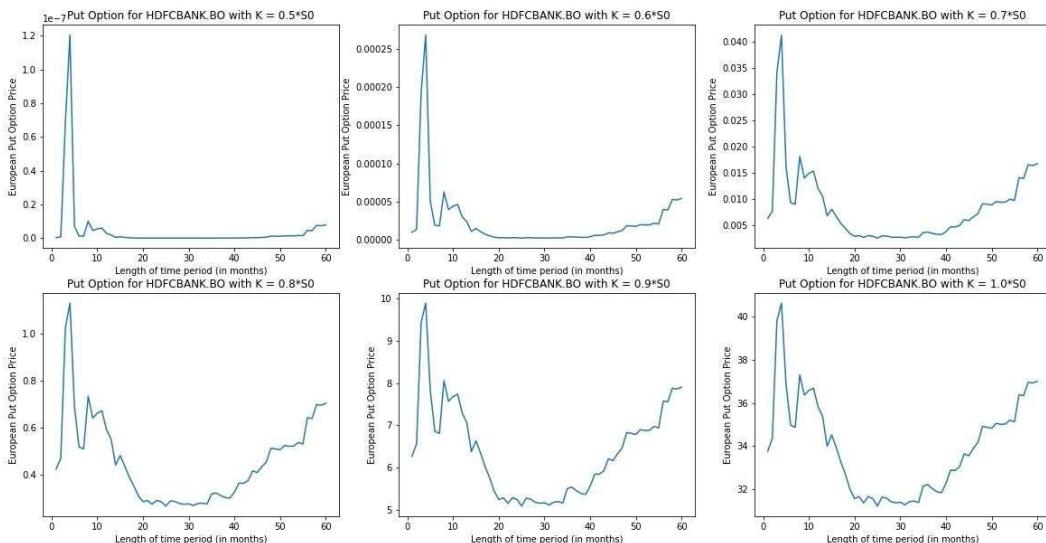


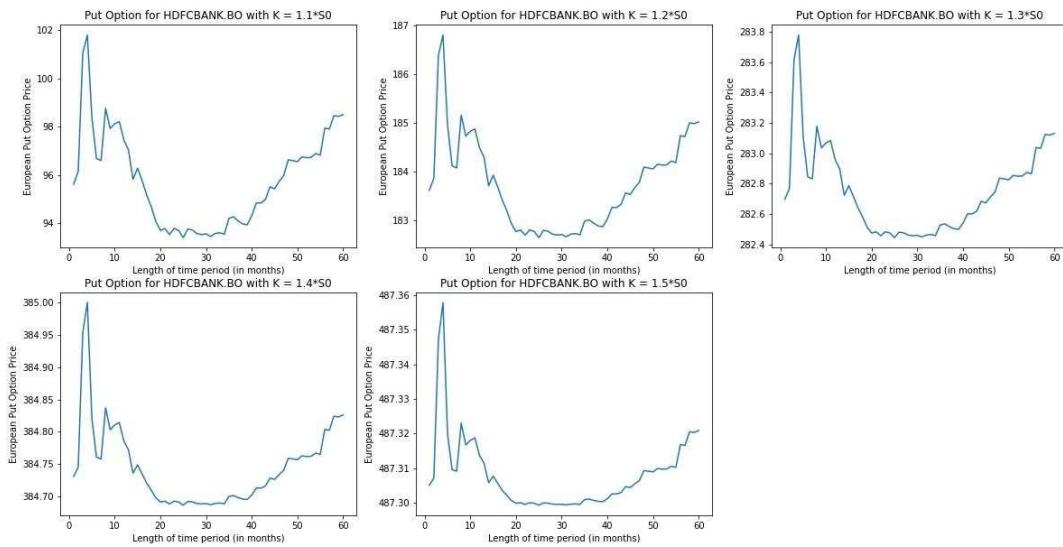
ii. Plots for Put Option - stocks in nsedata1:

