MA 374 – Financial Engineering Lab

Lab – 8

The historical volatility from last one month's data:

Sl No.	Stocks Name (from bsedata1)	Historical Volatility
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

Sl No.	Stocks Name (from nsedata1)	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

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:

i. For stocks in bsedata1:

```
**********************  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 - 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 - INFY.BO ****************
Historical volatility for last 1 month  = 0.27109896165658304

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 - MARUTI.BO ***********
Historical volatility for last 1 month  = 0.290557237968282

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 - NESTLEIND.BO **********
Historical volatility for last 1 month  = 0.23668108599521595

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 - 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 - TCS.BO *****************
Historical volatility for last 1 month  = 0.17980621449552703

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 - 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
```

ii. <u>For stocks in nsedata1:</u>

```
*********************** For stocks - NSE Index *************
Historical volatility for last 1 month  = 0.15773797914236246

Strike price (K)      Call Option    Put Option
------------------   -------------   -------------
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
1.3*S0                   8.15047    2917.55
1.4*S0                   1.10311    3969.68
1.5*S0                   0.12143    5027.87
```

```
*********************** For stocks - BAJAJ-AUTO.NS ********
Historical volatility for last 1 month  = 0.2646819256693275

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  = 0.16690948948038953

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  = 0.35209001941047746

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 - INFY.NS ***************
Historical volatility for last 1 month  = 0.2763140345931938

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 - MARUTI.NS **************
Historical volatility for last 1 month  = 0.29415801174853756

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 - 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 - RELIANCE.NS **********
Historical volatility for last 1 month  = 0.2383561661853663

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
```

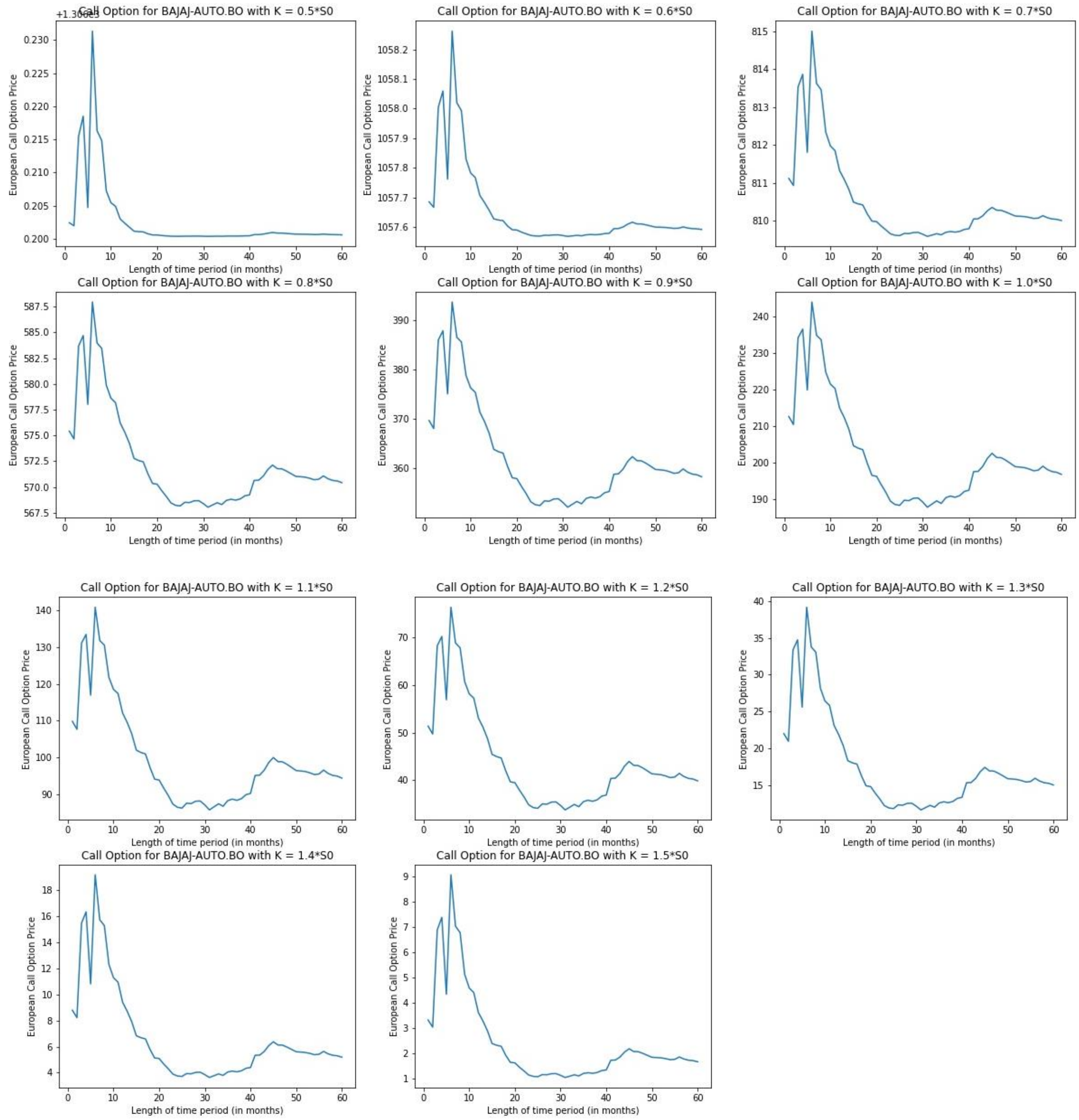
```
***********************  For stocks - TATAMOTORS.NS ********
Historical volatility for last 1 month  = 0.3494139705247439

Strike price (K)      Call Option    Put Option
------------------  -------------  ------------
0.5*S0                  87.5497       0.0155051
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
```

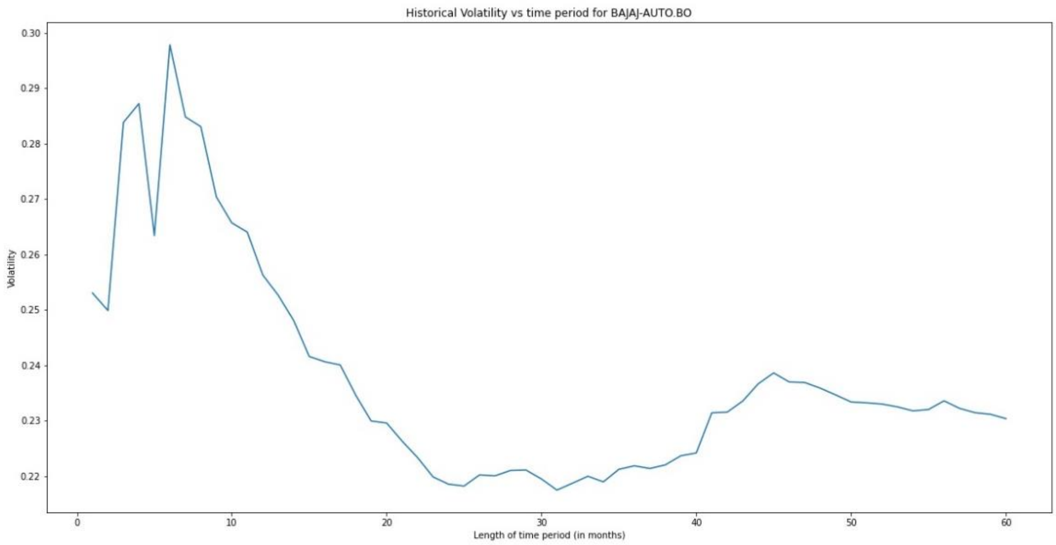
```
***********************  For stocks - TCS.NS ****************
Historical volatility for last 1 month  = 0.18165036953378483

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 - 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
```