i) BAJA-AUTO.BO

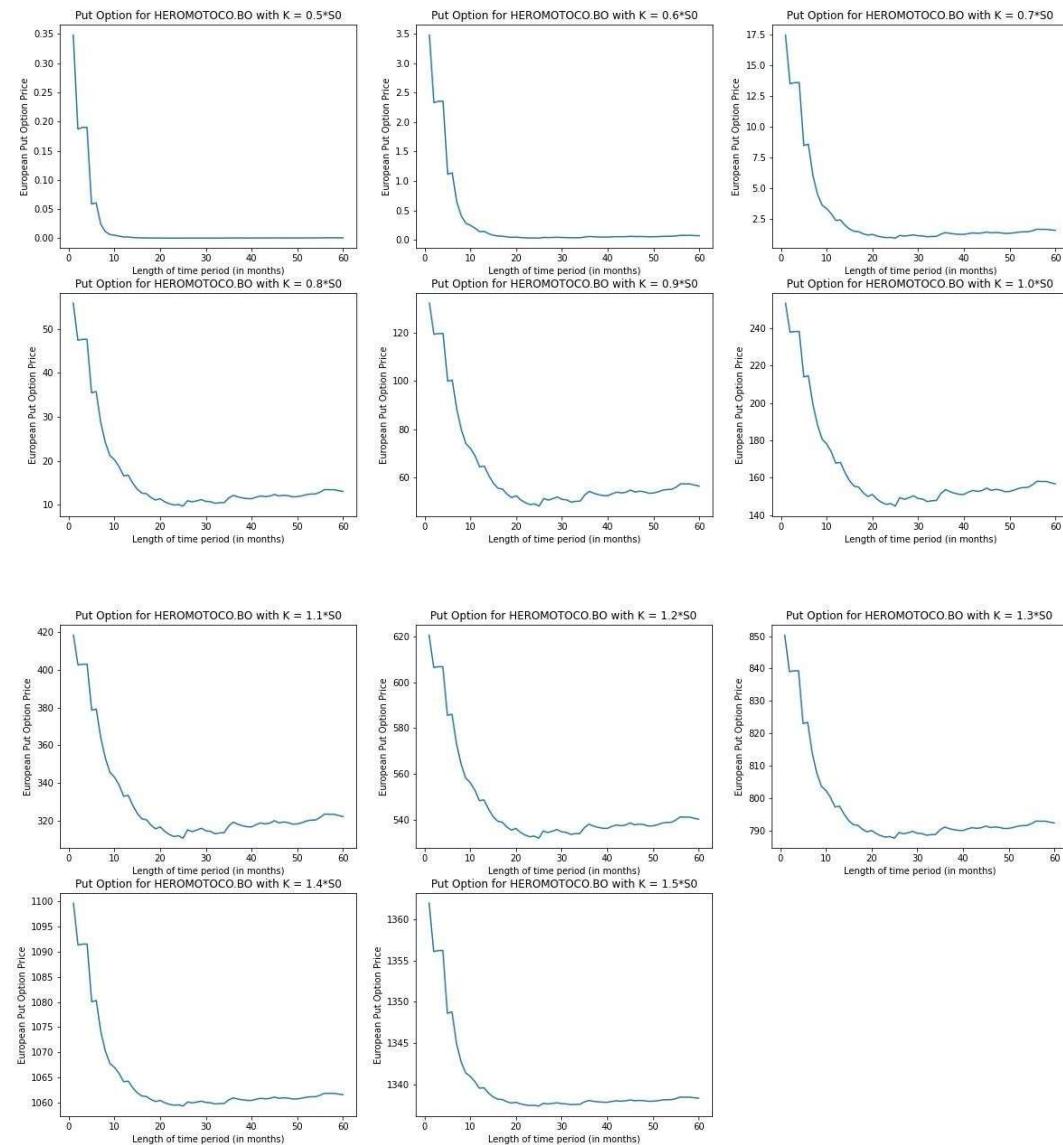


ii) HDFCBANK.BO

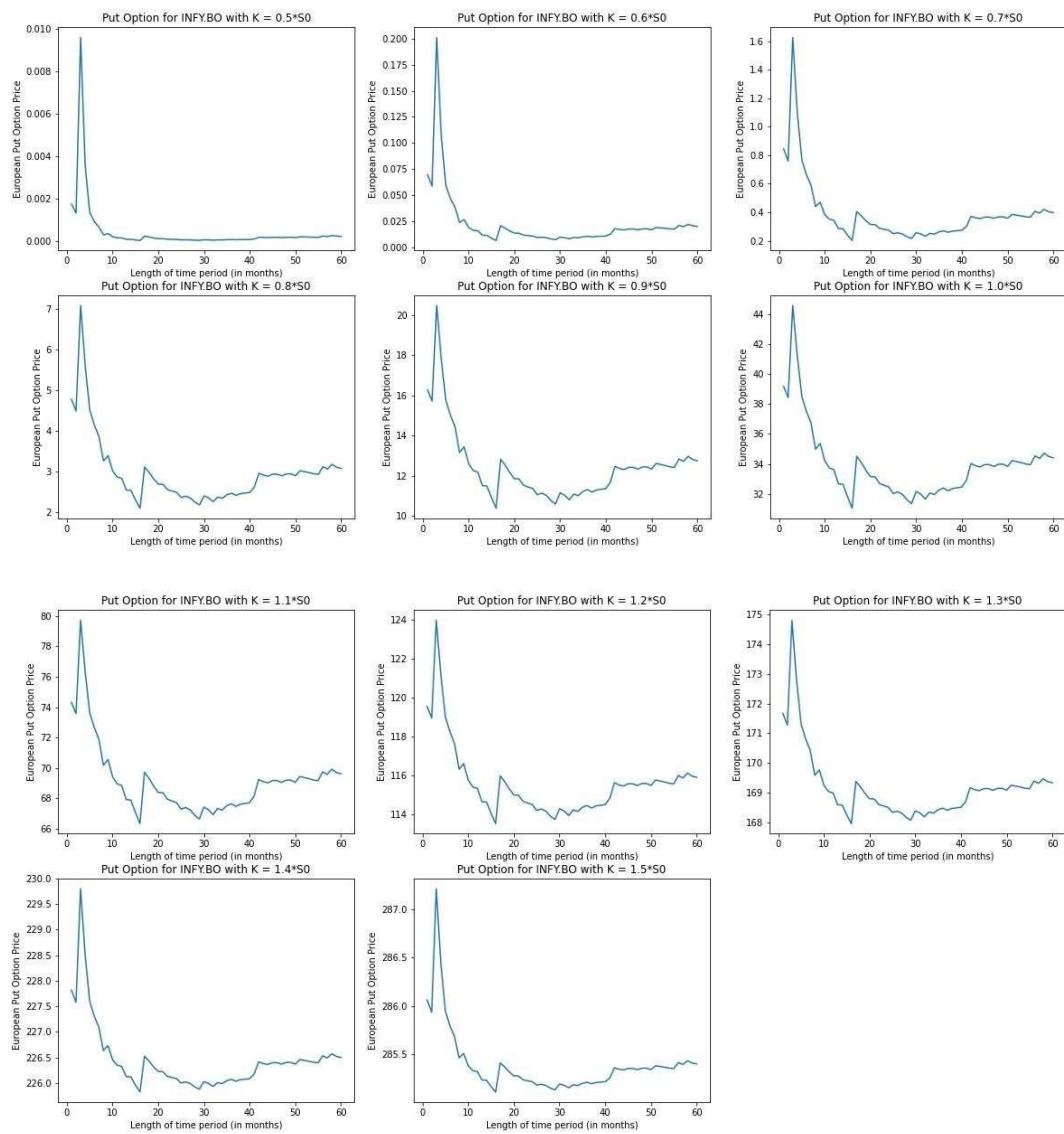




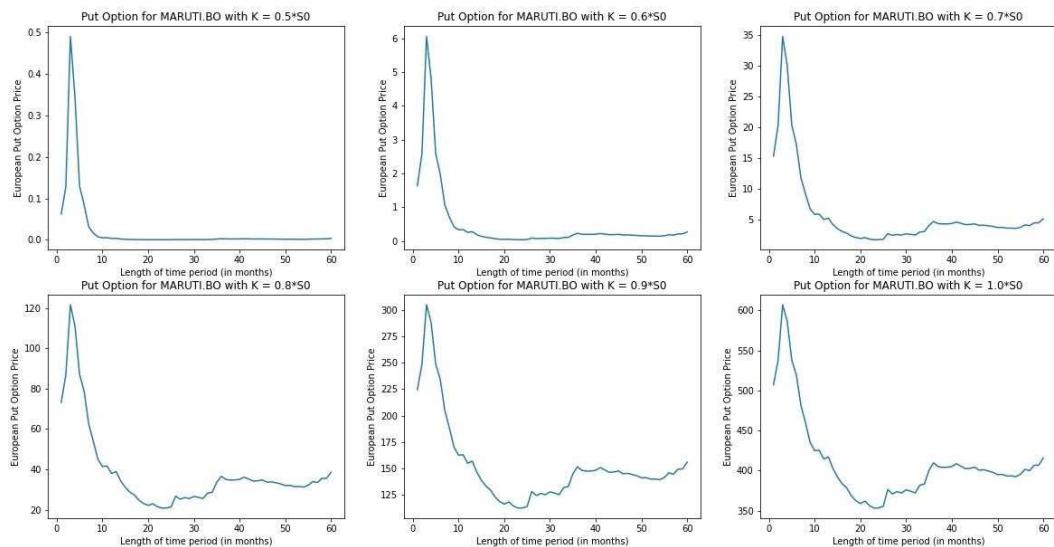
iii) HEROMOTOCO.B0

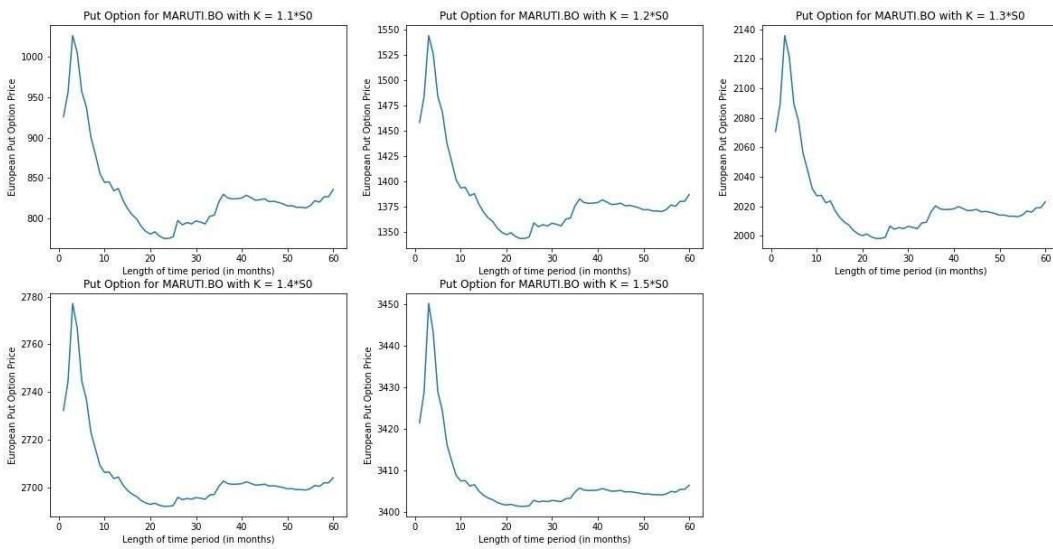


iv) INFY.BO

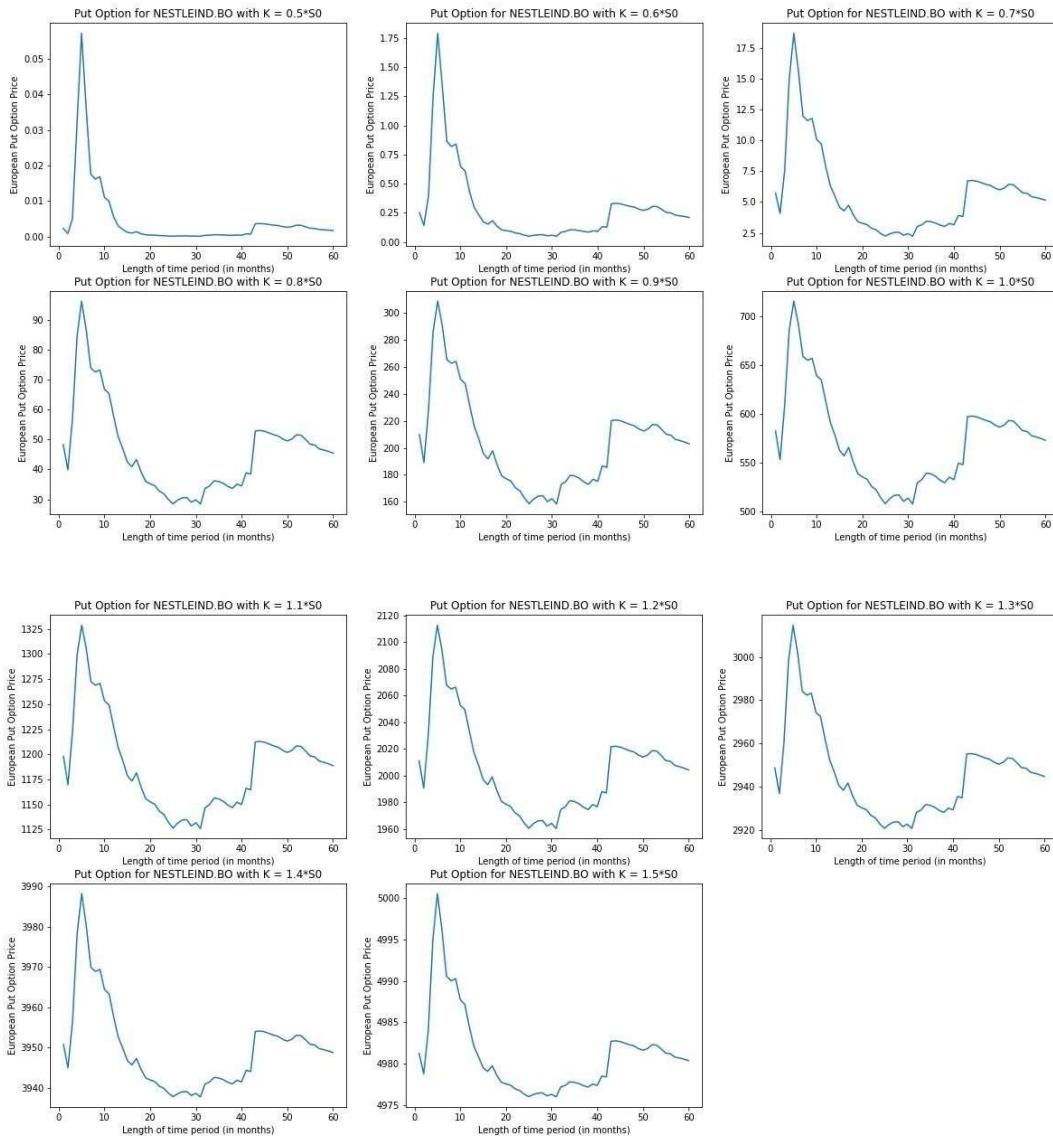


v) MARUTI.BO

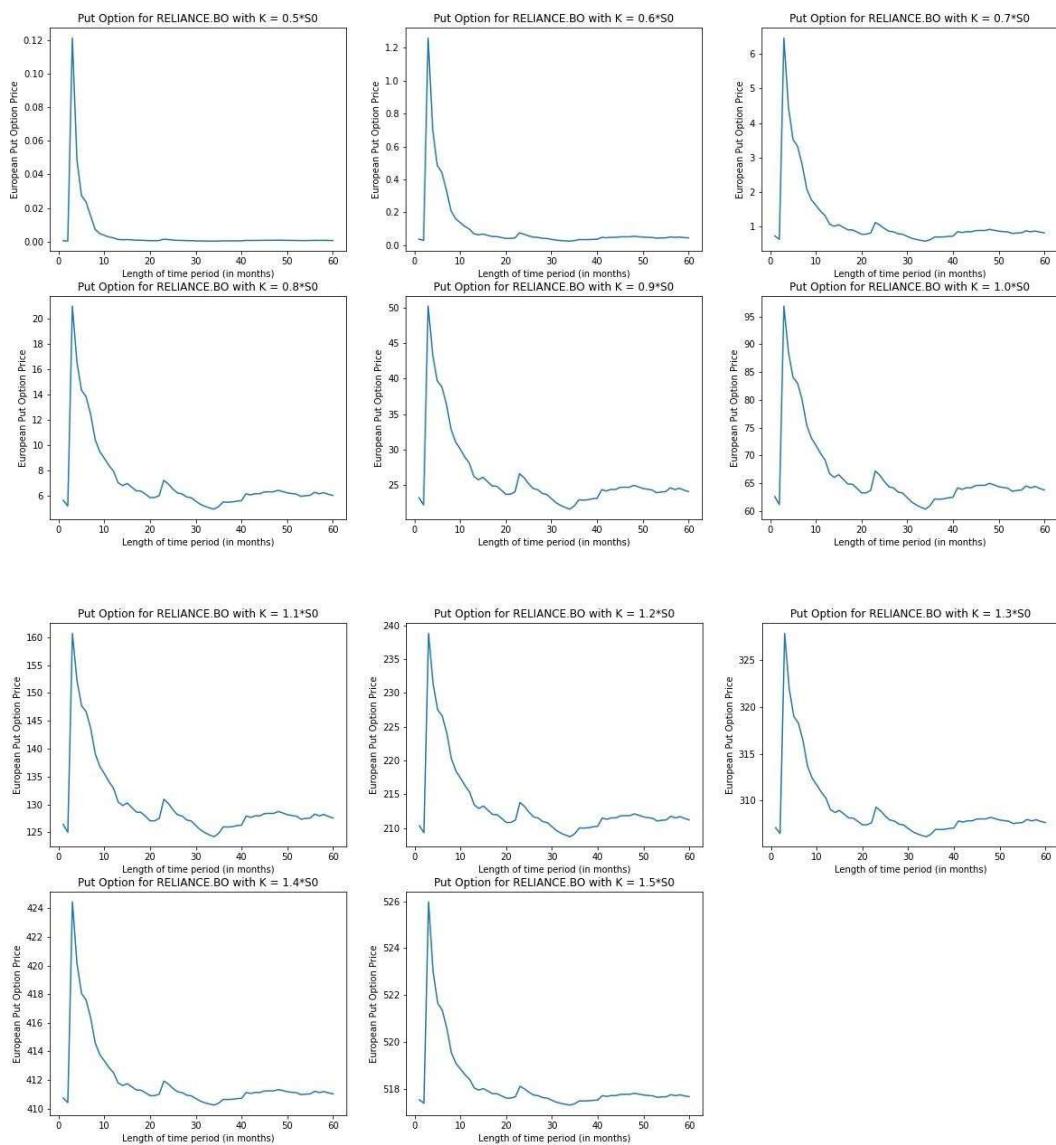




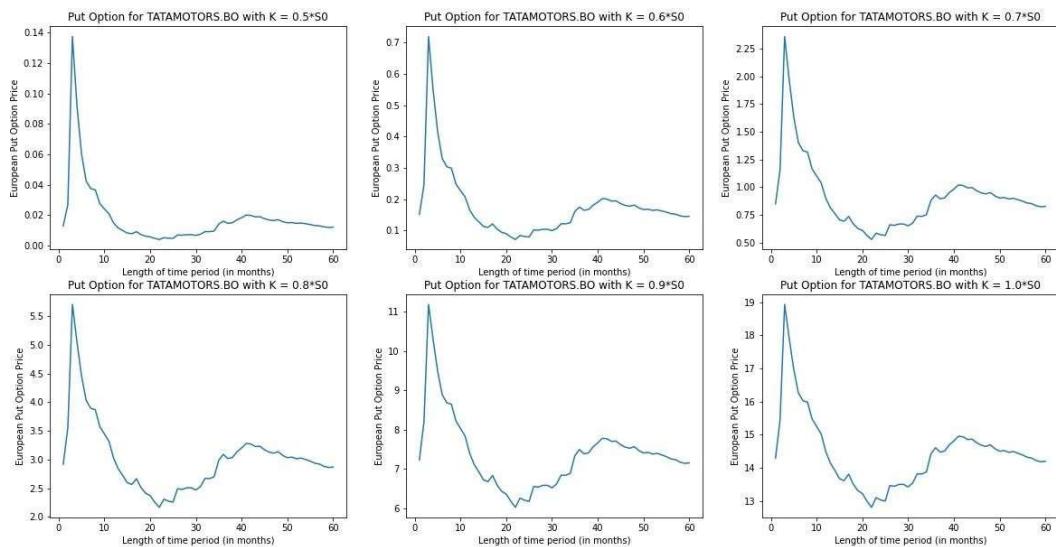
vi) NESTLEIND.BO

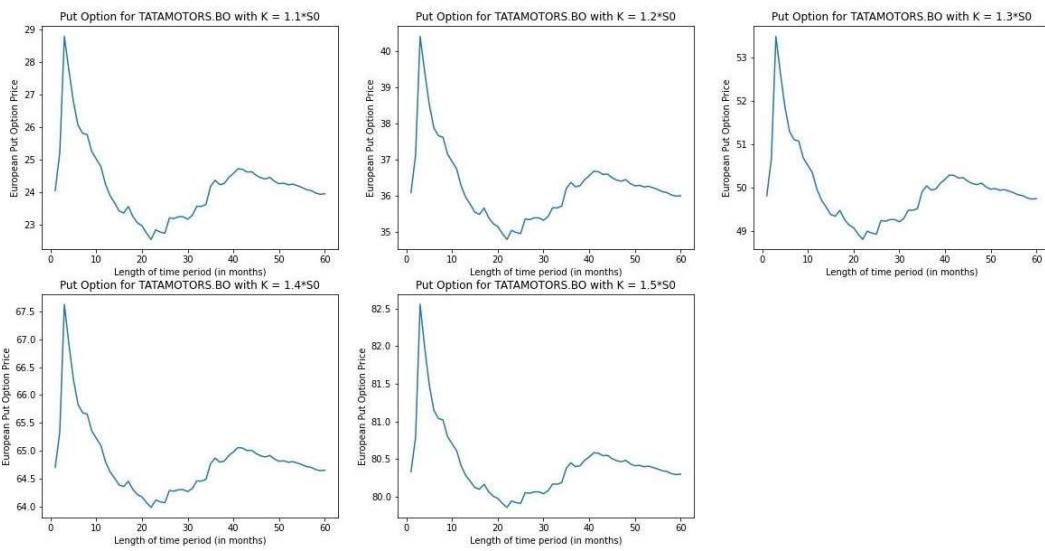


vii) RELIANCE.BO

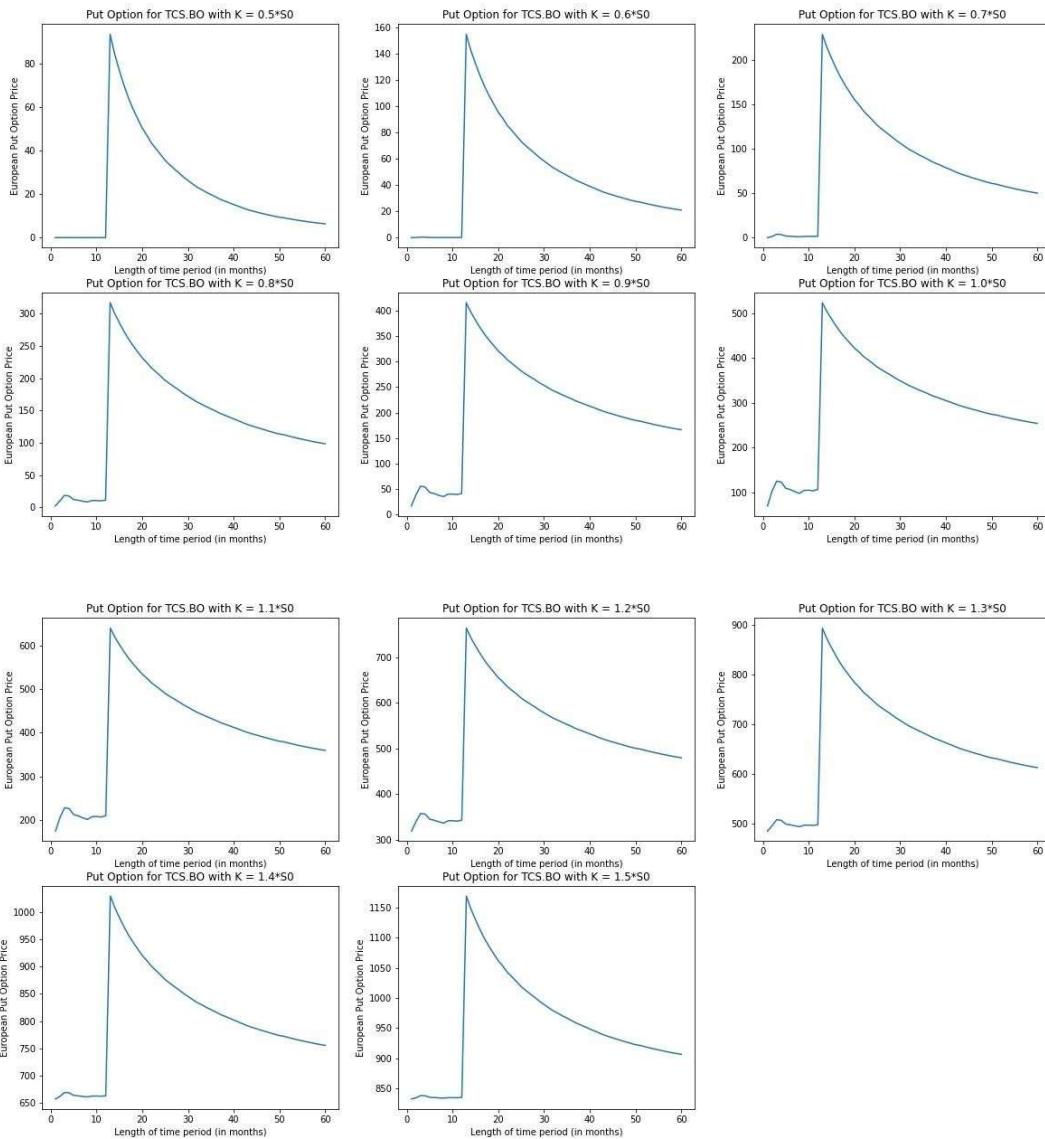


viii) TATAMOTORS.BO

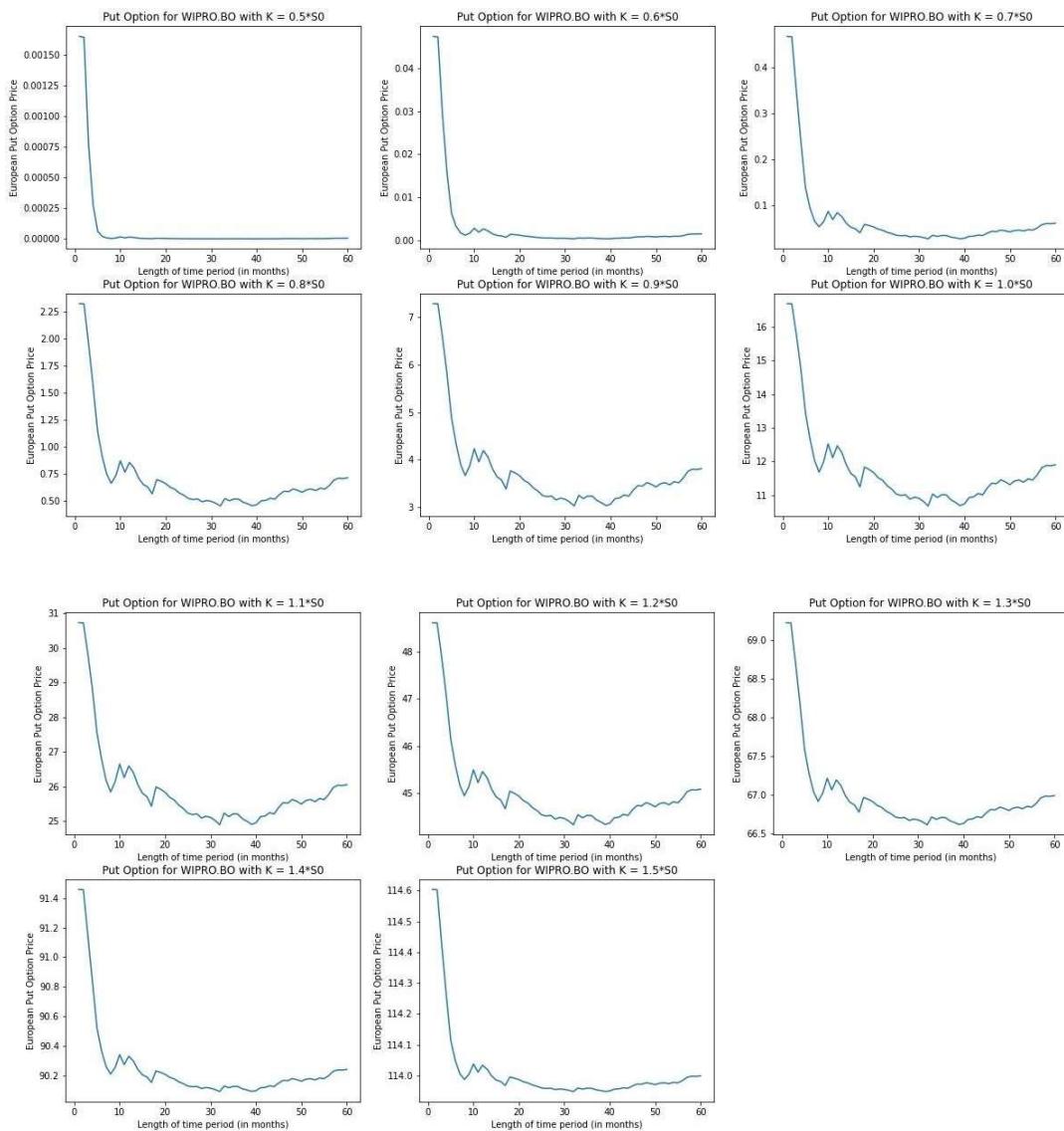




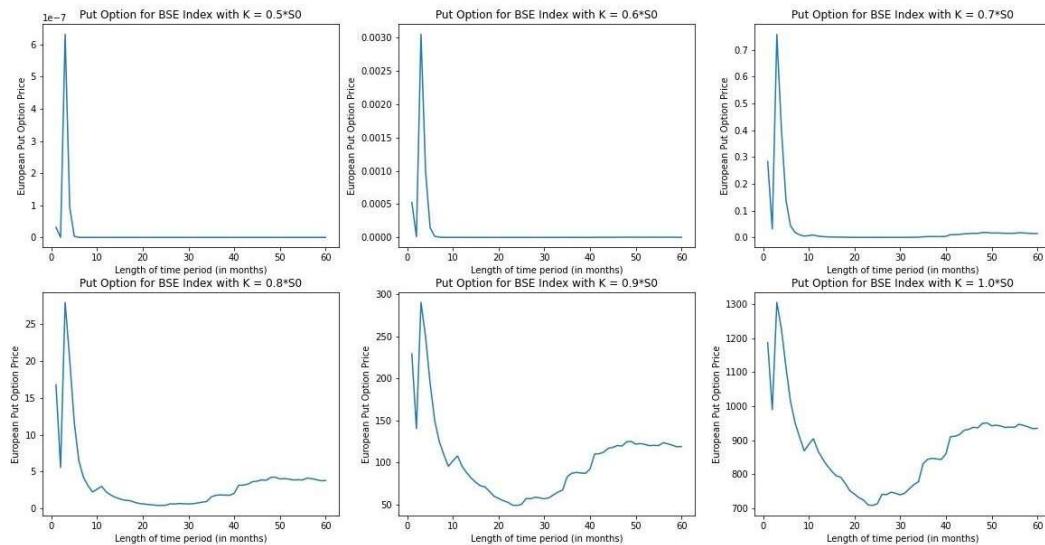
ix) TCS.BO

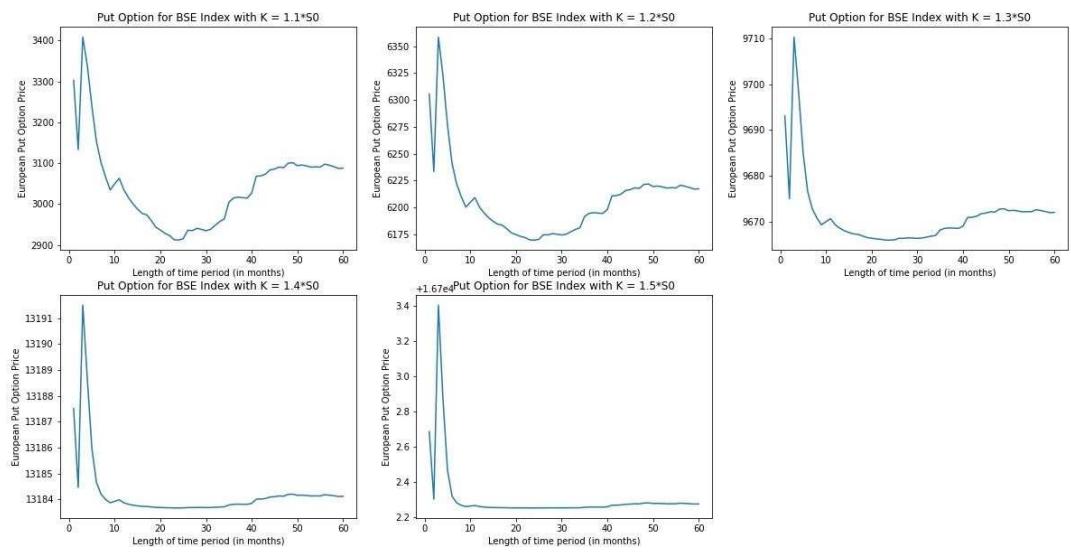


x) WIPRO.BO



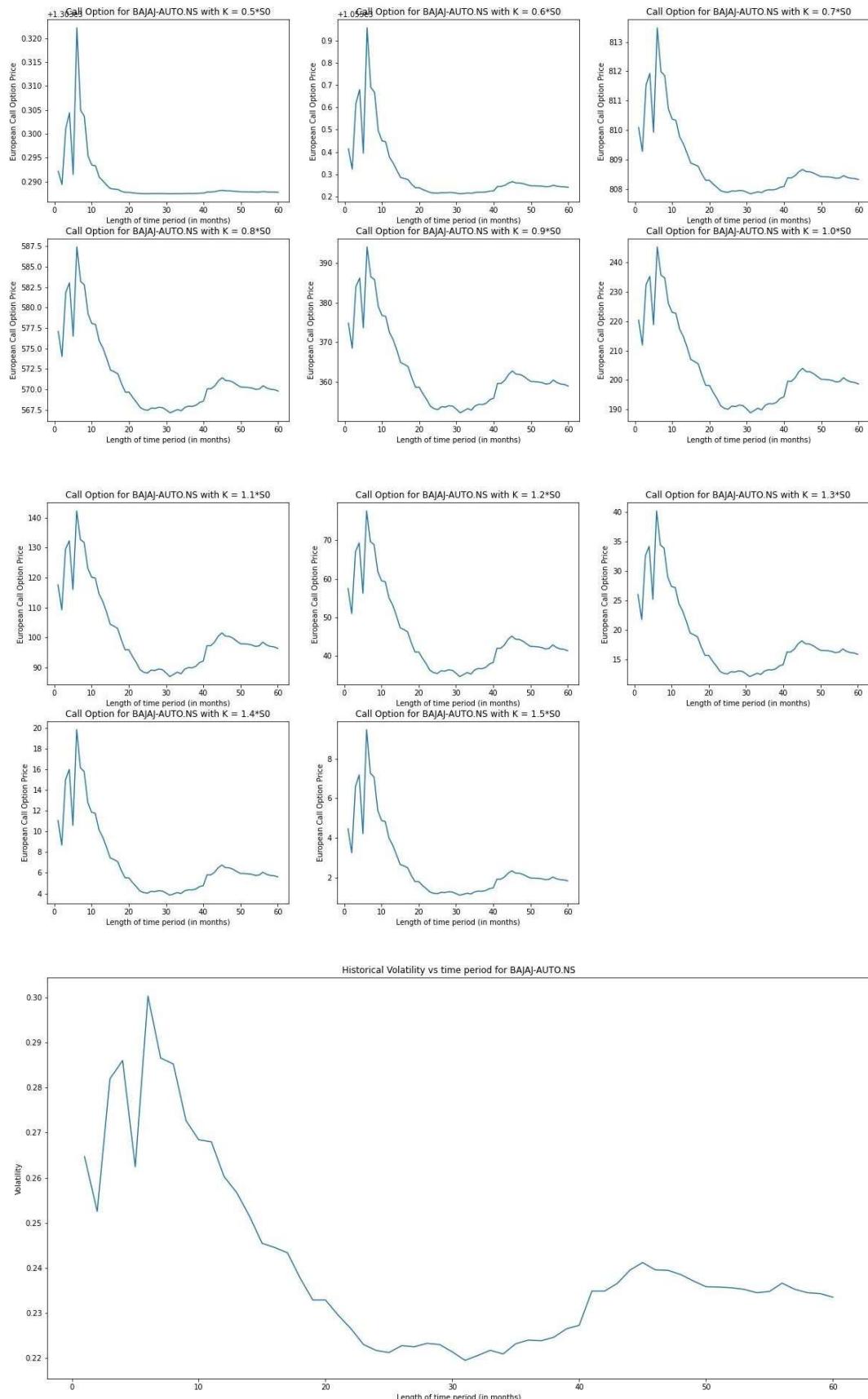
xi) BSE Index



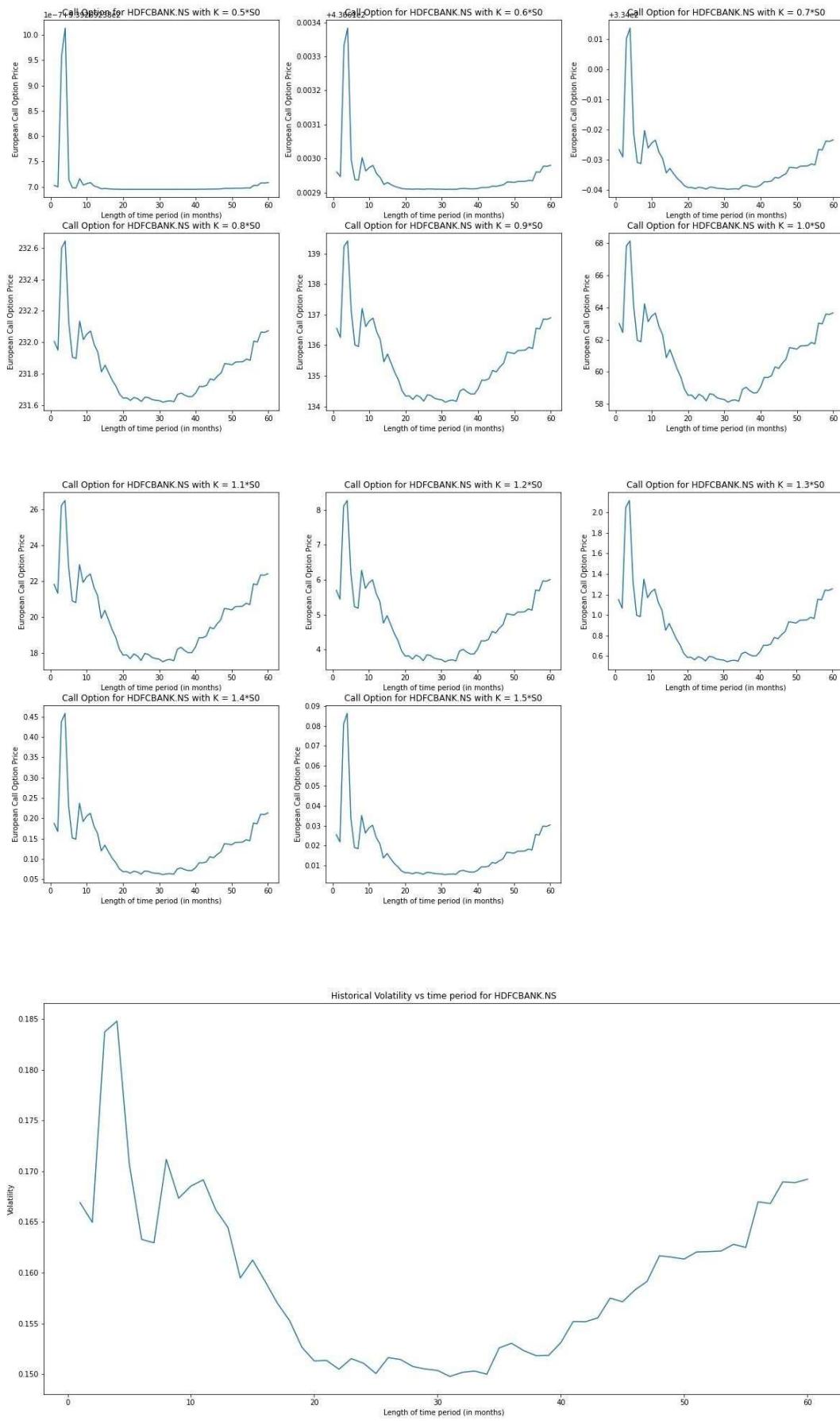


iii. Plots for Call Option and Volatility - stocks in nsedata1:

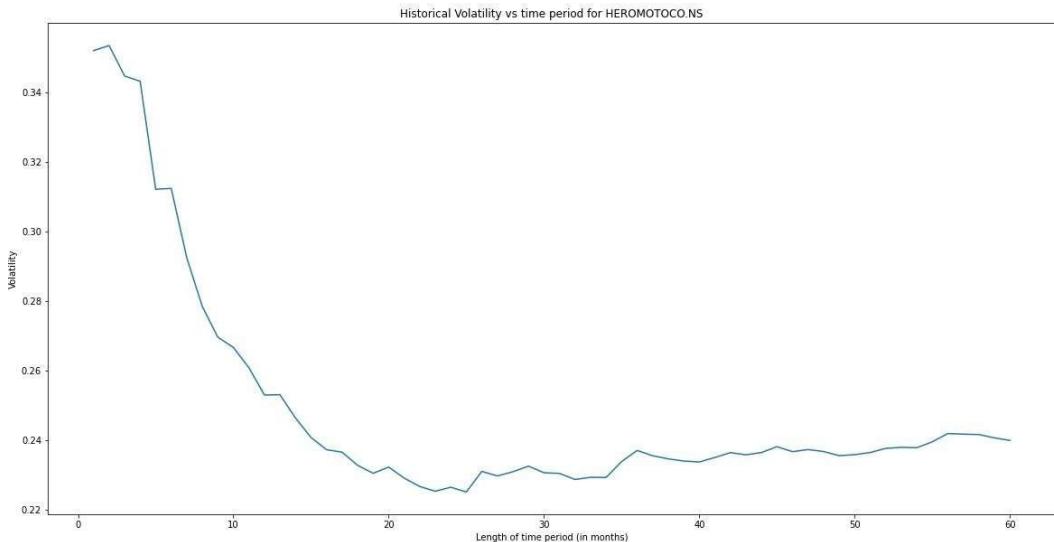
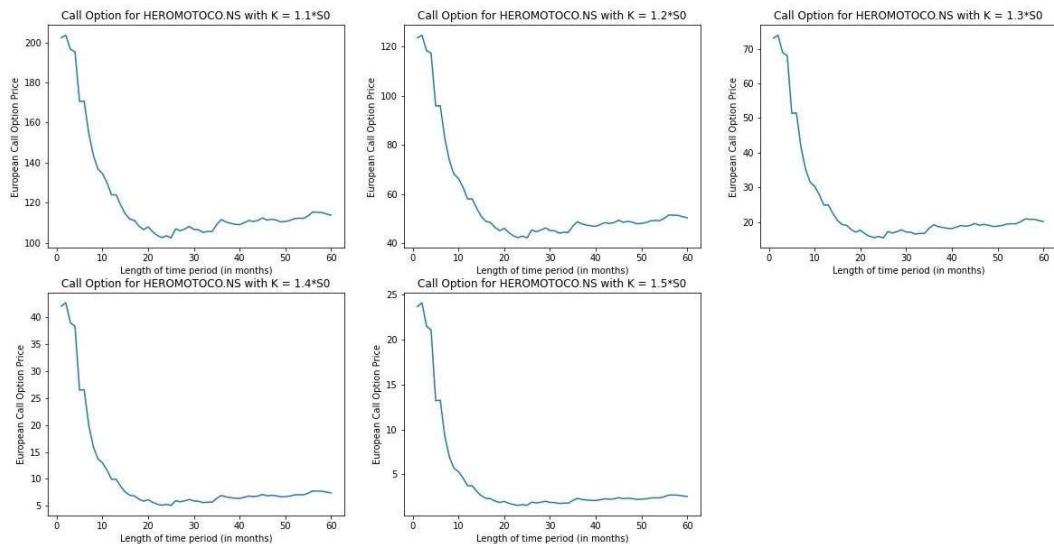
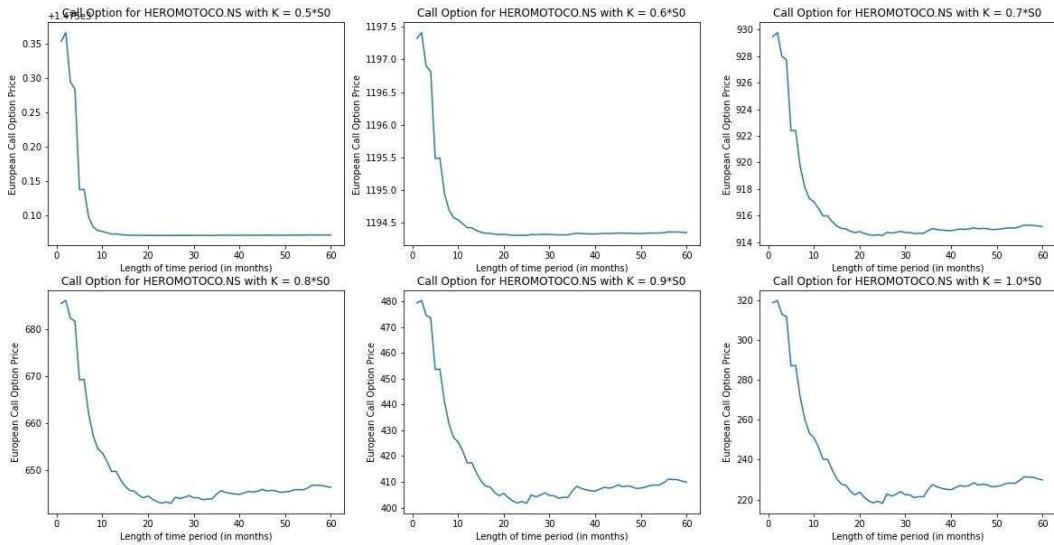
i) BAJAJ-AUTO.NS