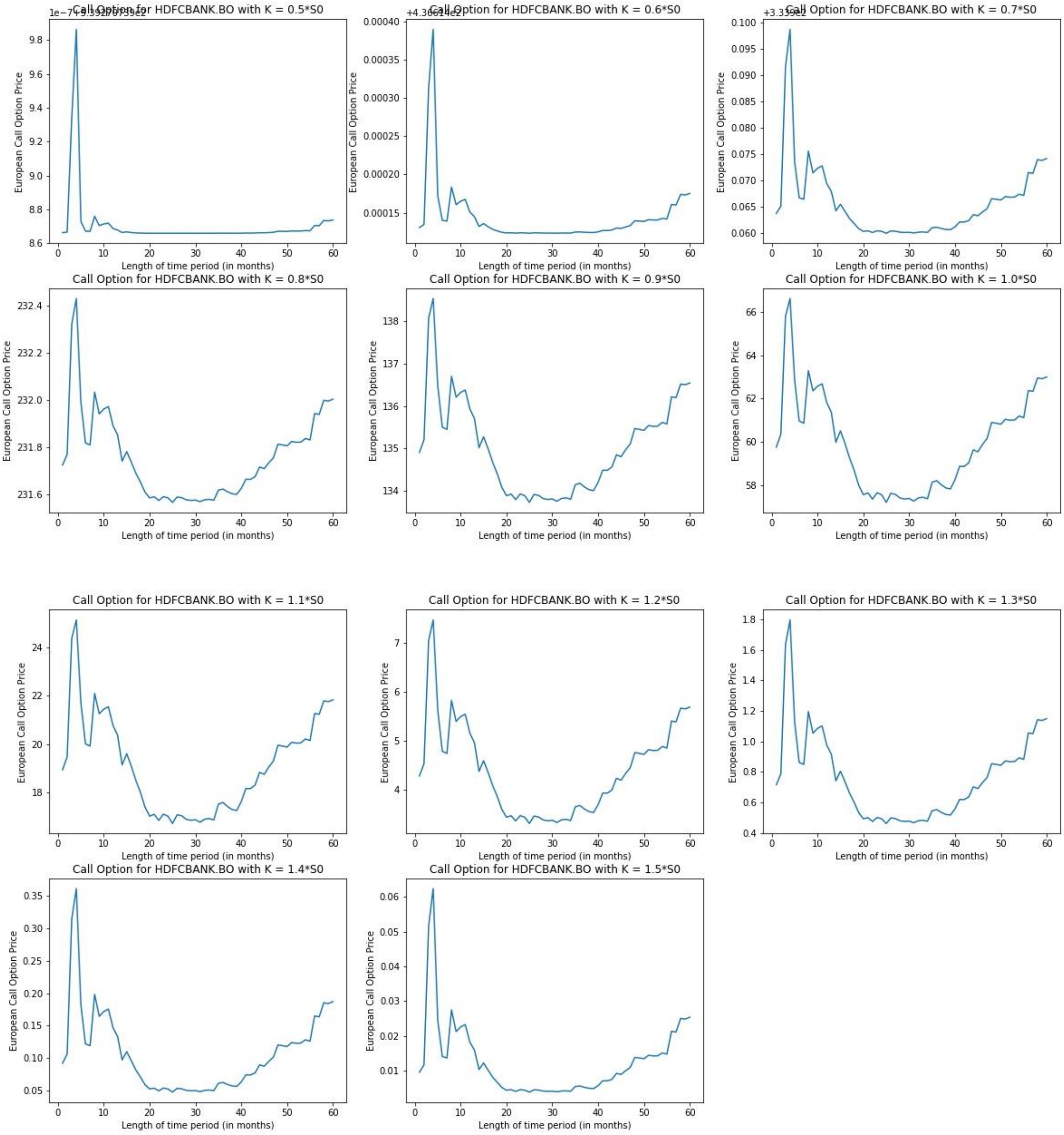
i. Plots for Call Option and Volatility - stocks in bsedata1:

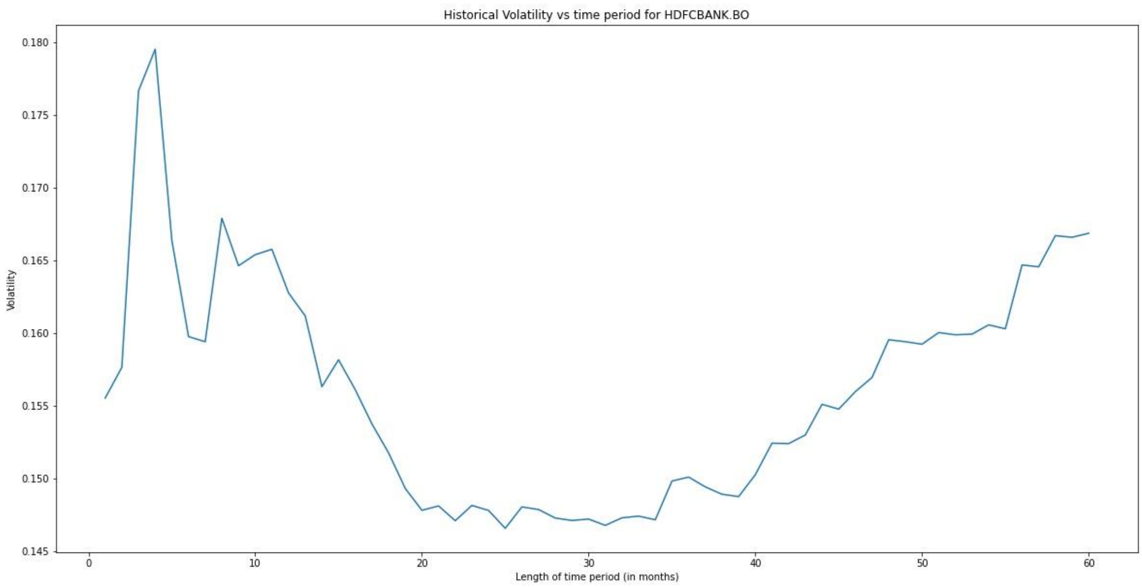
i) BAJA-AUTO.BO



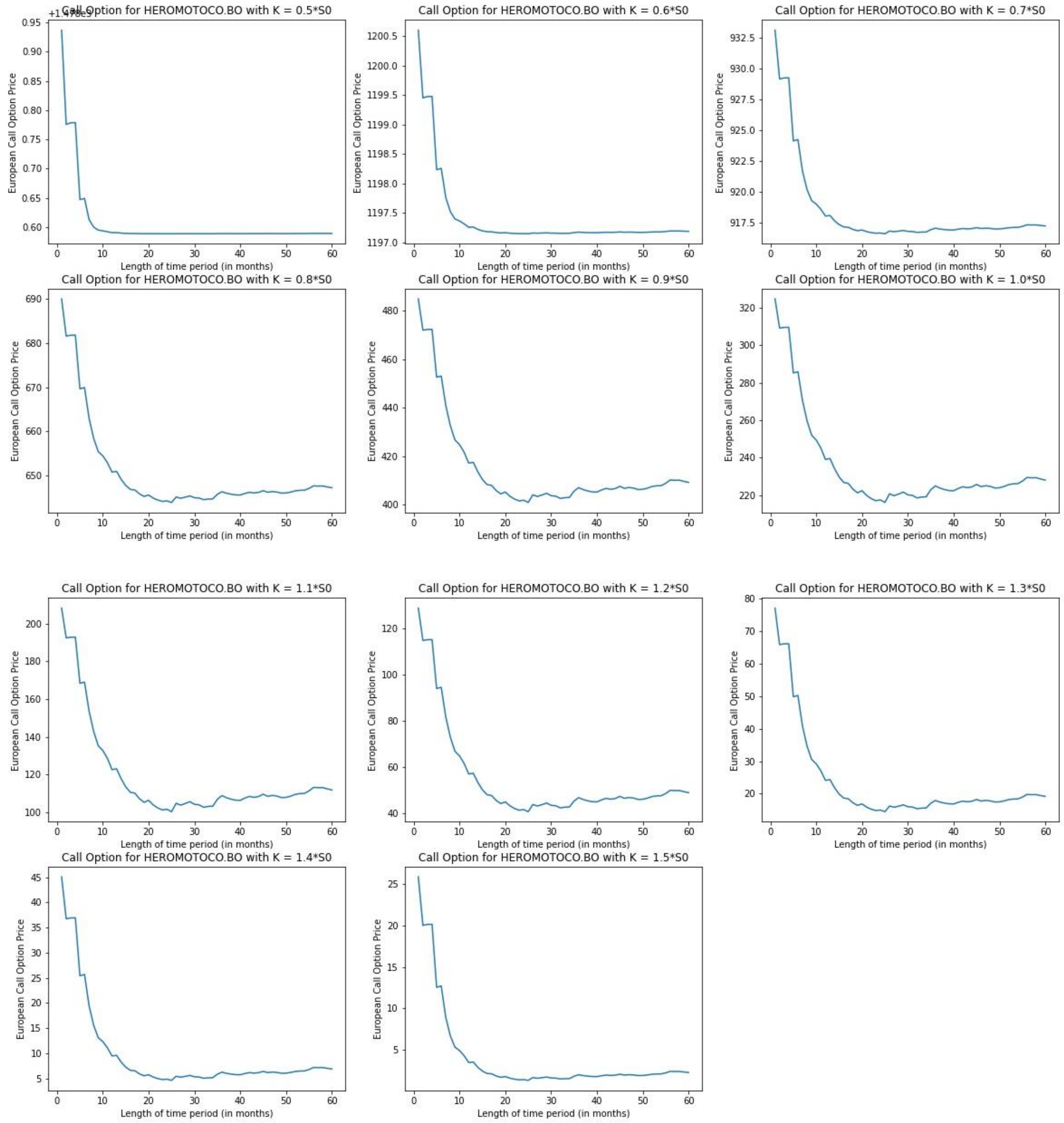


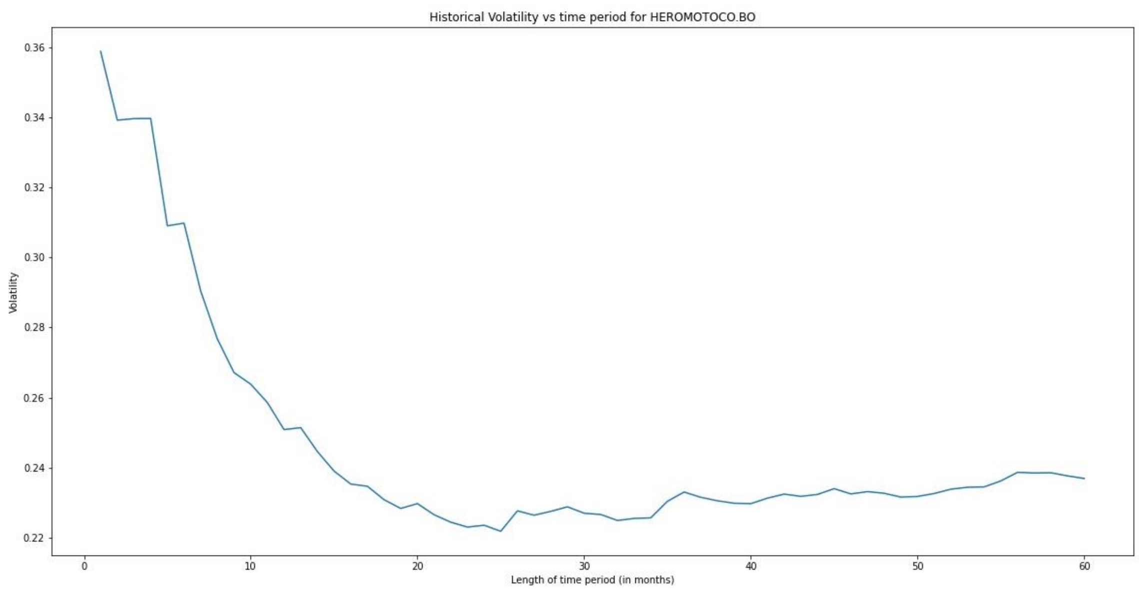
ii) HDFCBANK.BO



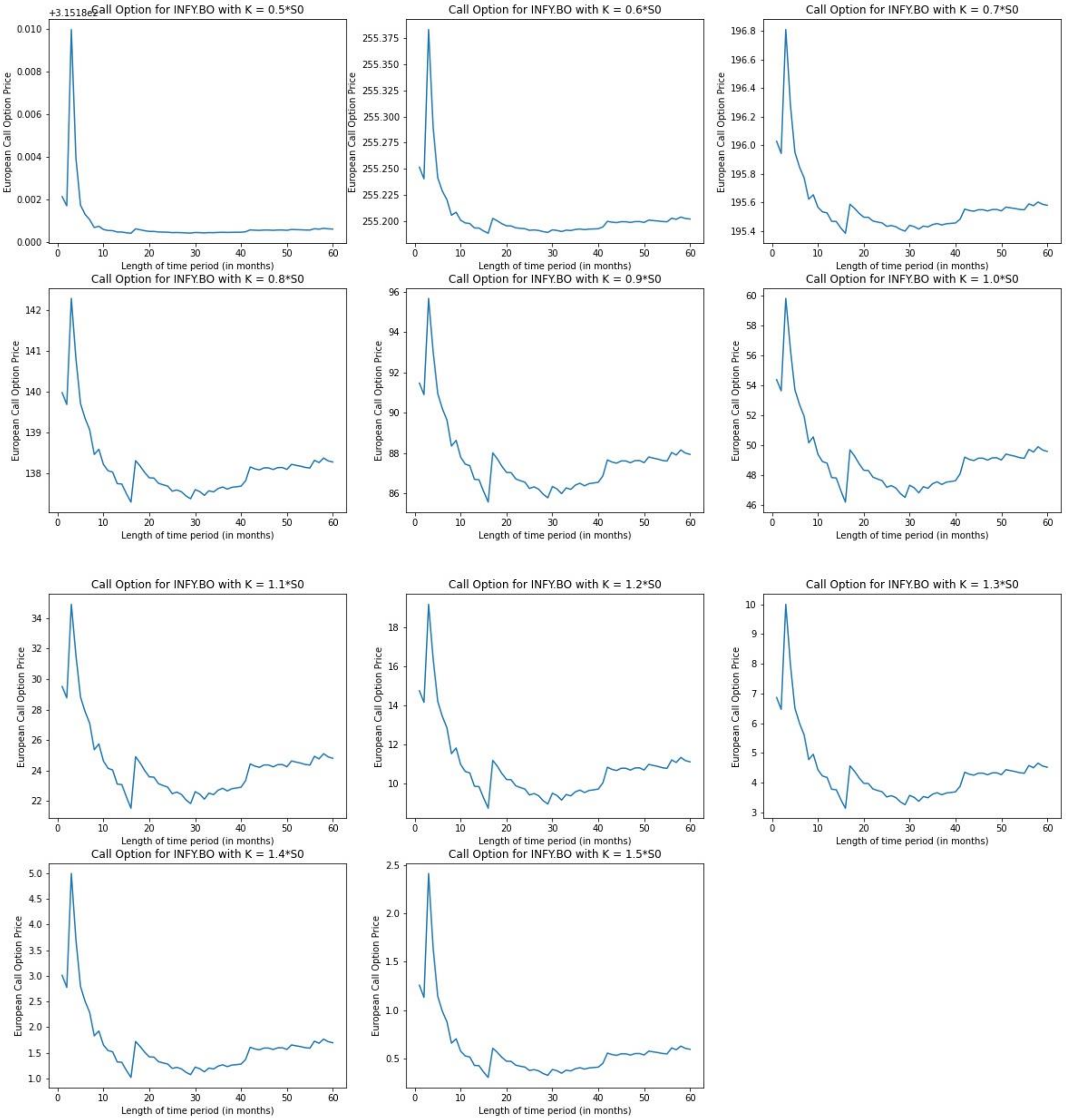


iii) HEROMOTOCO.BO

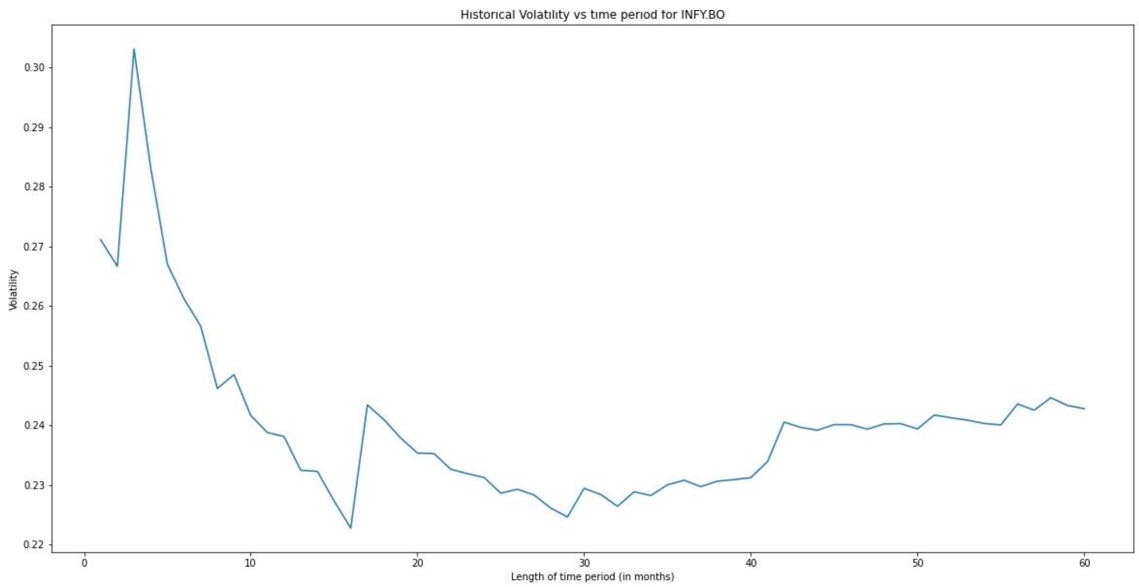




iv) INFY.BO

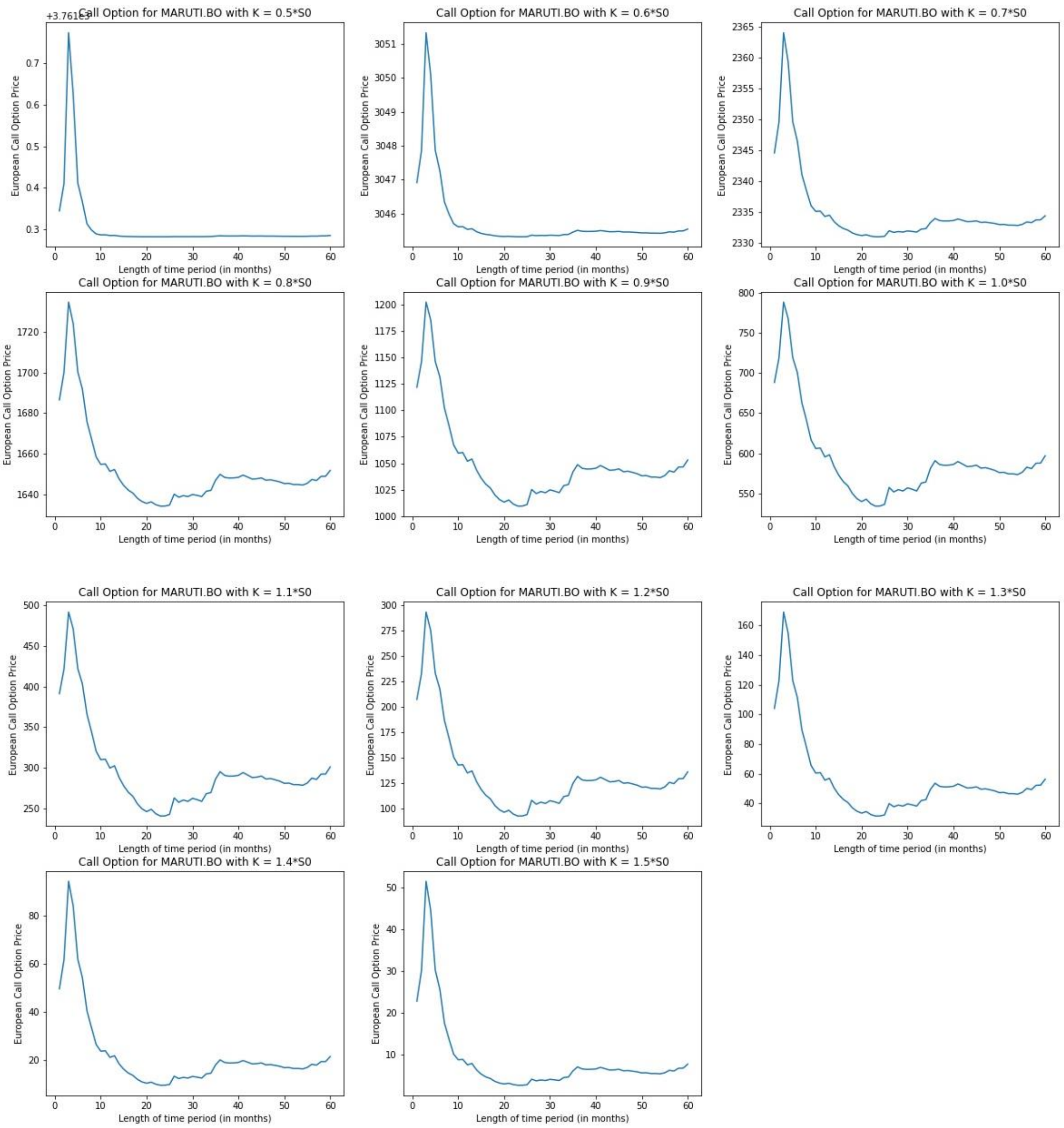


Call Option for INFY.BO with K = 0.5*S0
+3.1518e2
Call Option for INFY.BO with K = 0.6*S0
Call Option for INFY.BO with K = 0.7*S0
Call Option for INFY.BO with K = 0.8*S0