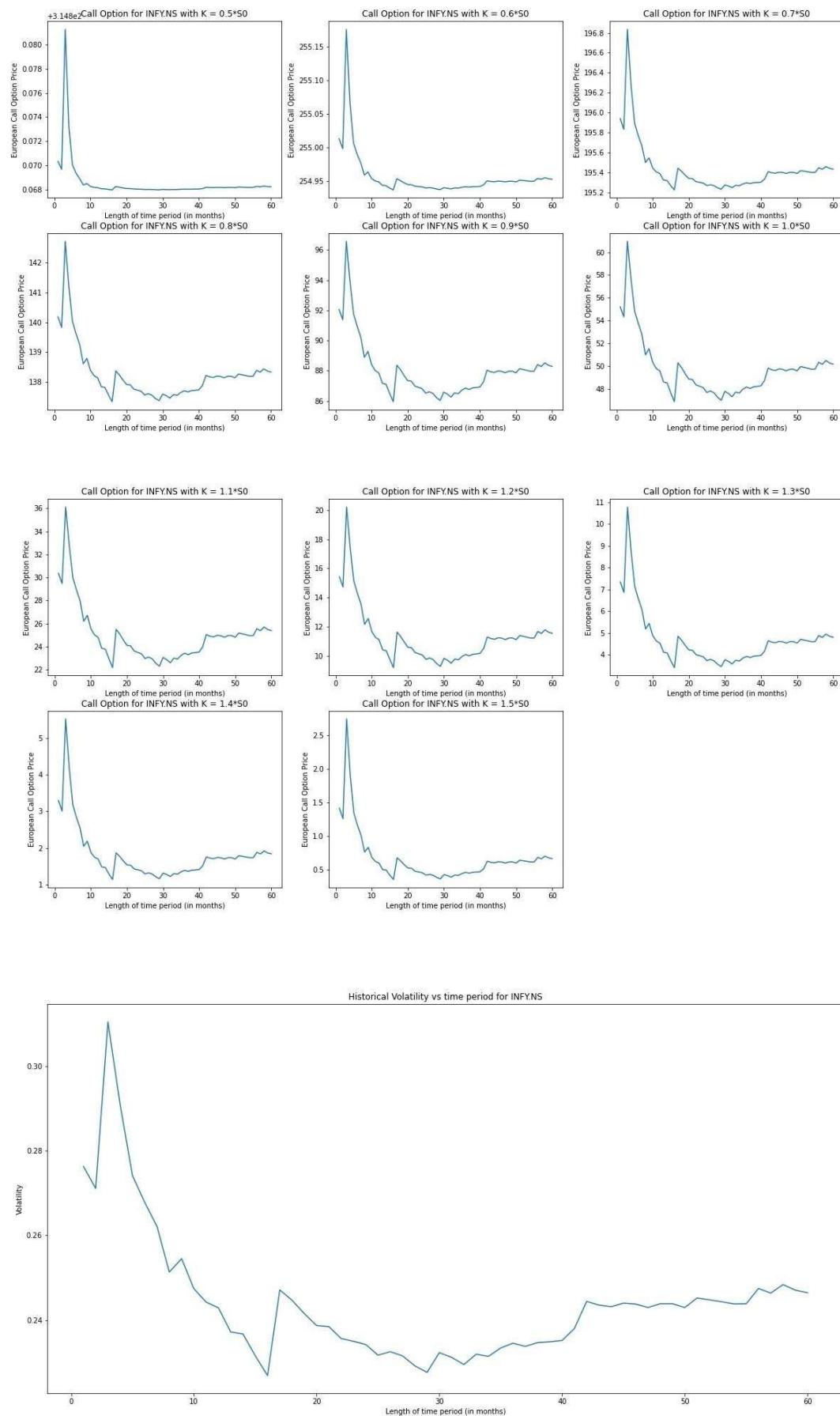
ii) HDFCBANK.NS



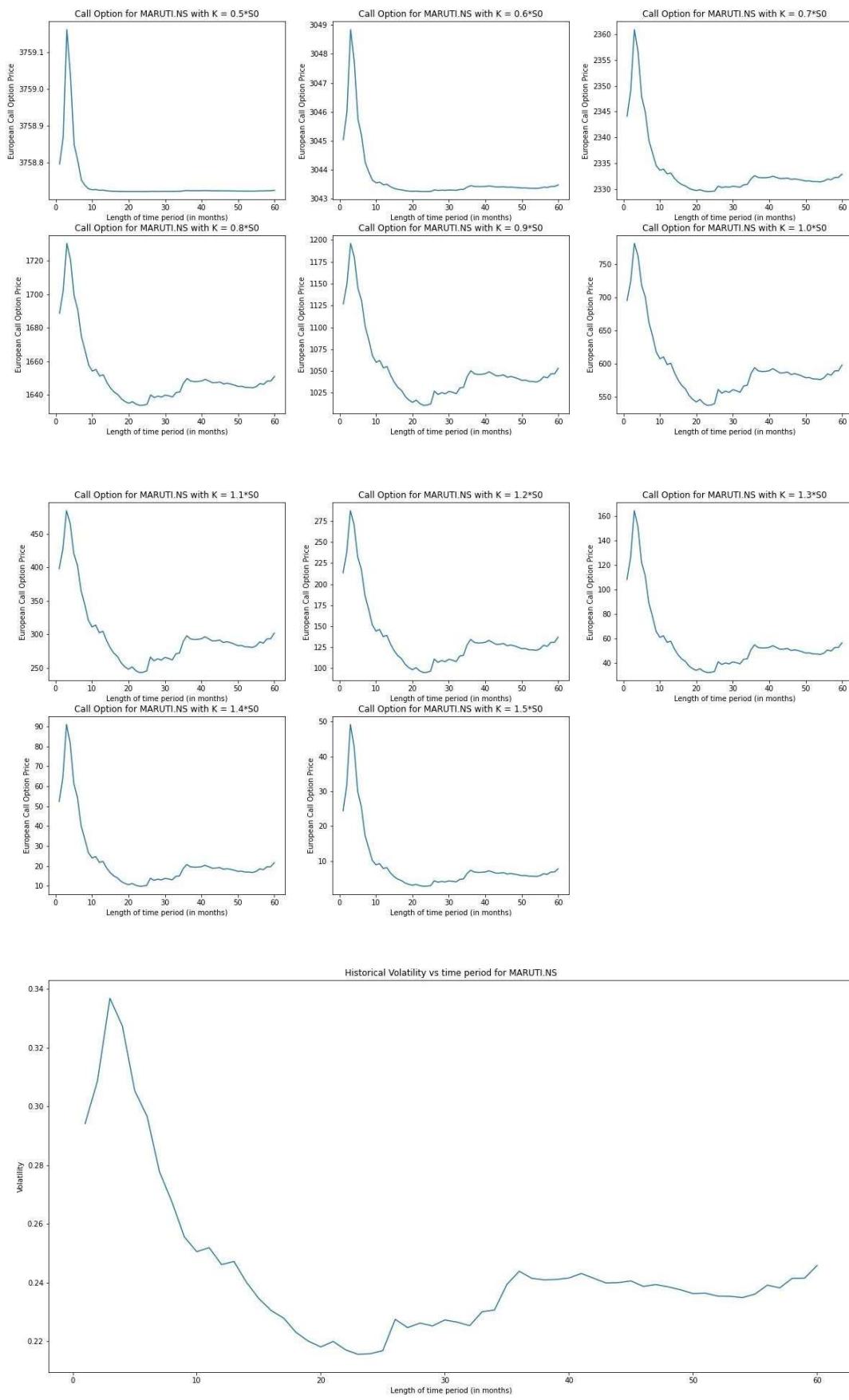
iii) HEROMOTOCO.NS



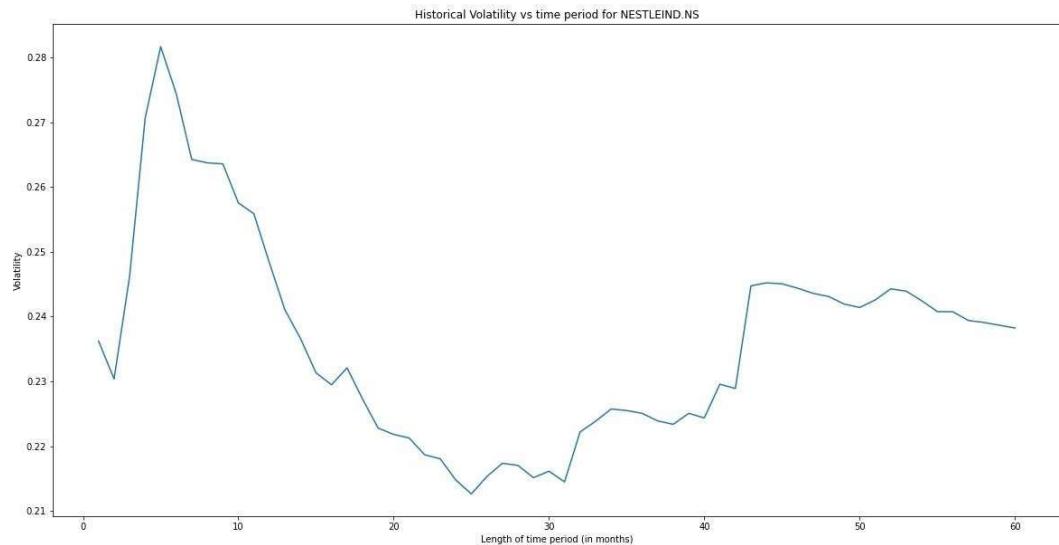
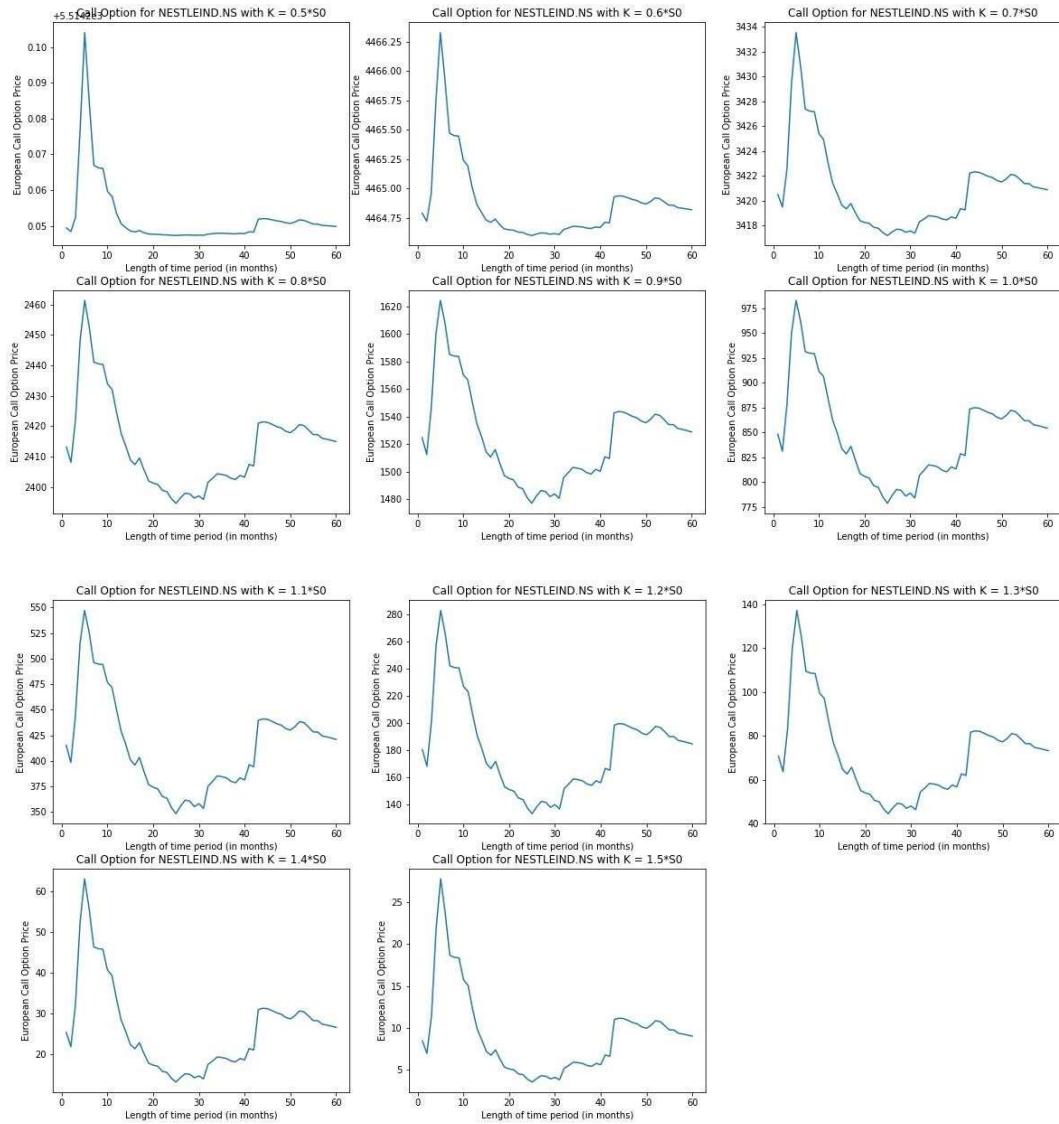
iv) INFY.NS