Call Option for INFY.BO with K = 0.9*S0
Call Option for INFY.BO with K = 1.0*S0
Call Option for INFY.BO with K = 1.1*S0
Call Option for INFY.BO with K = 1.2*S0
Call Option for INFY.BO with K = 1.3*S0
Call Option for INFY.BO with K = 1.4*S0
Call Option for INFY.BO with K = 1.5*S0
European Call Option Price
Length of time period (in months)

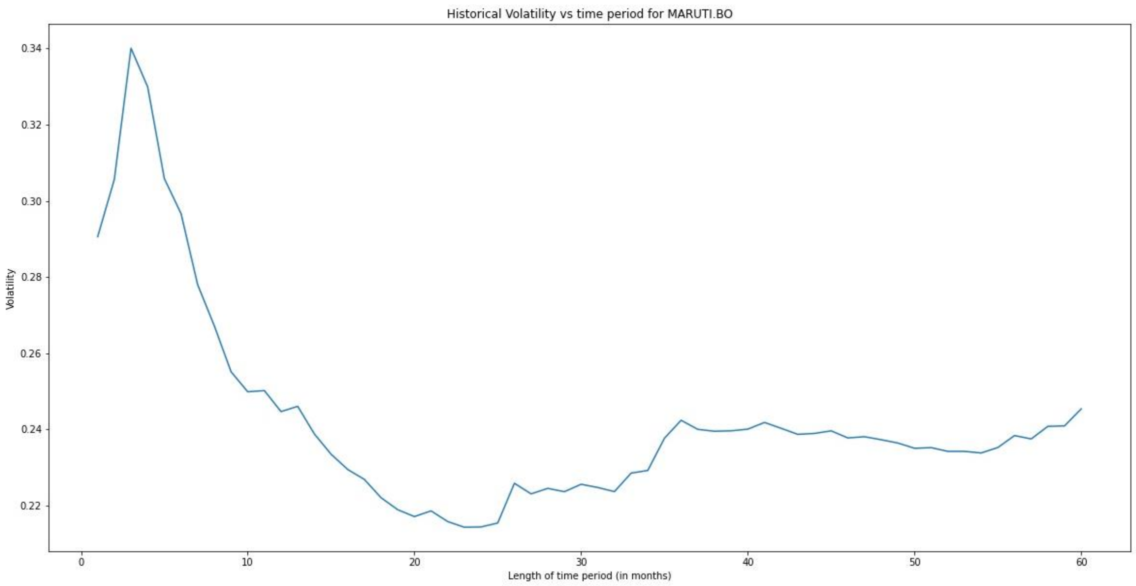


Historical Volatility vs time period for INFY.BO
Volatility
Length of time period (in months)