v) MARUTI.NS

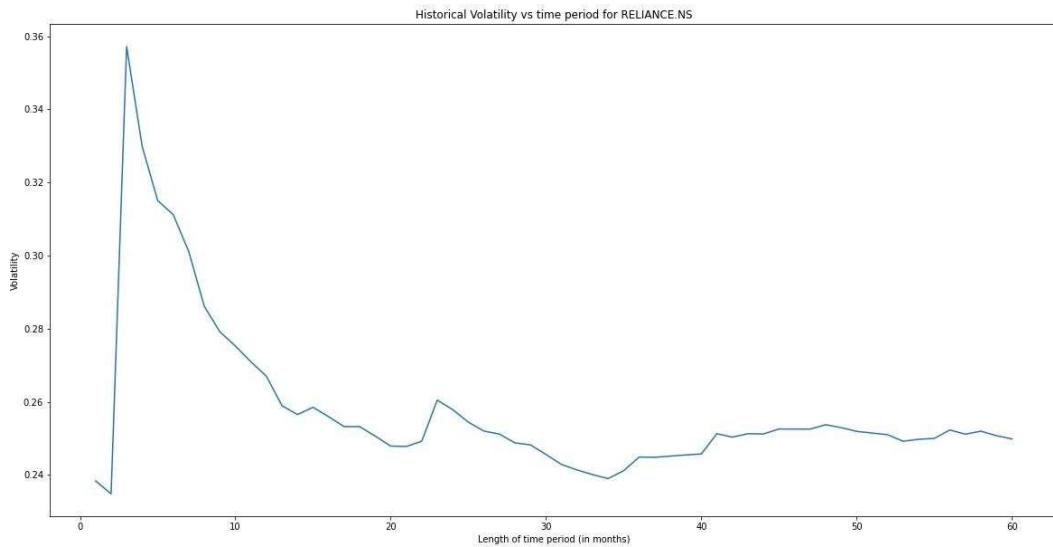
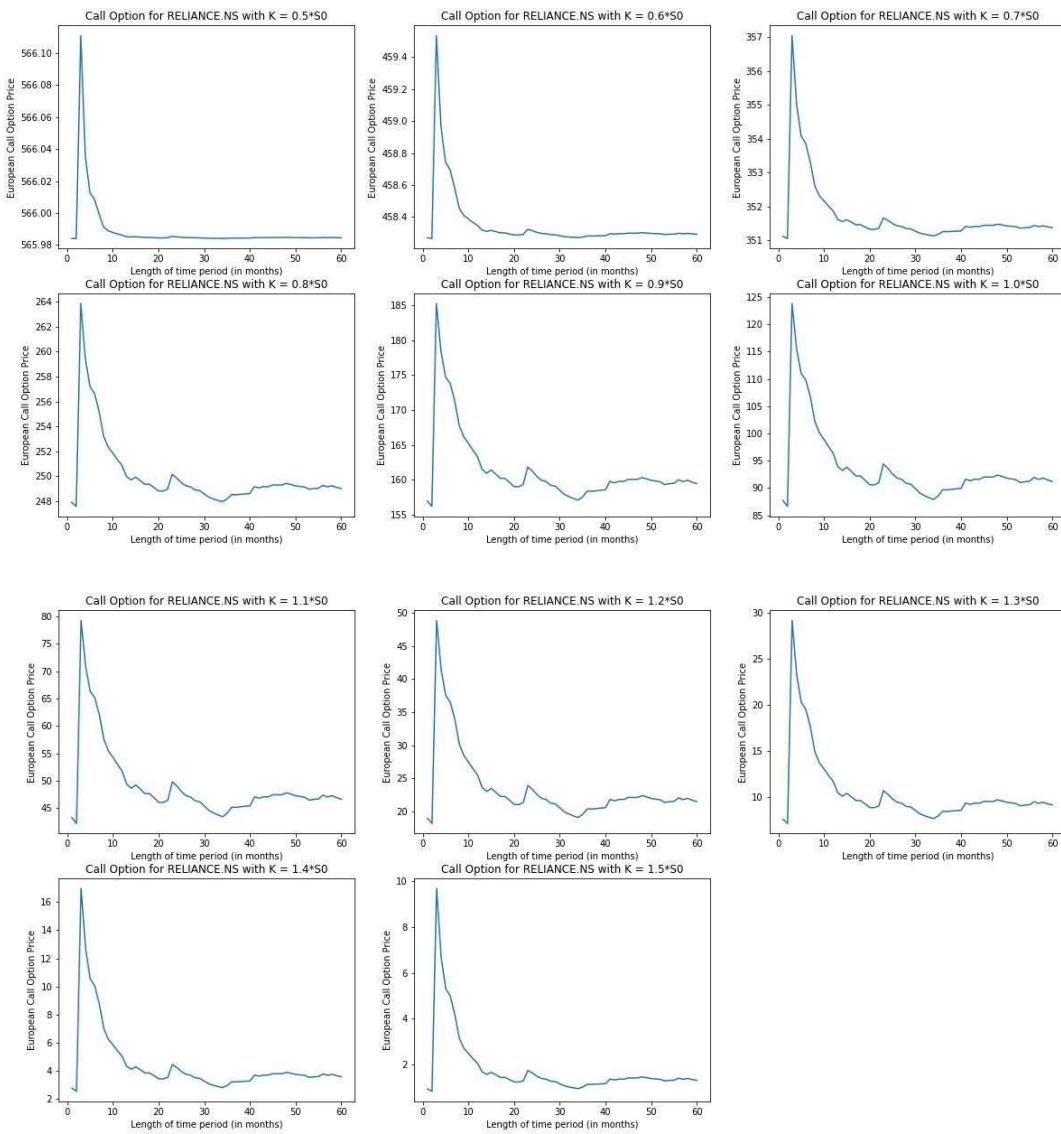


vi) NESTLEIND.NS



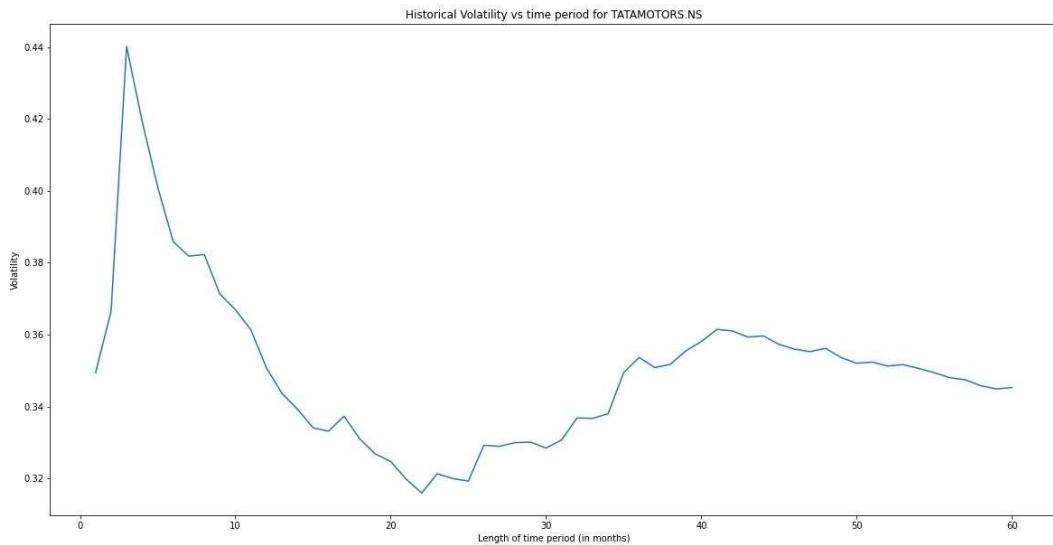
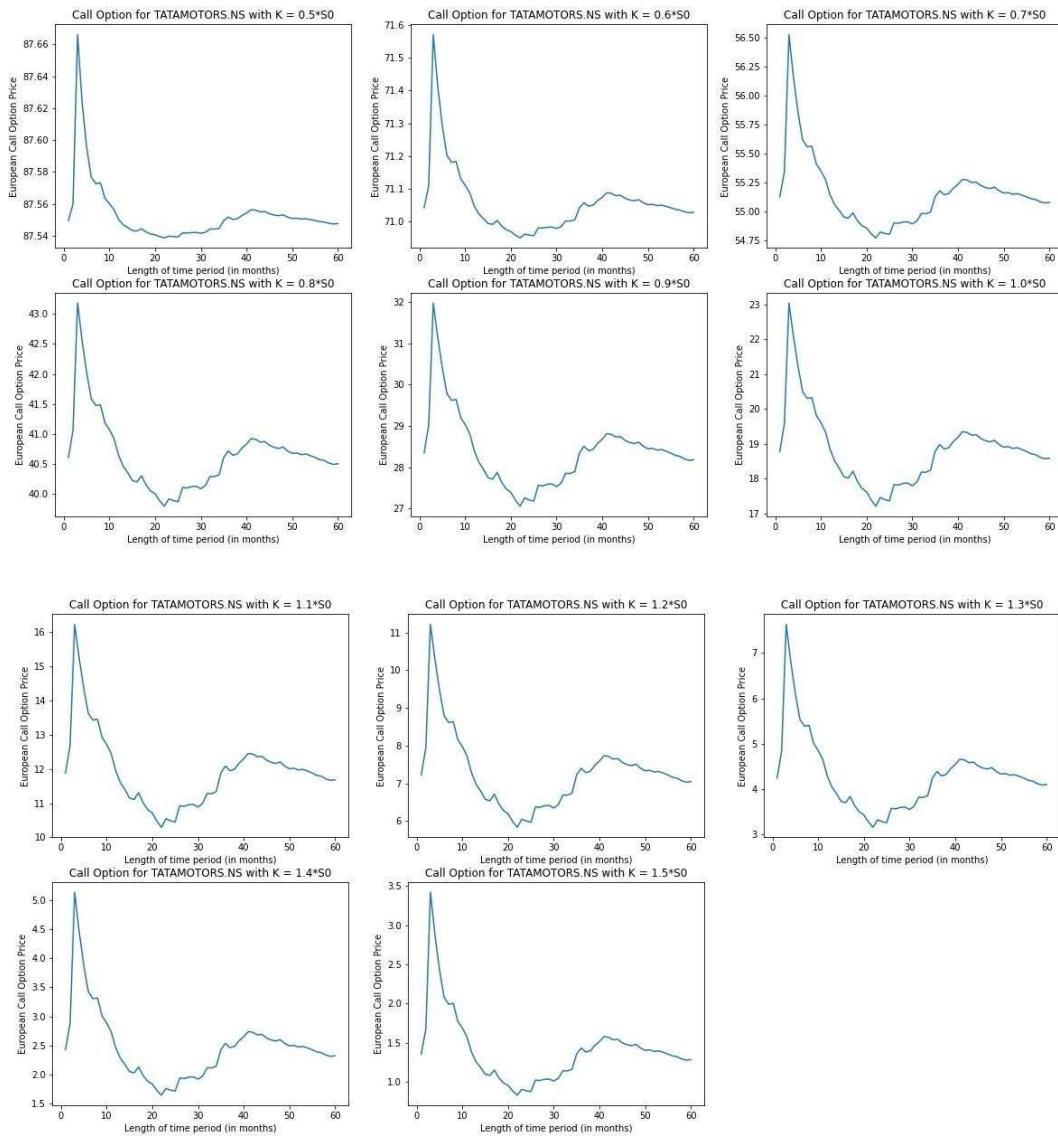
vii)

RELIANCE.NS

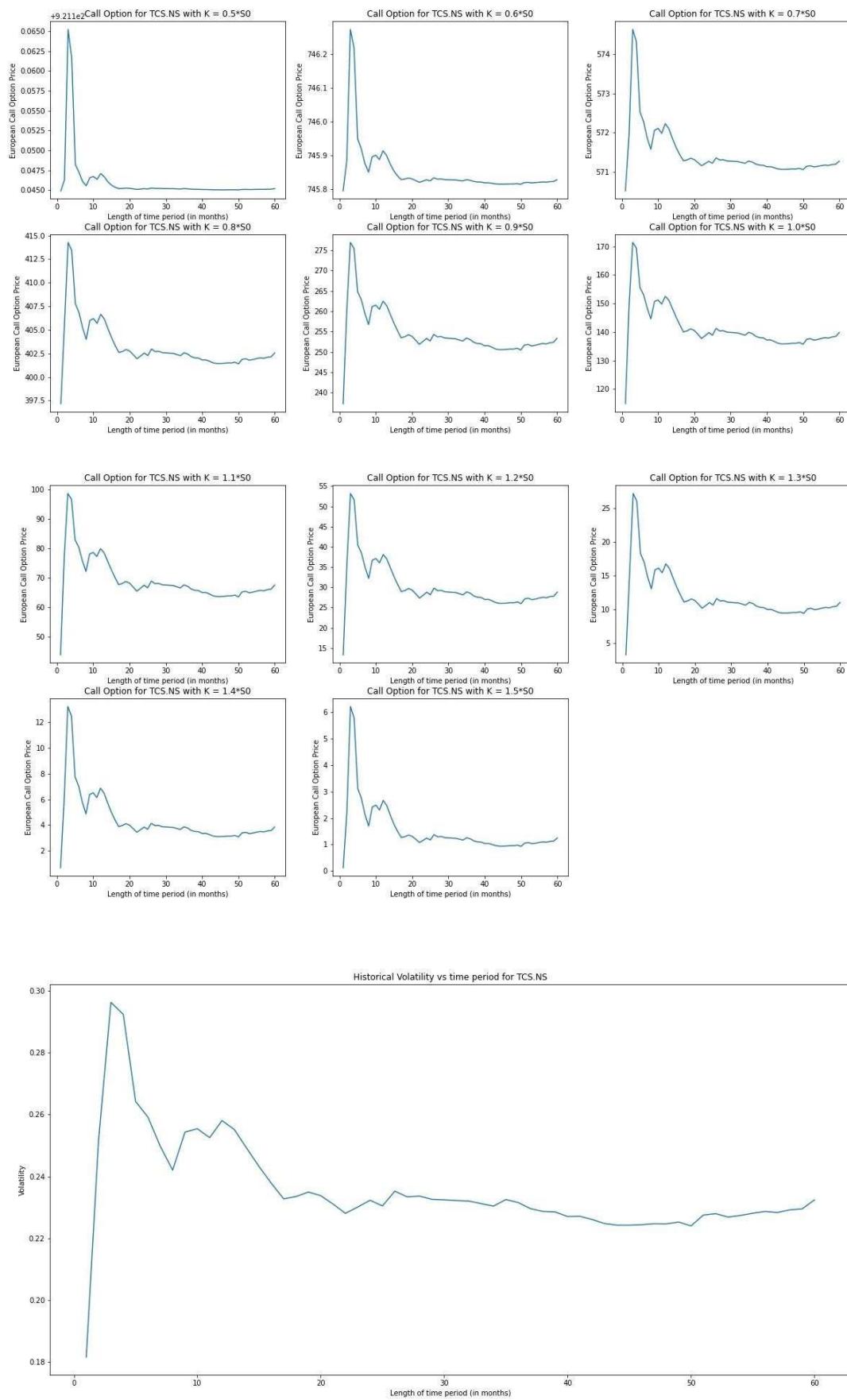


viii)

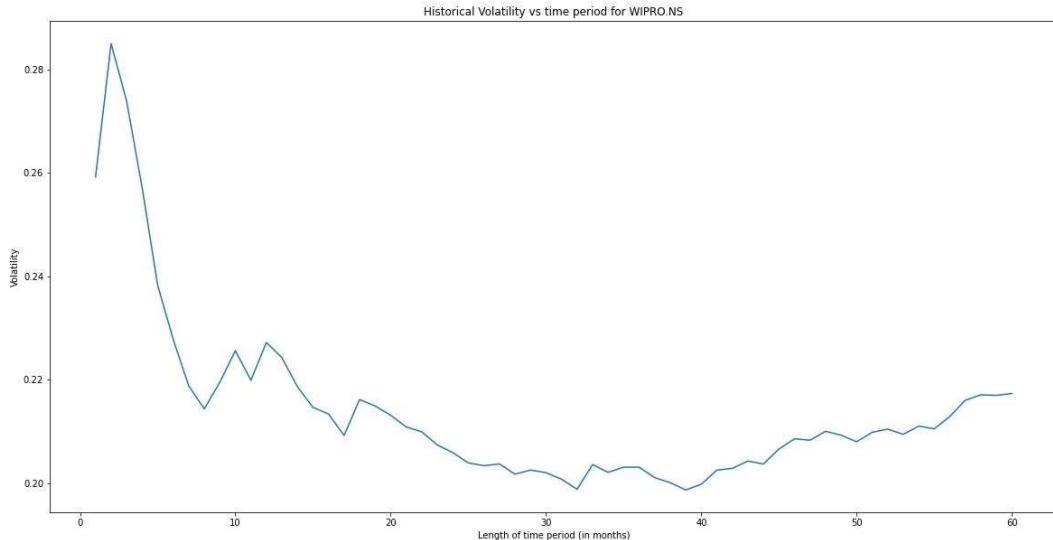
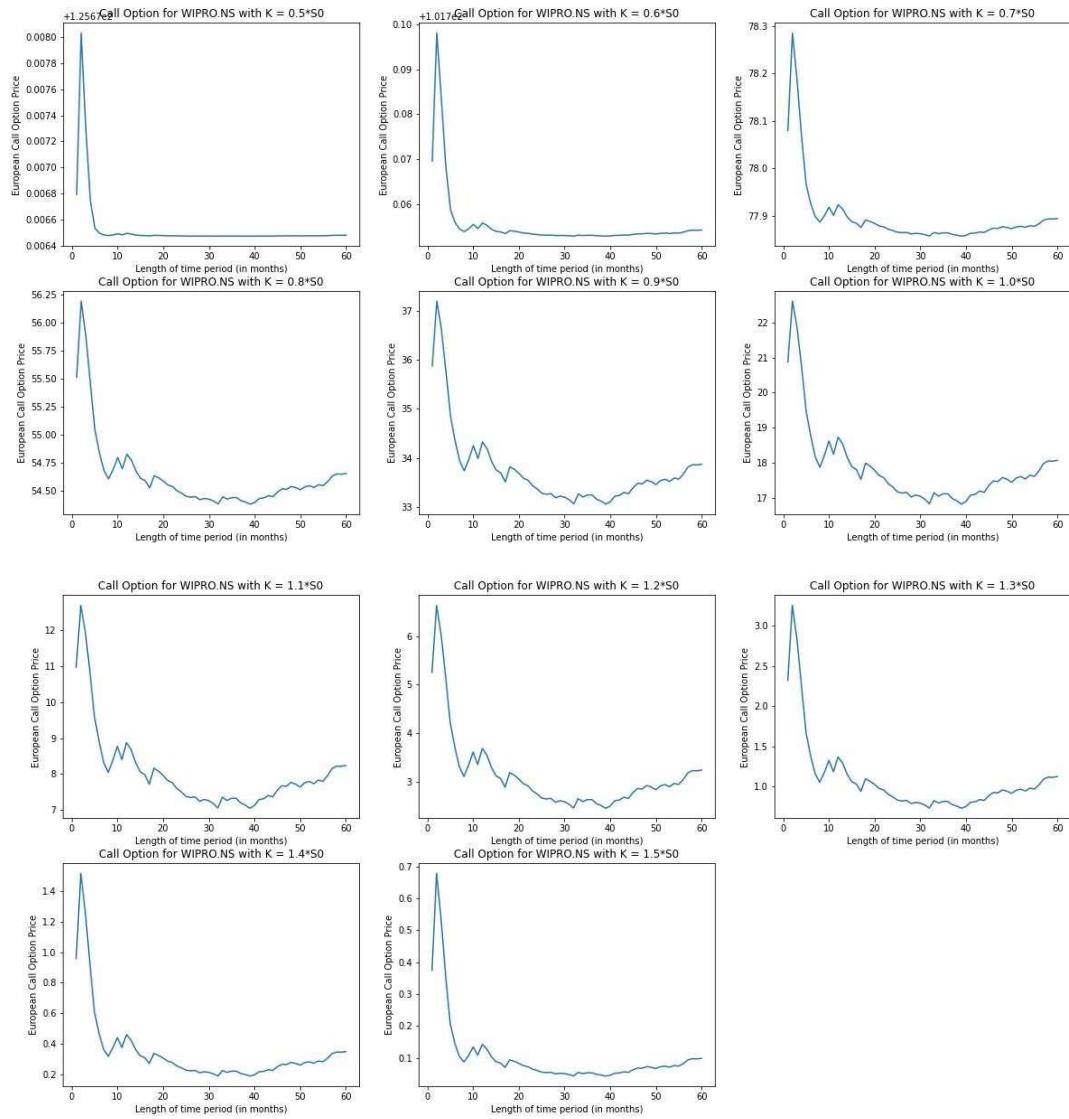
TATAMOTORS.NS