v) MARUTI.BO

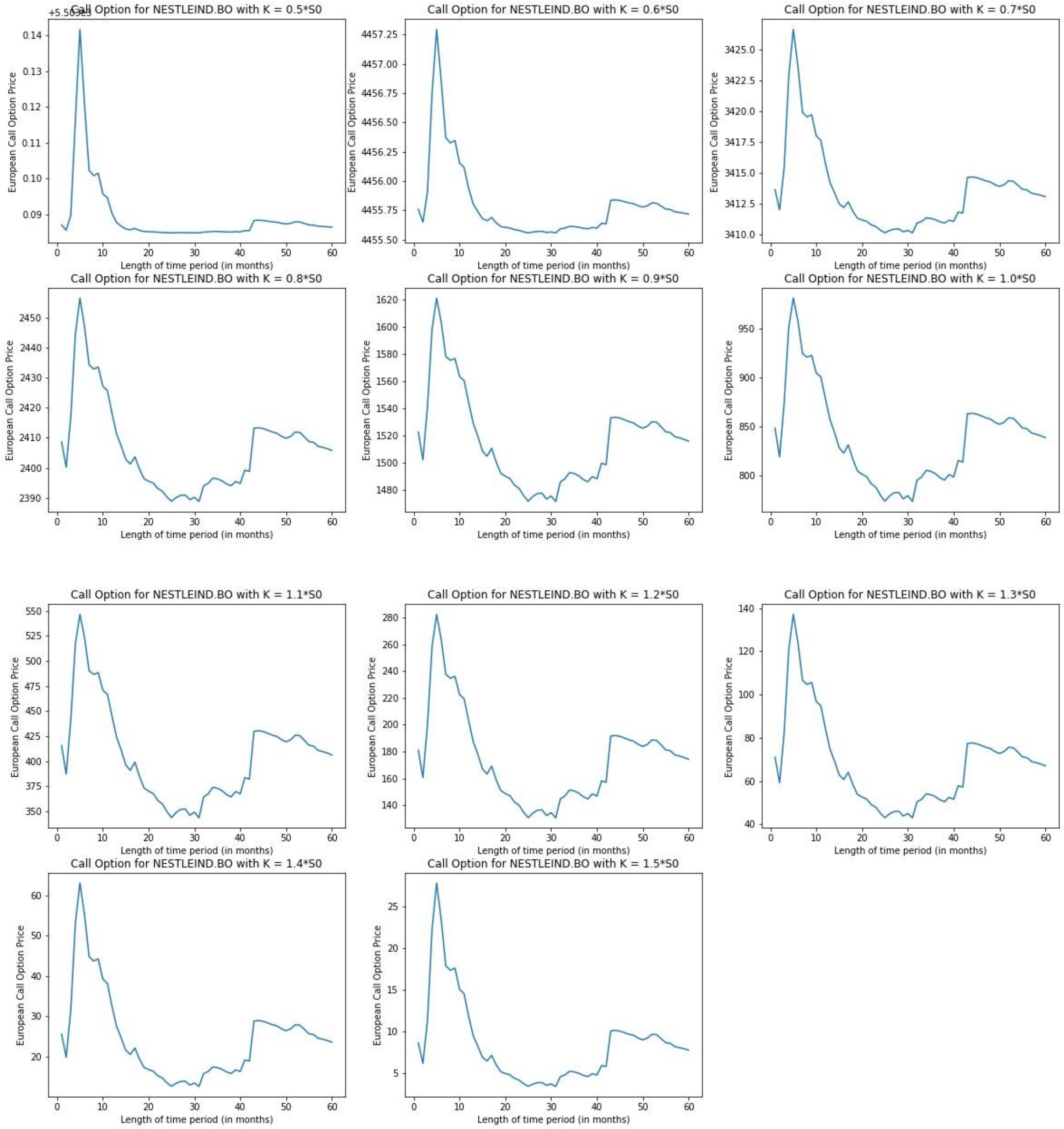


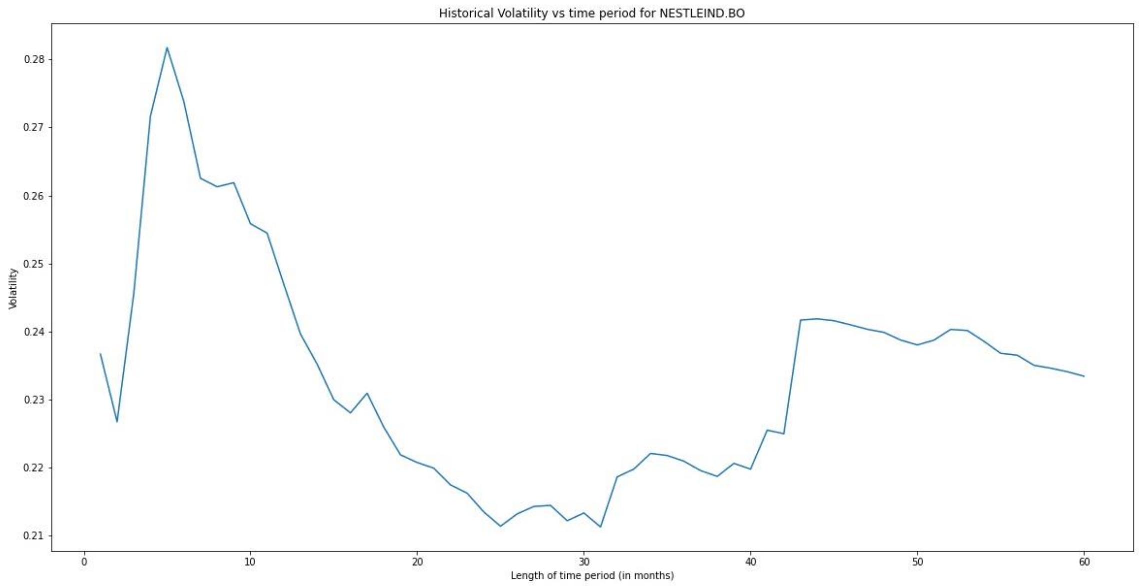
Call Option for MARUTI.BO with K = 0.5*S0
Call Option for MARUTI.BO with K = 0.6*S0
Call Option for MARUTI.BO with K = 0.7*S0
Call Option for MARUTI.BO with K = 0.8*S0
Call Option for MARUTI.BO with K = 0.9*S0
Call Option for MARUTI.BO with K = 1.0*S0
Call Option for MARUTI.BO with K = 1.1*S0
Call Option for MARUTI.BO with K = 1.2*S0
Call Option for MARUTI.BO with K = 1.3*S0
Call Option for MARUTI.BO with K = 1.4*S0
Call Option for MARUTI.BO with K = 1.5*S0
European Call Option Price
Length of time period (in months)



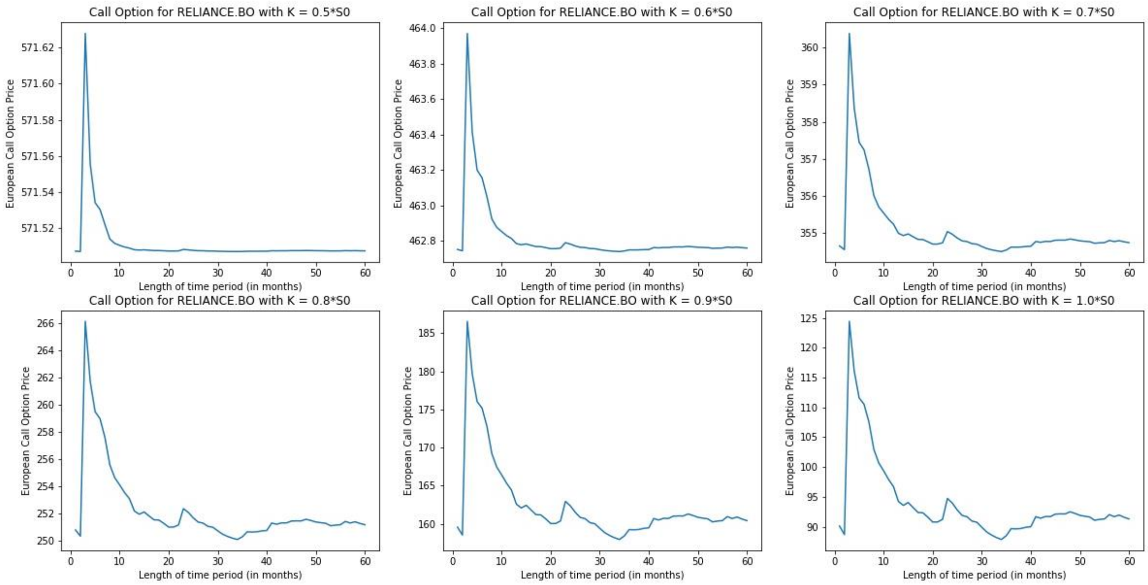
Historical Volatility vs time period for MARUTI.BO
Volatility
Length of time period (in months)

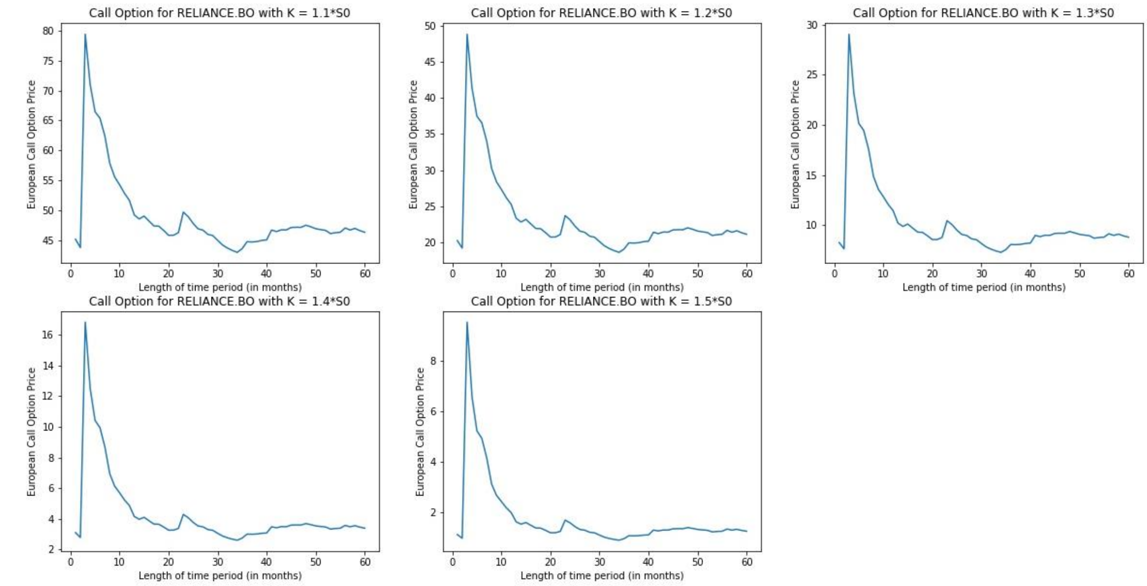
vi) NESTLEIND.BO

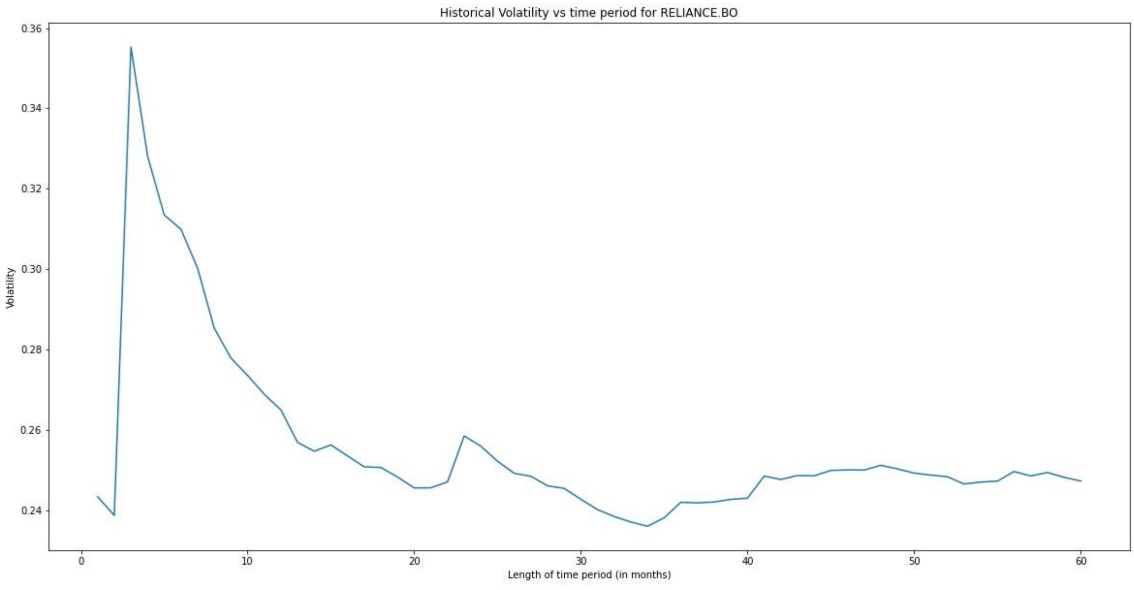




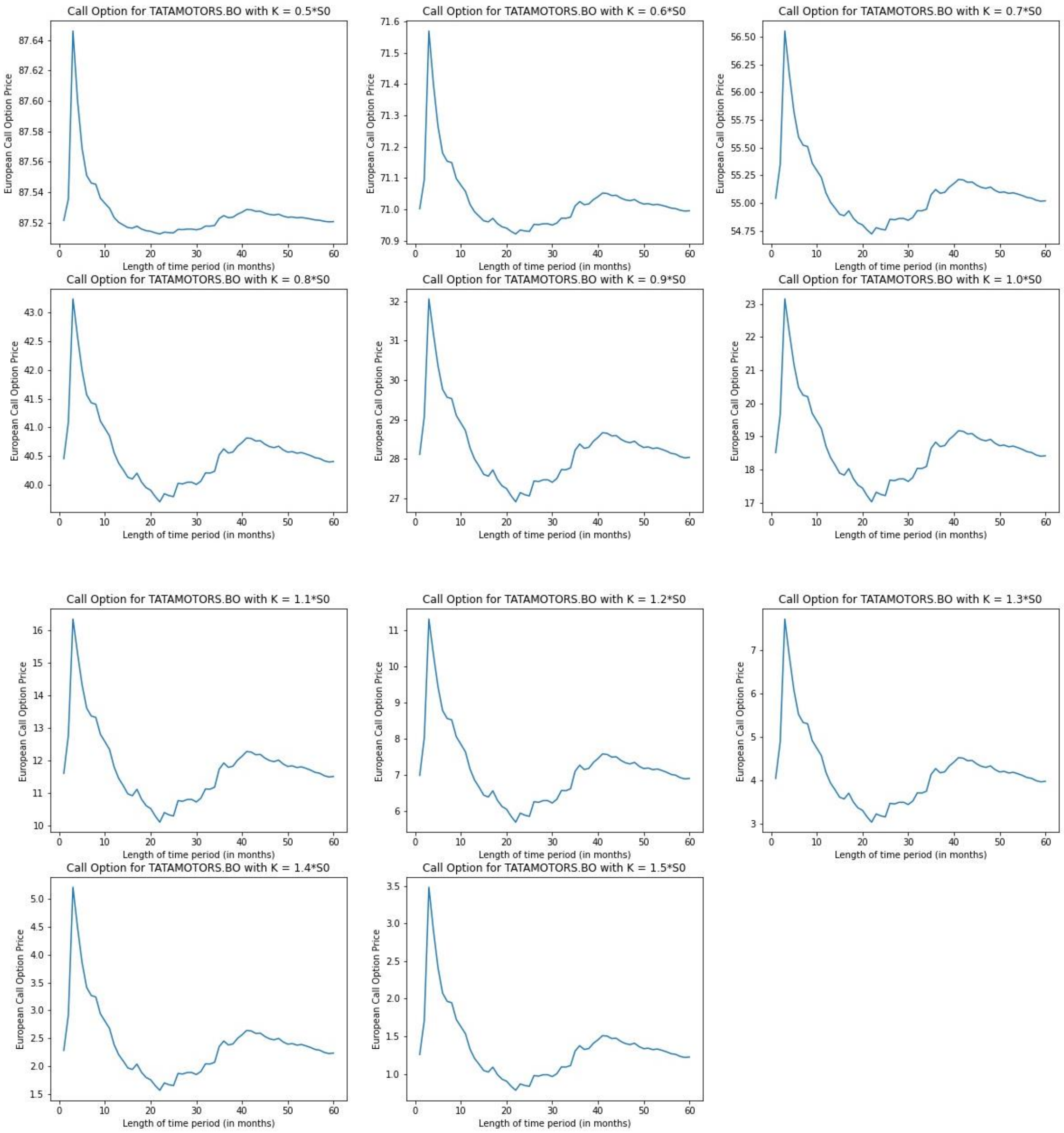
vii) RELIANCE.BO

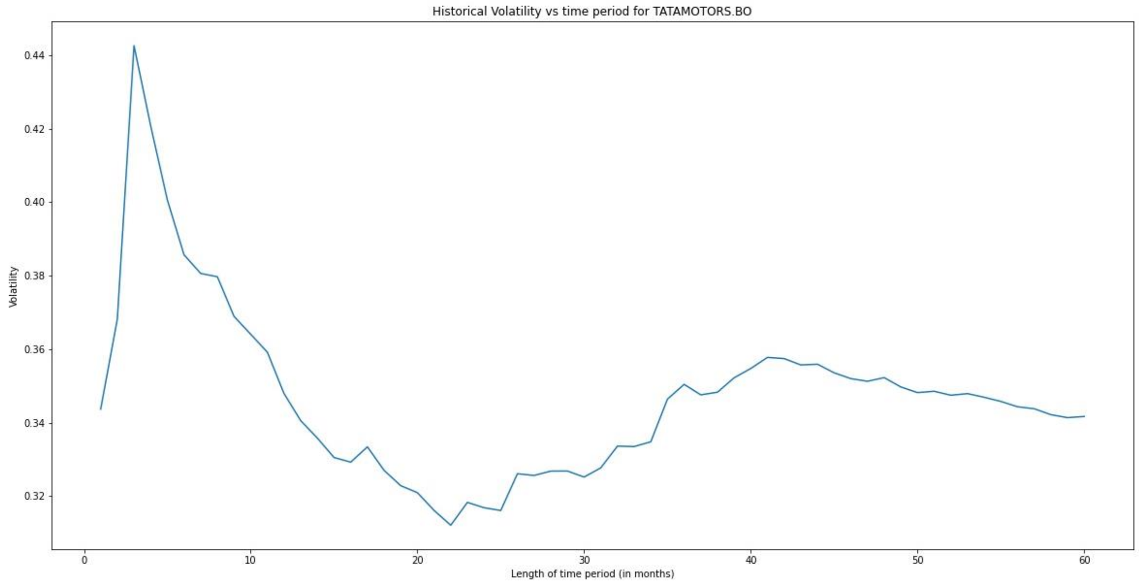




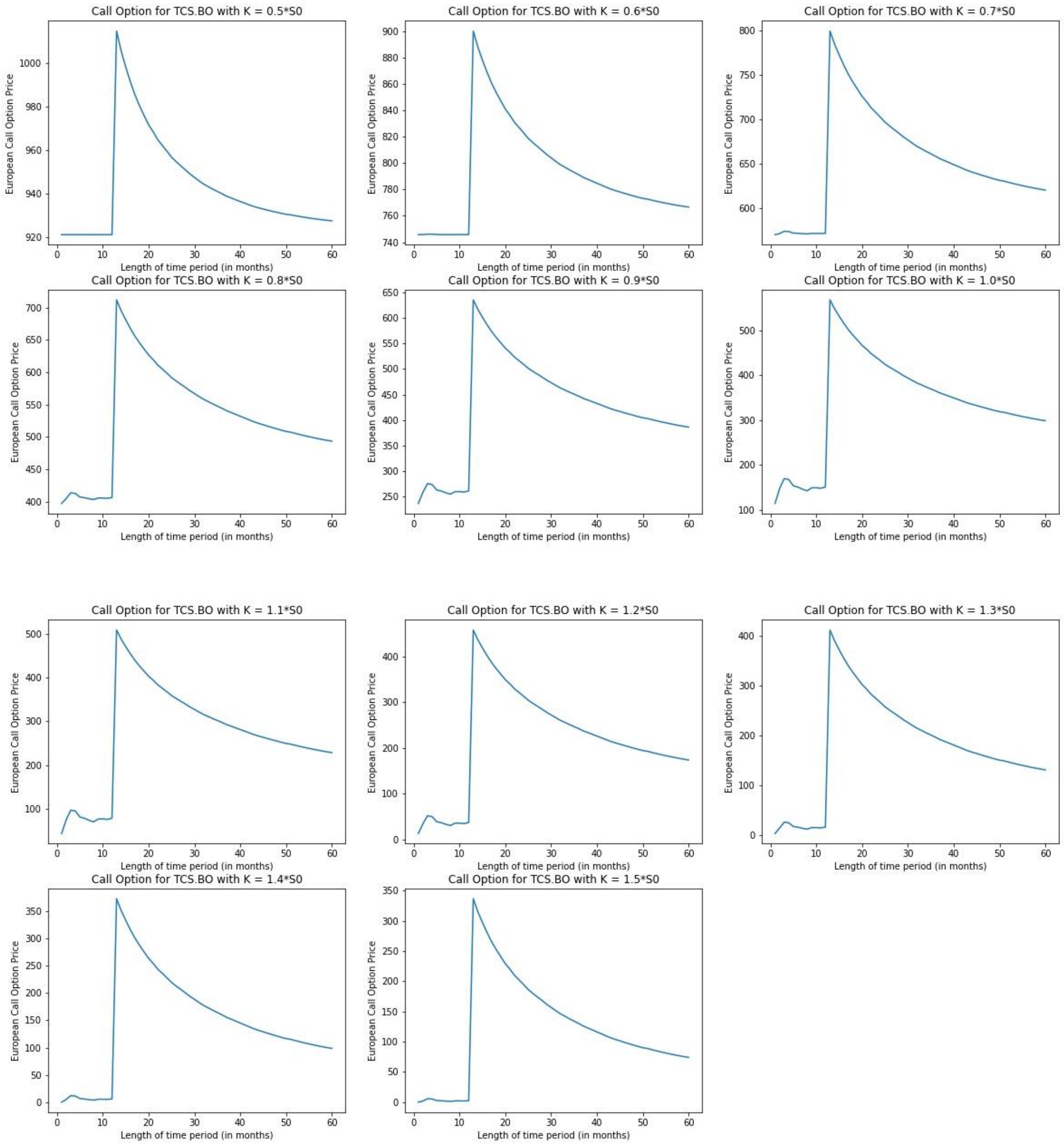


viii) TATAMOTORS.BO

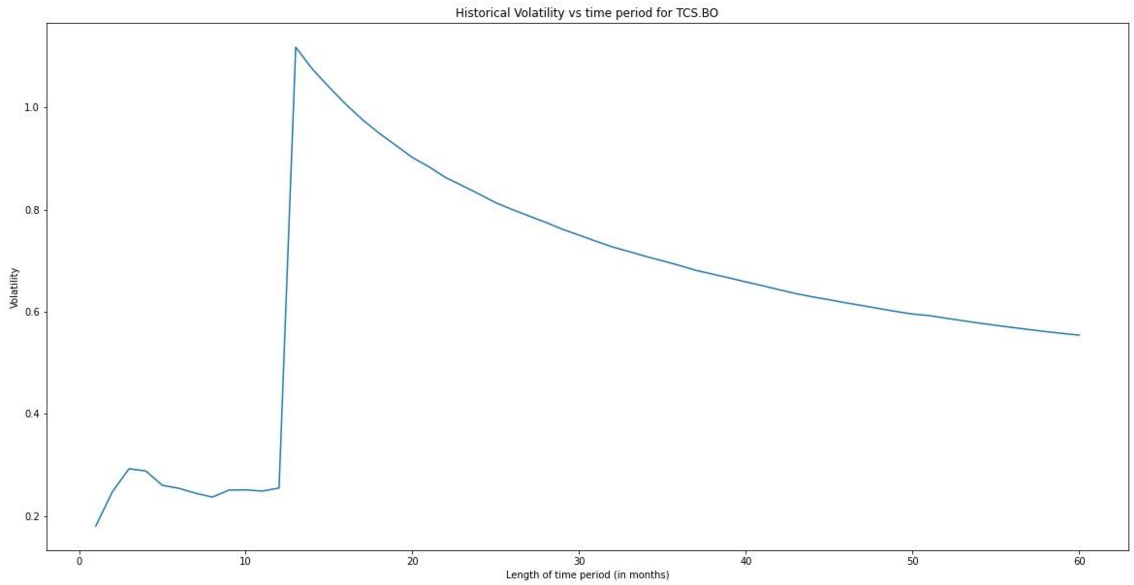




ix) TCS.BO

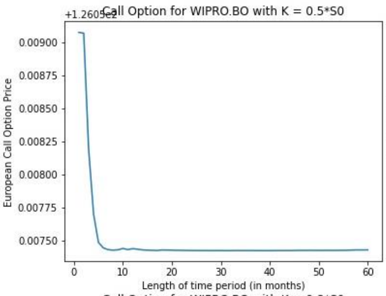


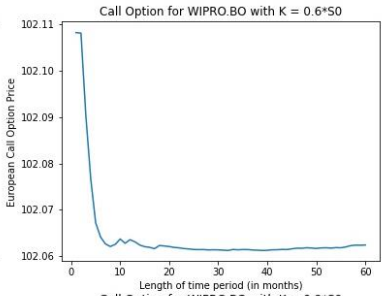
Call Option for TCS.BO with K = 0.5*S0
Call Option for TCS.BO with K = 0.6*S0
Call Option for TCS.BO with K = 0.7*S0
Call Option for TCS.BO with K = 0.8*S0
Call Option for TCS.BO with K = 0.9*S0
Call Option for TCS.BO with K = 1.0*S0
Call Option for TCS.BO with K = 1.1*S0
Call Option for TCS.BO with K = 1.2*S0