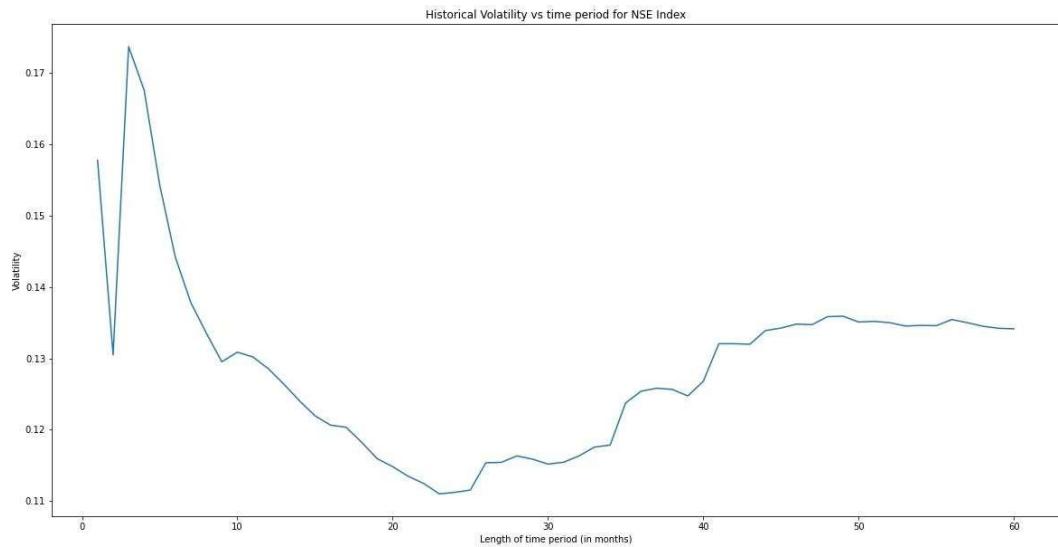
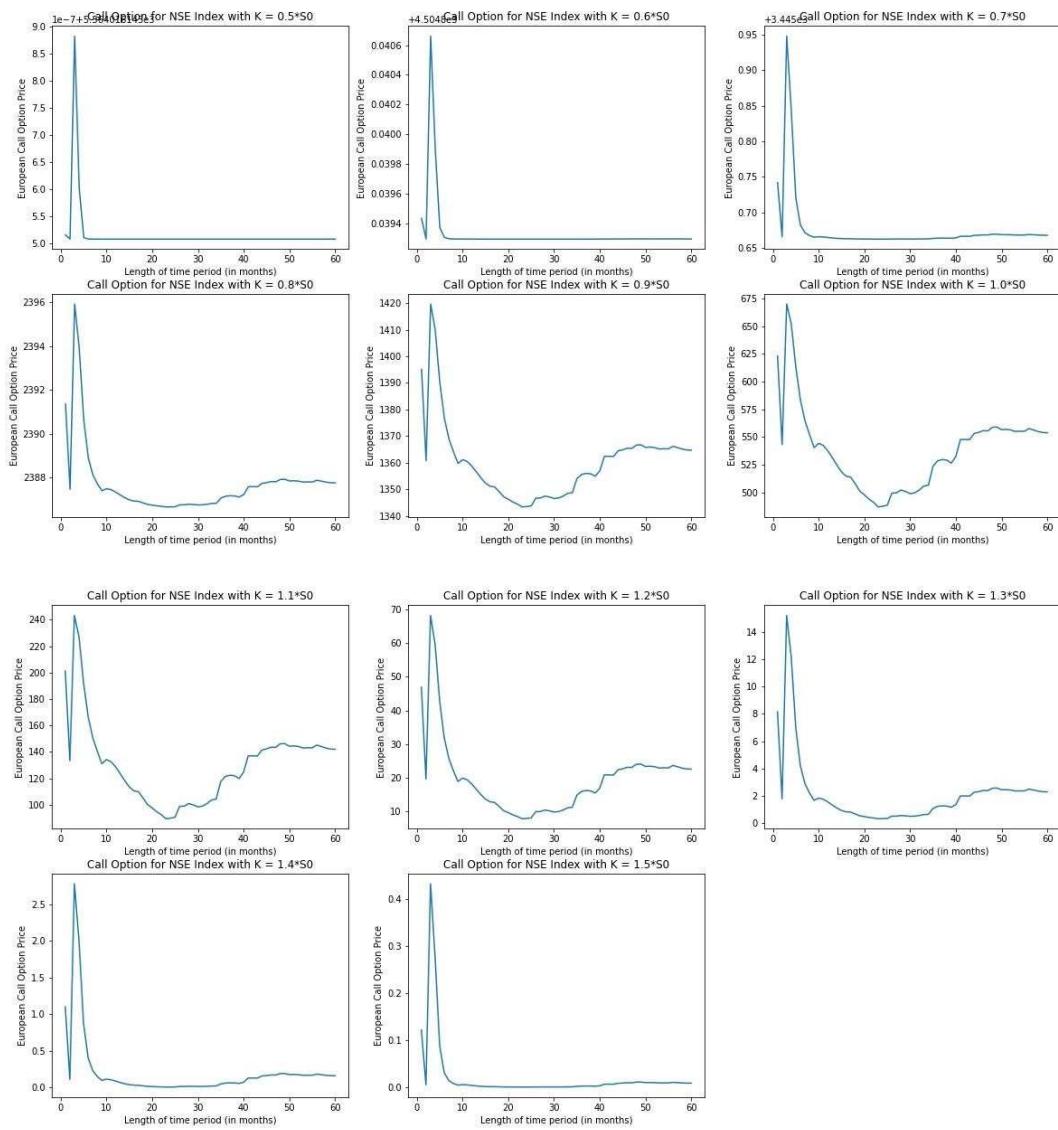
ix) TCS.NS



x) WIPRO.NS

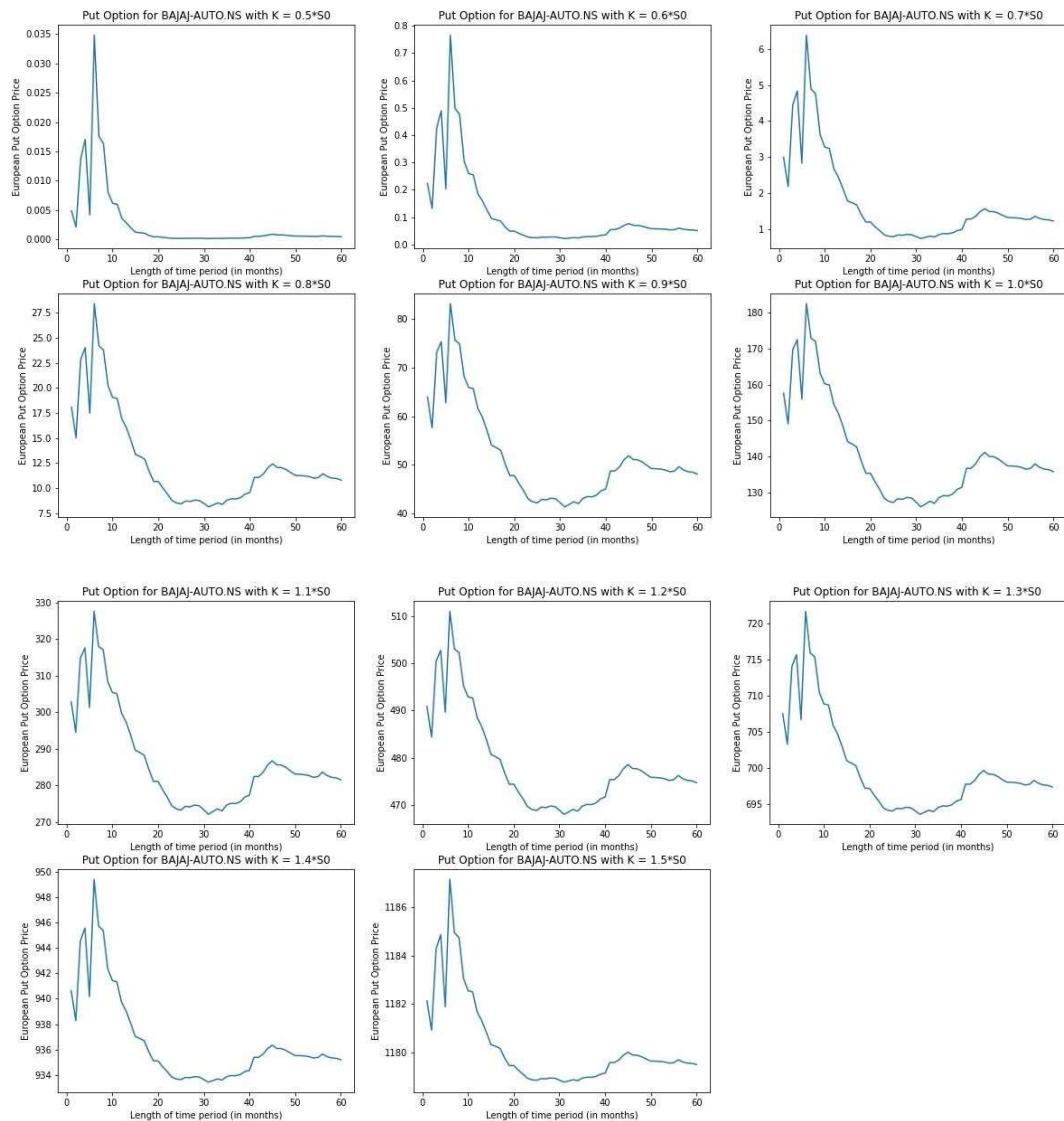


xii) NSE Index

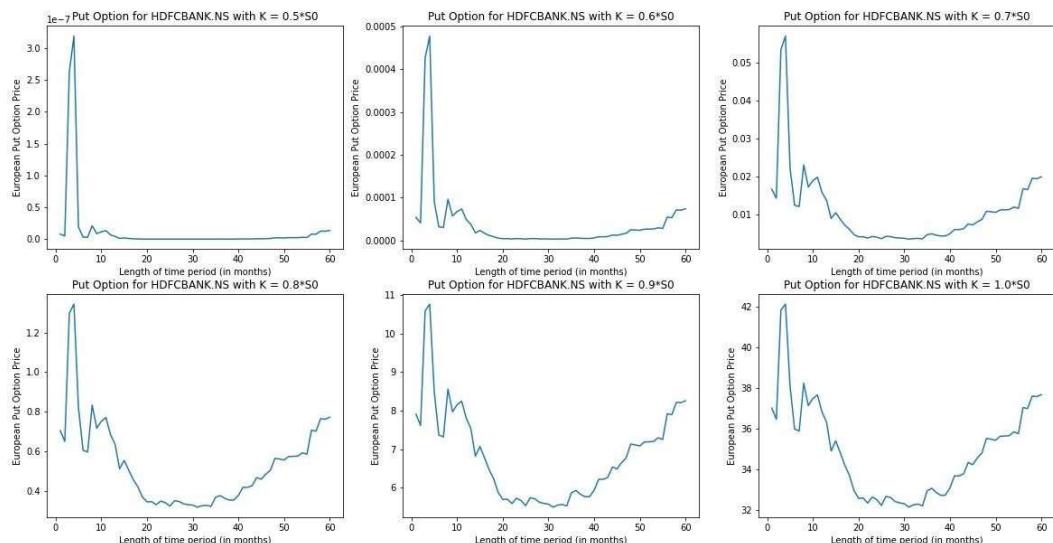


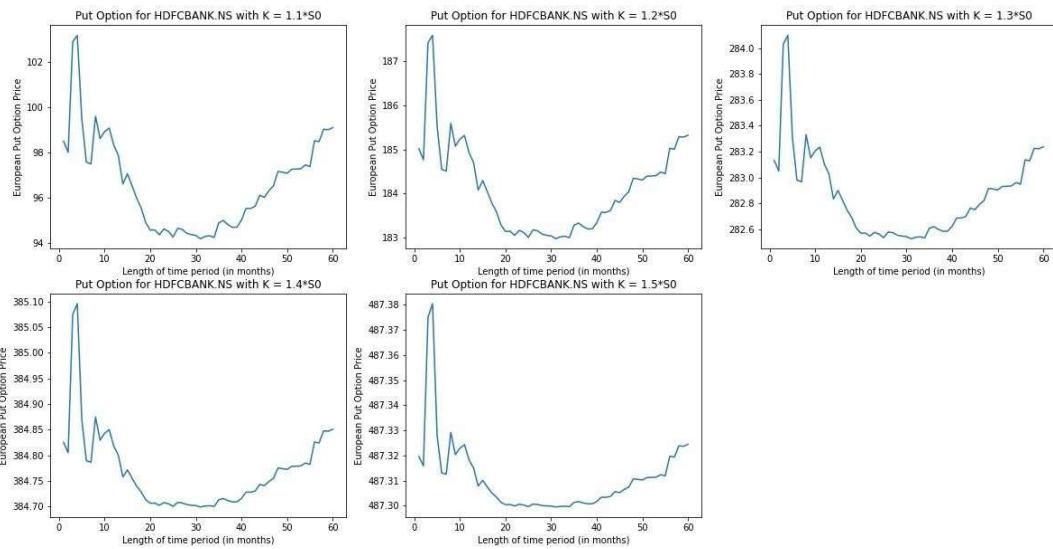
iv. Plots for Put Option - stocks in nsedata1:

i) BAJAJ-AUTO.NS

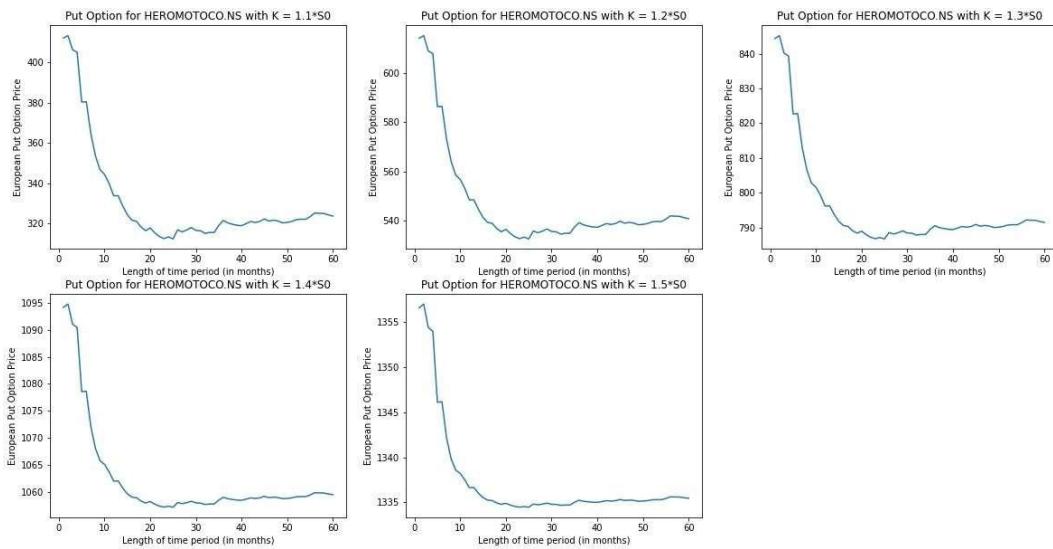
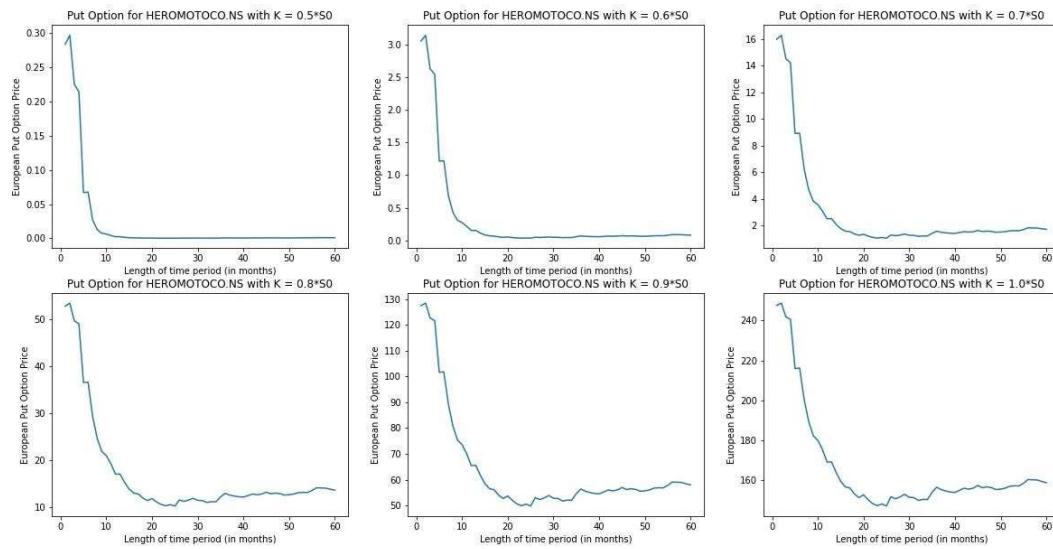


ii) HDFCBANK.NS

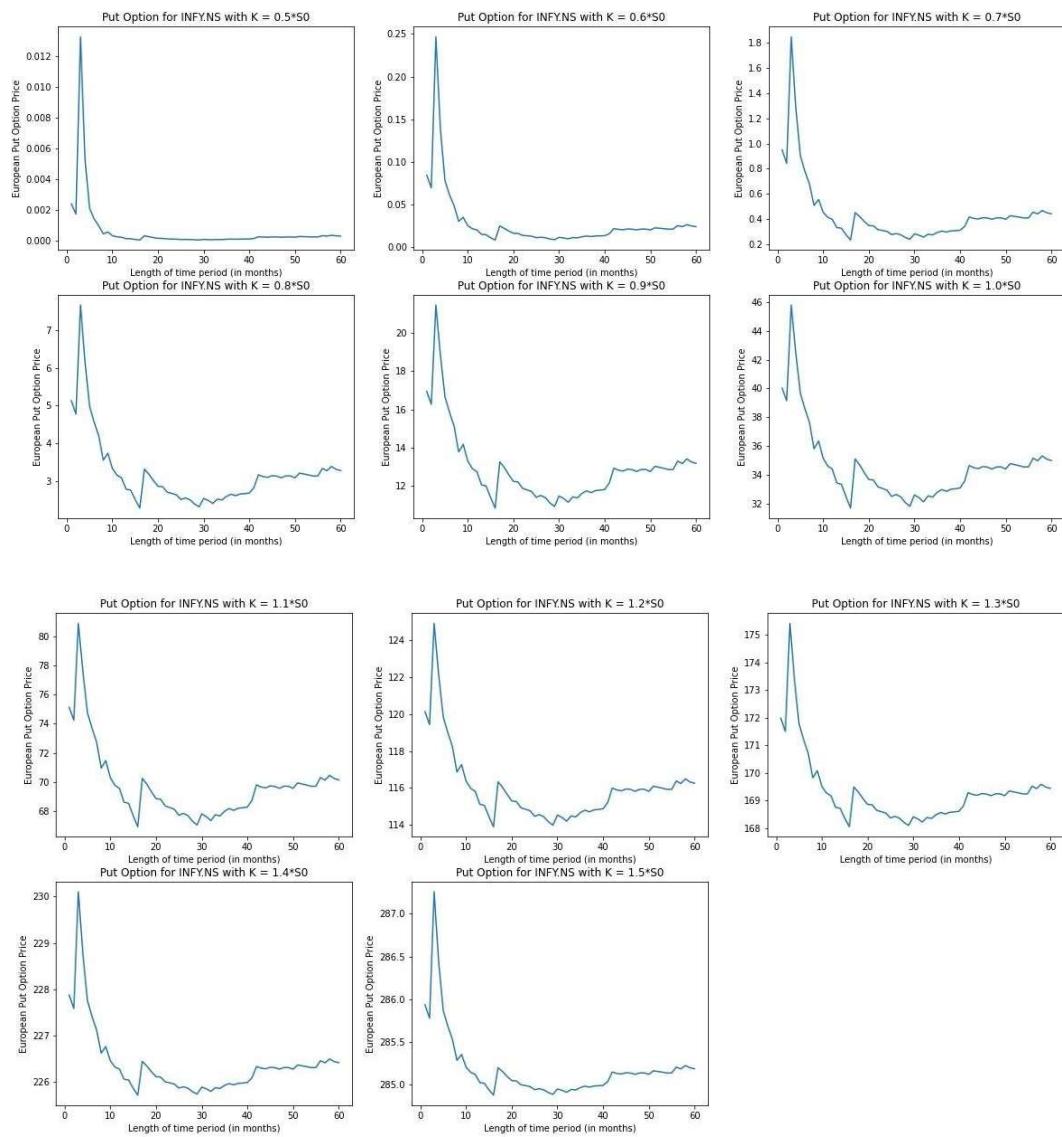




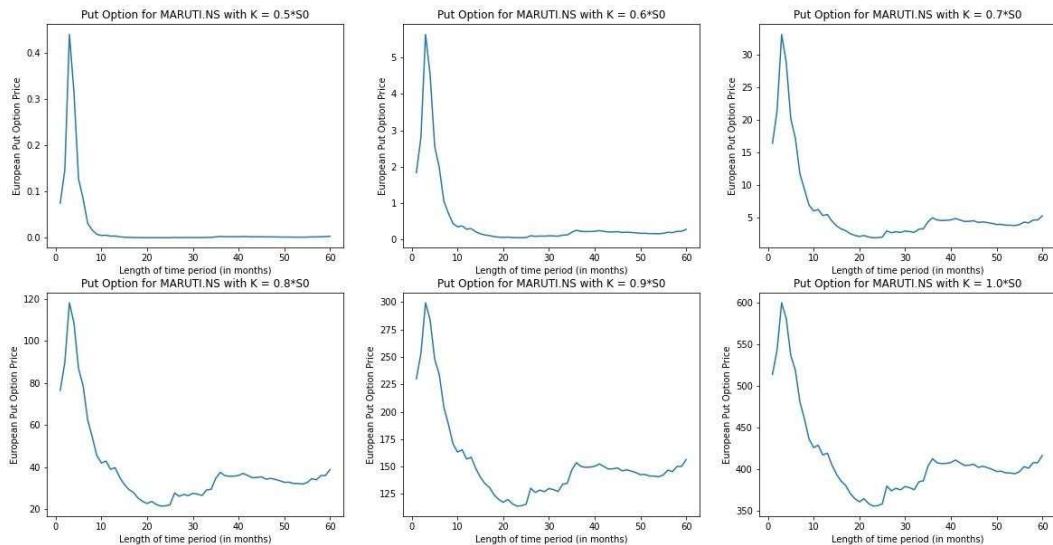
iii) HEROMOTOCO.NS

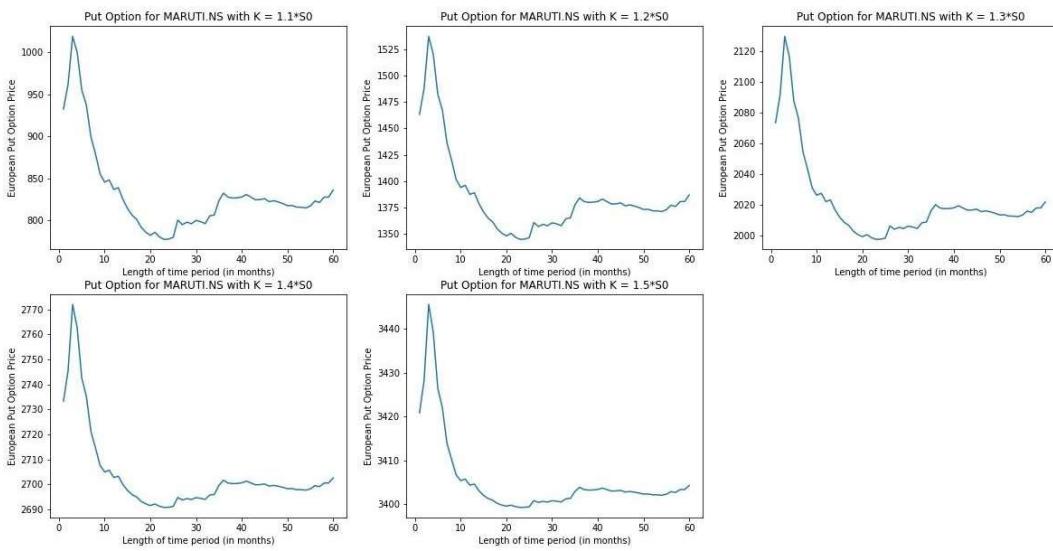


iv) INFY.NS

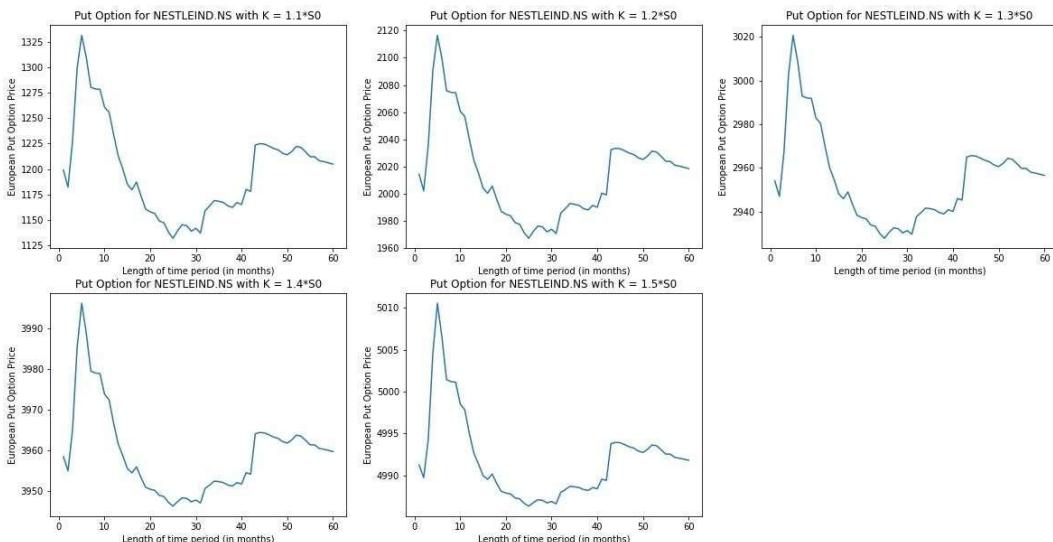
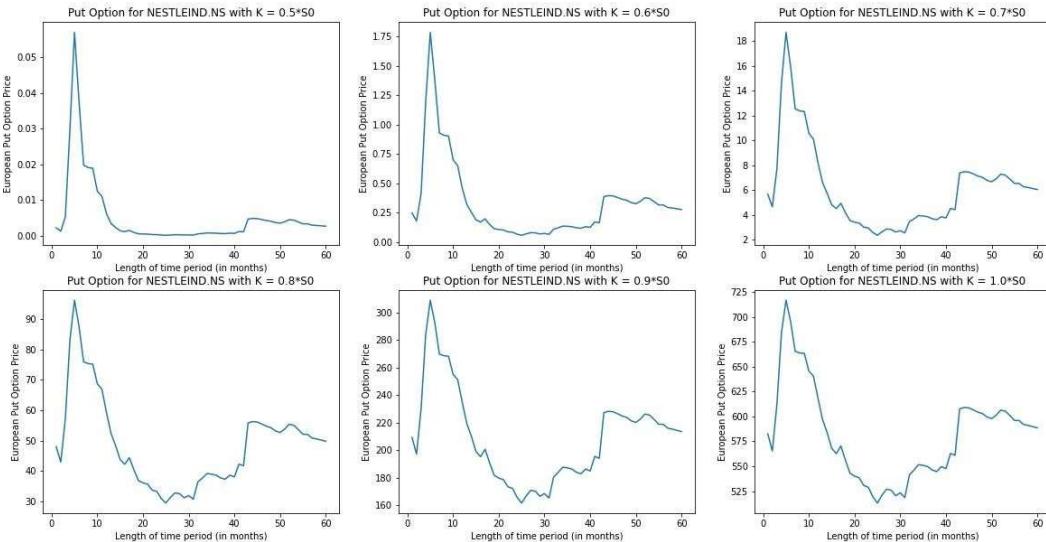


v) MARUTI.NS



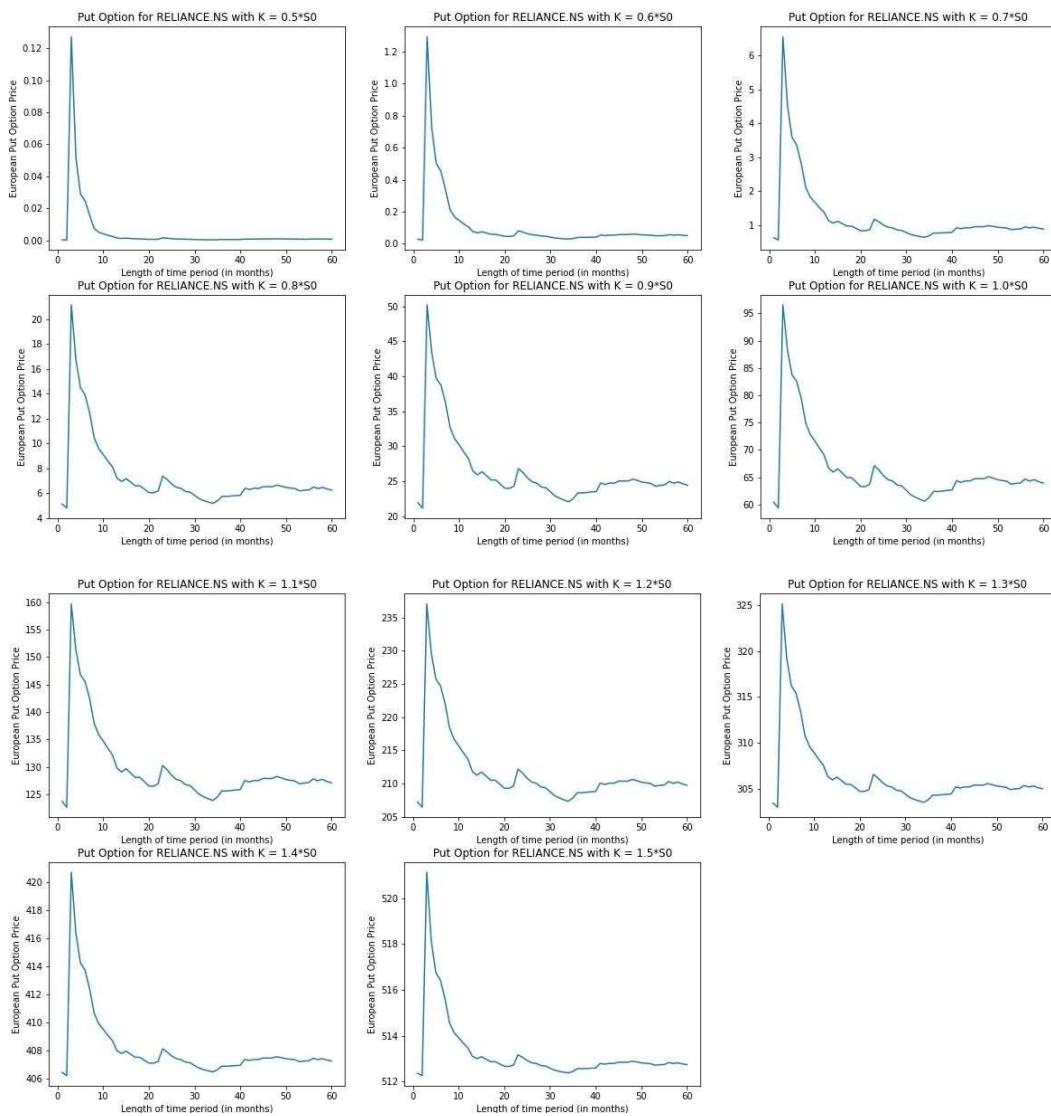


vi) NESTLEIND.NS



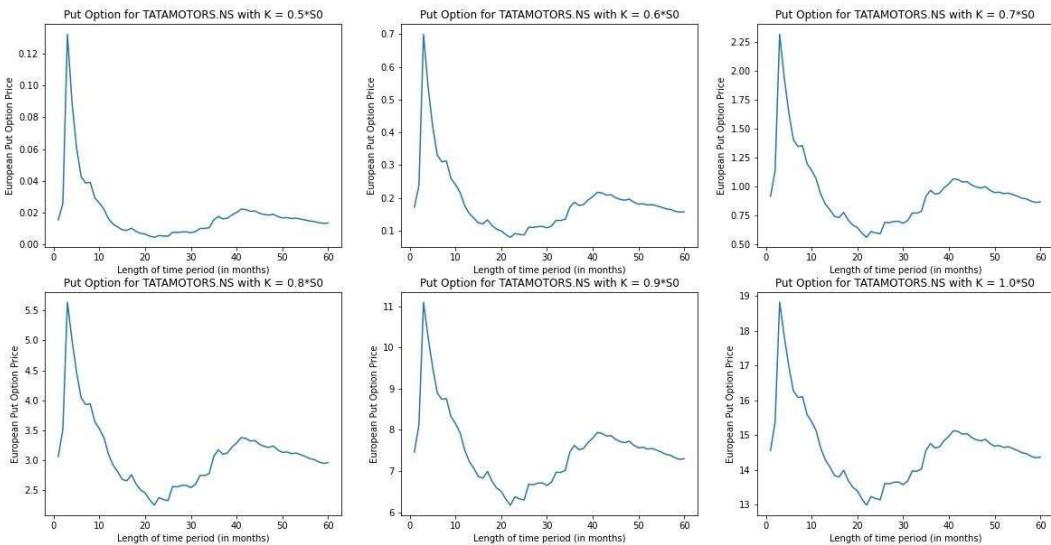
vii)