Call Option for TCS.BO with K = 1.3*S0
Call Option for TCS.BO with K = 1.4*S0
Call Option for TCS.BO with K = 1.5*S0
European Call Option Price
Length of time period (in months)

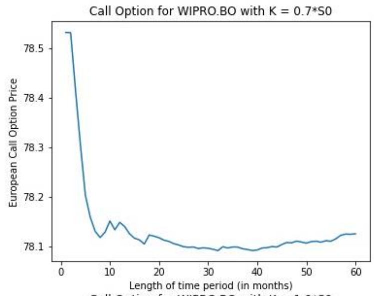


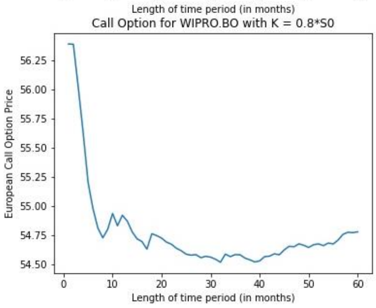
Historical Volatility vs time period for TCS.BO
Volatility
Length of time period (in months)

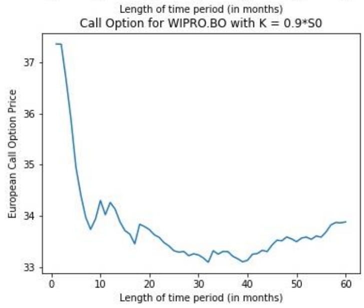
x) WIPRO.BO

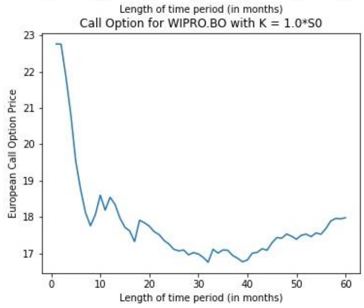

Call Option for WIPRO.BO with K = 0.5*S0
+1.2605e2
European Call Option Price
Length of time period (in months)

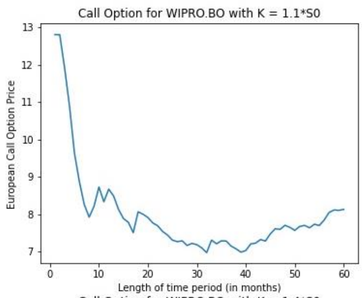

Call Option for WIPRO.BO with K = 0.6*S0
European Call Option Price
Length of time period (in months)