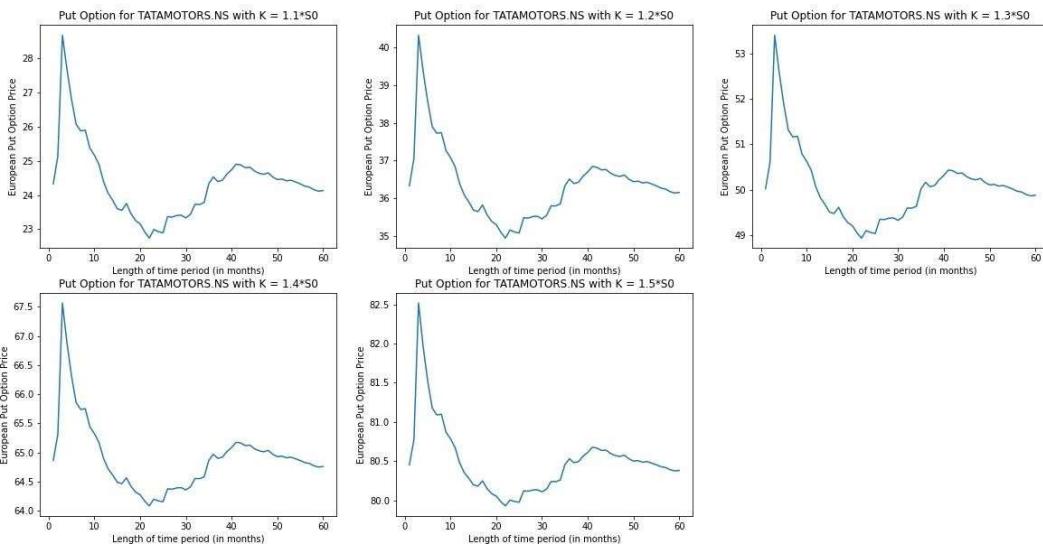
RELIANCE.NS



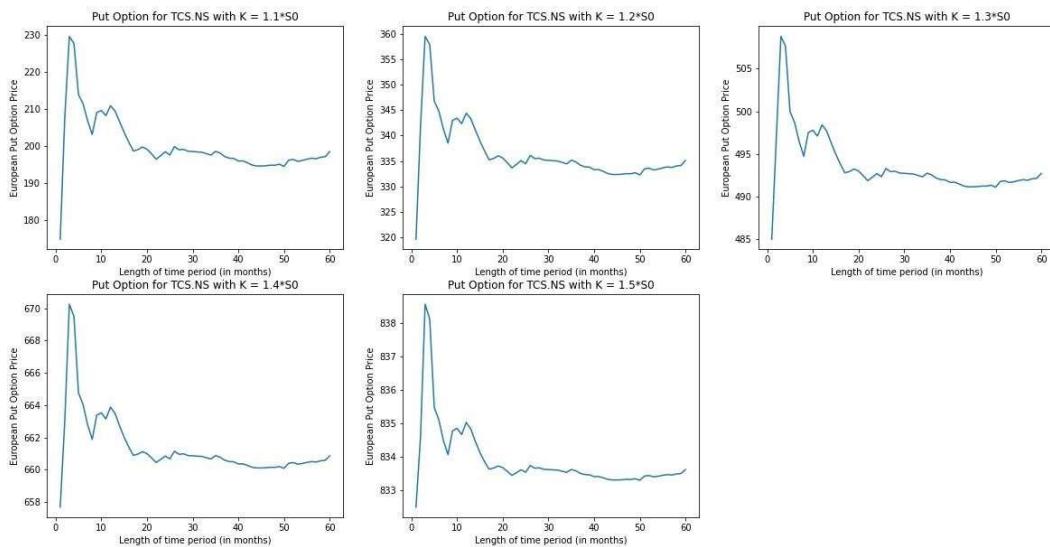
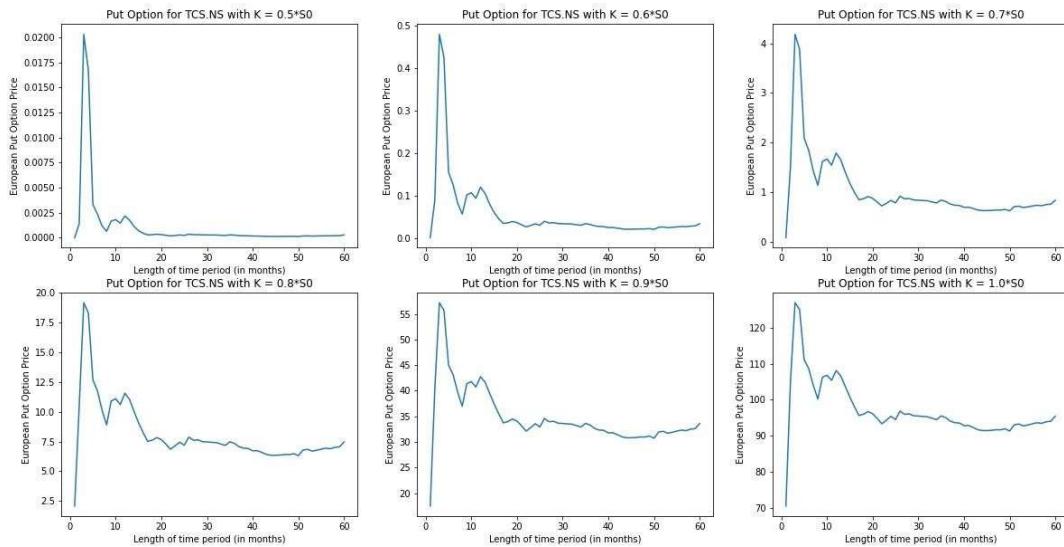
viii)

TATAMOTORS.NS

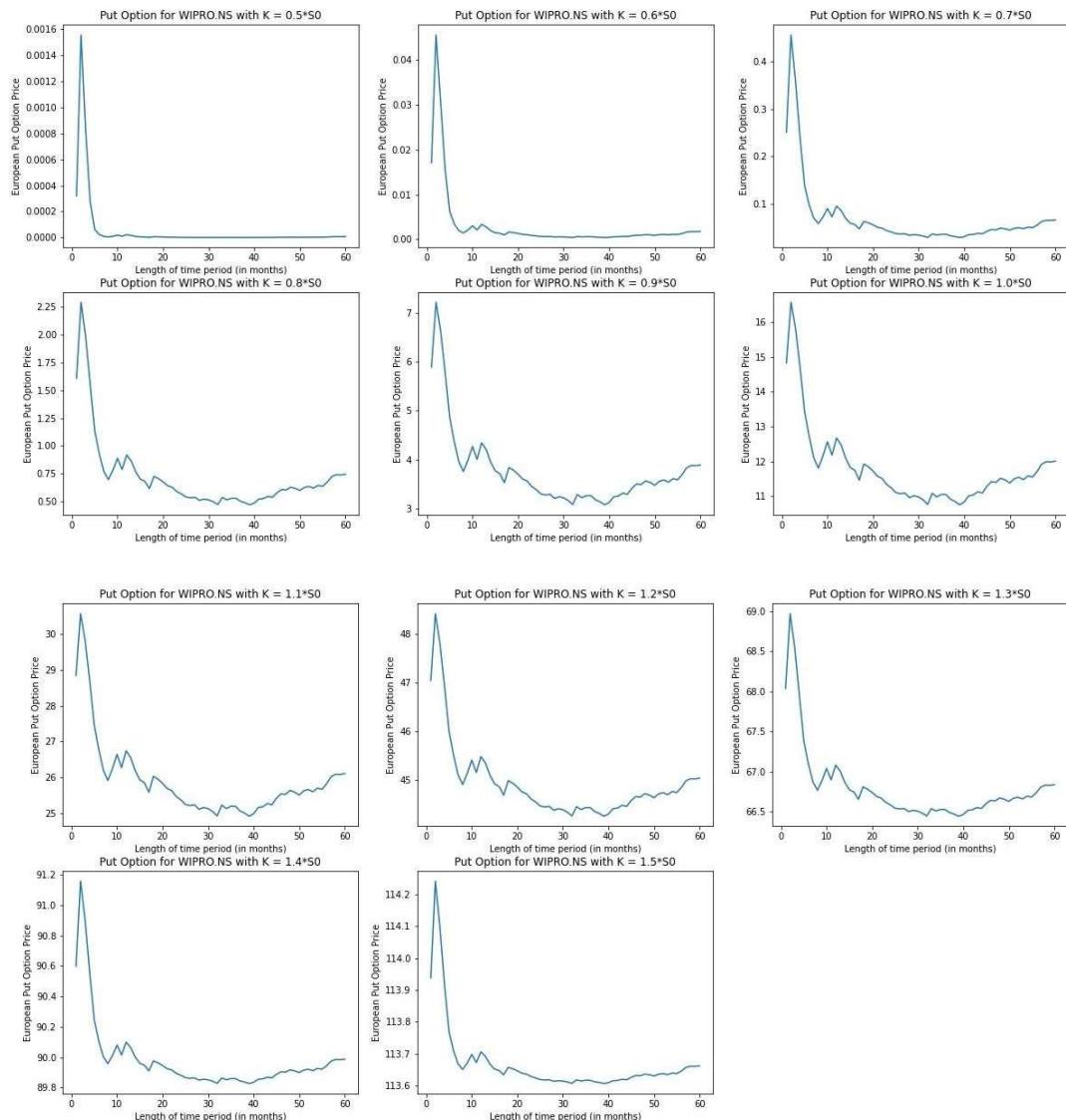




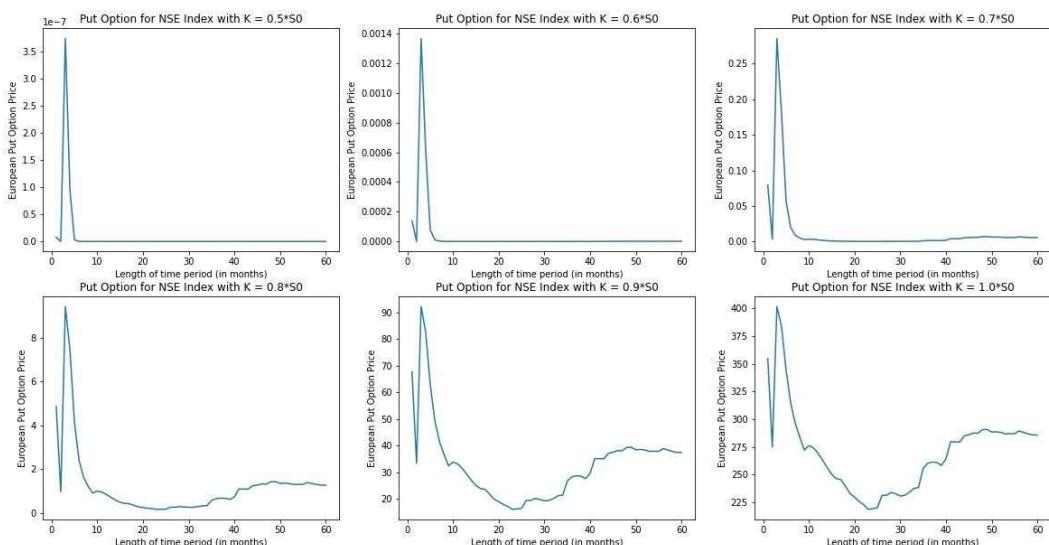
ix) TCS.NS

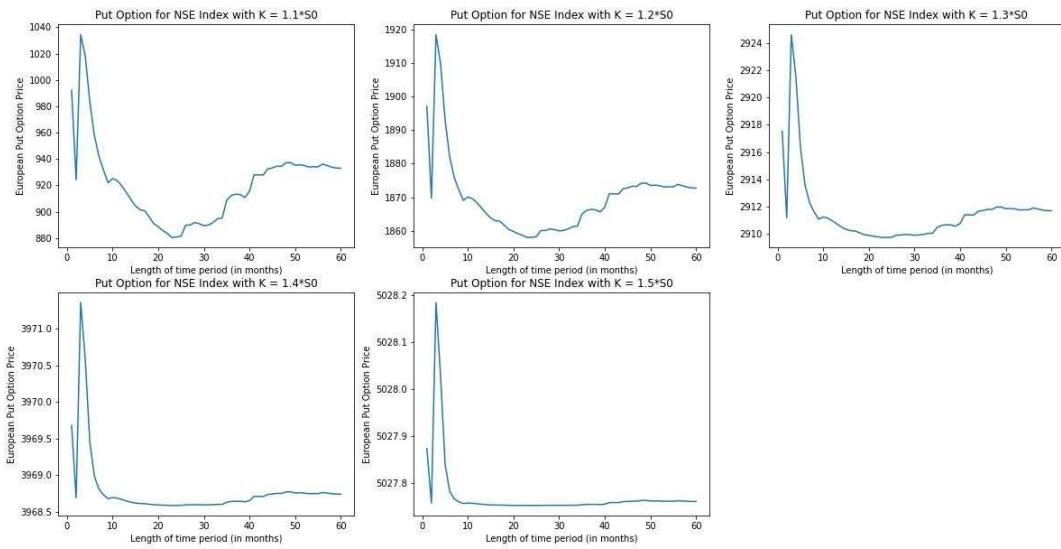


x) WIPRO.NS



xi) NSE Index





4 QUESTION – 4 :

The collected data is in the file **NIFTYoptiondata.csv**. The option prices are collected for the time period from 1st Jan 2014 to 31st Dec 2018, with varying strike prices and maturities.

Theory Involved & Formulae used:

- The price of European Call and Put Option given by BSM framework obtained after solving Black-Scholes-Merton PDE is:

$$C(x, t) = xN(d_1) - Ke^{-r(T-t)}N(d_2)$$

$$P(x, t) = Ke^{-r(T-t)}N(-d_2) - xN(-d_1)$$

where,

$$d_1 = \frac{\log(\frac{x}{K}) + (r + \frac{1}{2}\sigma^2)(T-t)}{\sigma\sqrt{T-t}}$$

$$d_2 = \frac{\log(\frac{x}{K}) + (r - \frac{1}{2}\sigma^2)(T-t)}{\sigma\sqrt{T-t}}$$

$$N(x) = \frac{1}{\sqrt{2\pi}} \int_{-\infty}^x e^{-\frac{y^2}{2}} dy$$

- Put-Call Parity for European Options on a stock that pays no Dividends:

$$C^E - P^E = S(0) - Ke^{-rT}$$

where,

C^E = European call option

P^E = European put option

K = Strike price

T = exercise time