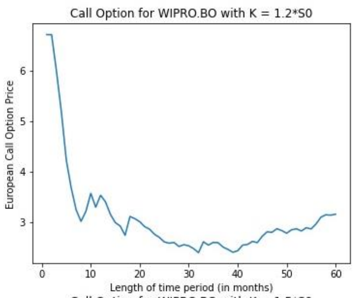

Call Option for WIPRO.BO with K = 0.7*S0
European Call Option Price
Length of time period (in months)

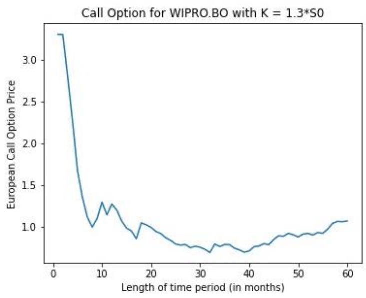

Call Option for WIPRO.BO with K = 0.8*S0
European Call Option Price
Length of time period (in months)

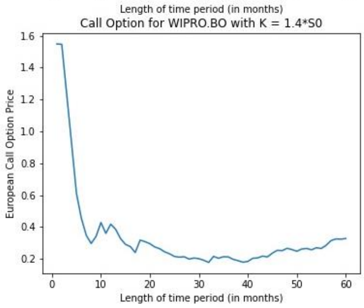

Call Option for WIPRO.BO with K = 0.9*S0
European Call Option Price
Length of time period (in months)

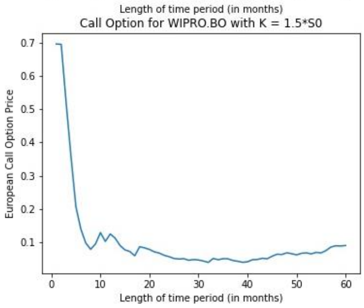

Call Option for WIPRO.BO with K = 1.0*S0
European Call Option Price
Length of time period (in months)

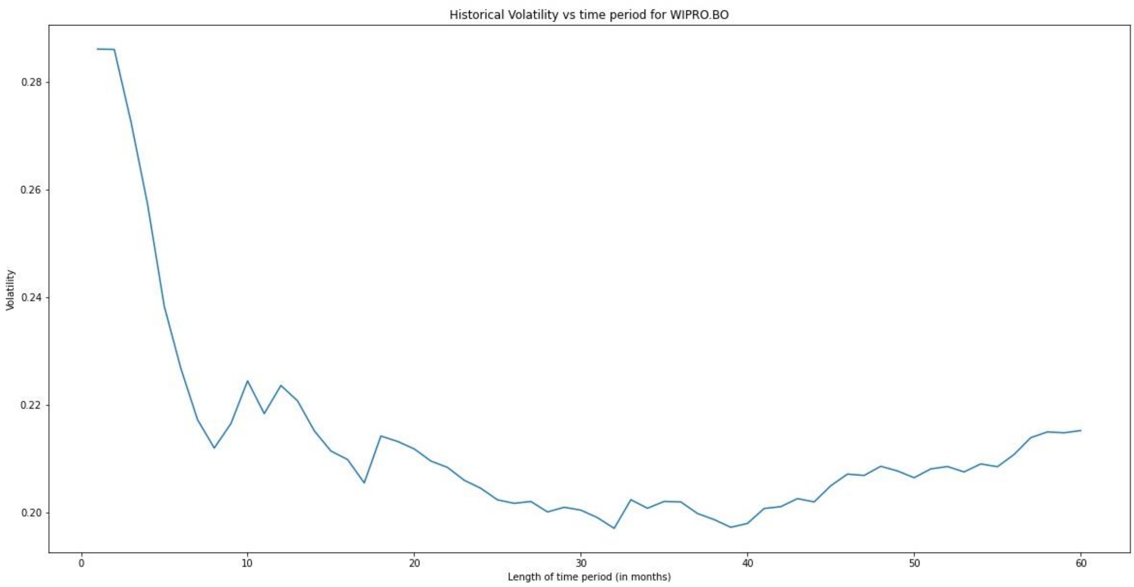

Call Option for WIPRO.BO with K = 1.1*S0
European Call Option Price
Length of time period (in months)


Call Option for WIPRO.BO with K = 1.2*S0
European Call Option Price
Length of time period (in months)

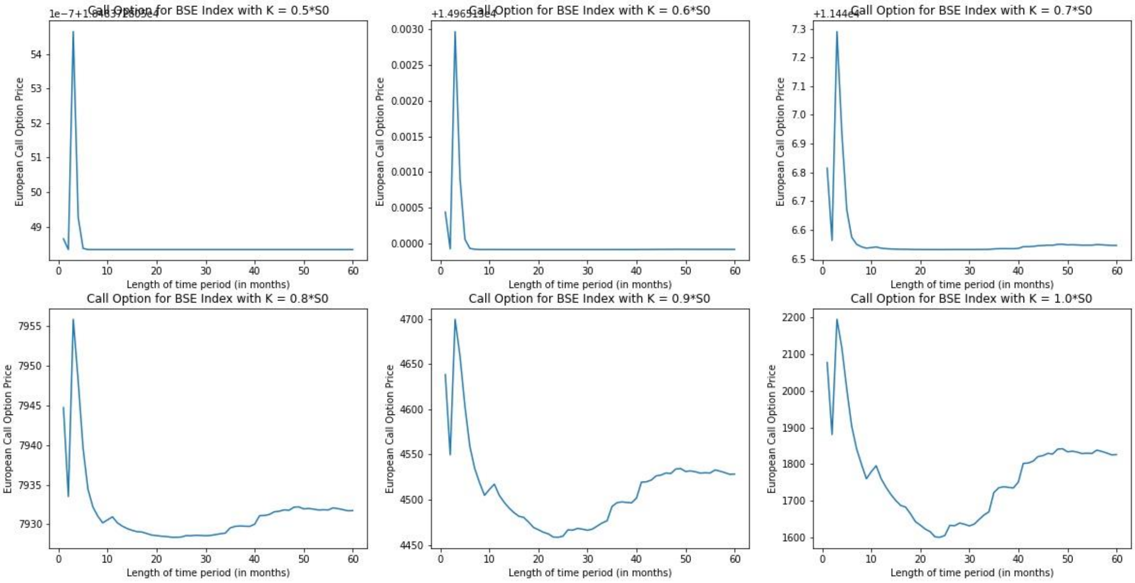

Call Option for WIPRO.BO with K = 1.3*S0
European Call Option Price
Length of time period (in months)


Call Option for WIPRO.BO with K = 1.4*S0
European Call Option Price
Length of time period (in months)

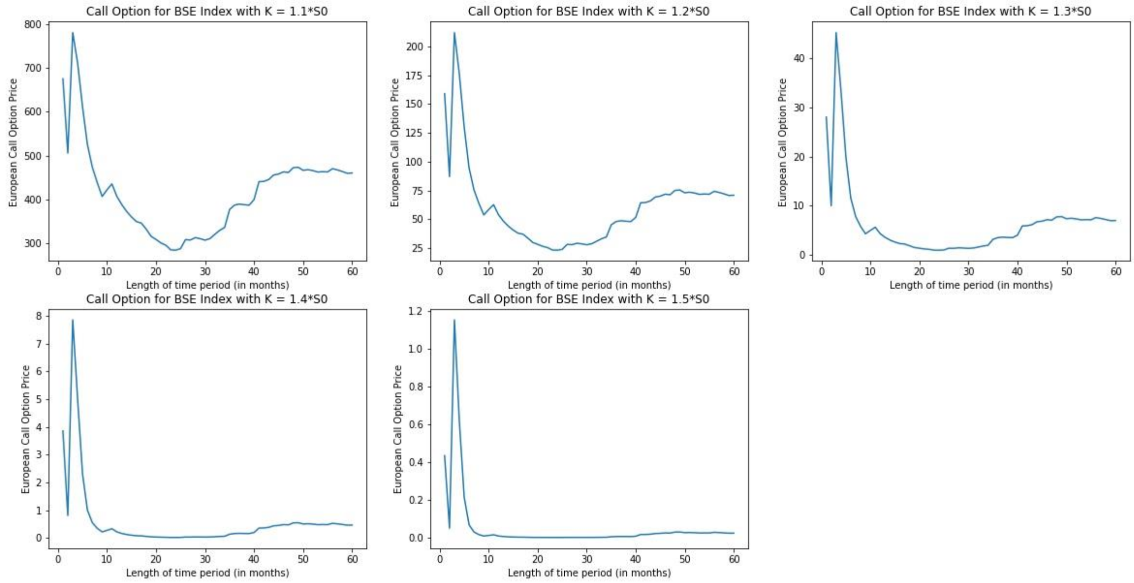

Call Option for WIPRO.BO with K = 1.5*S0
European Call Option Price
Length of time period (in months)


Historical Volatility vs time period for WIPRO.BO
Volatility
Length of time period (in months)

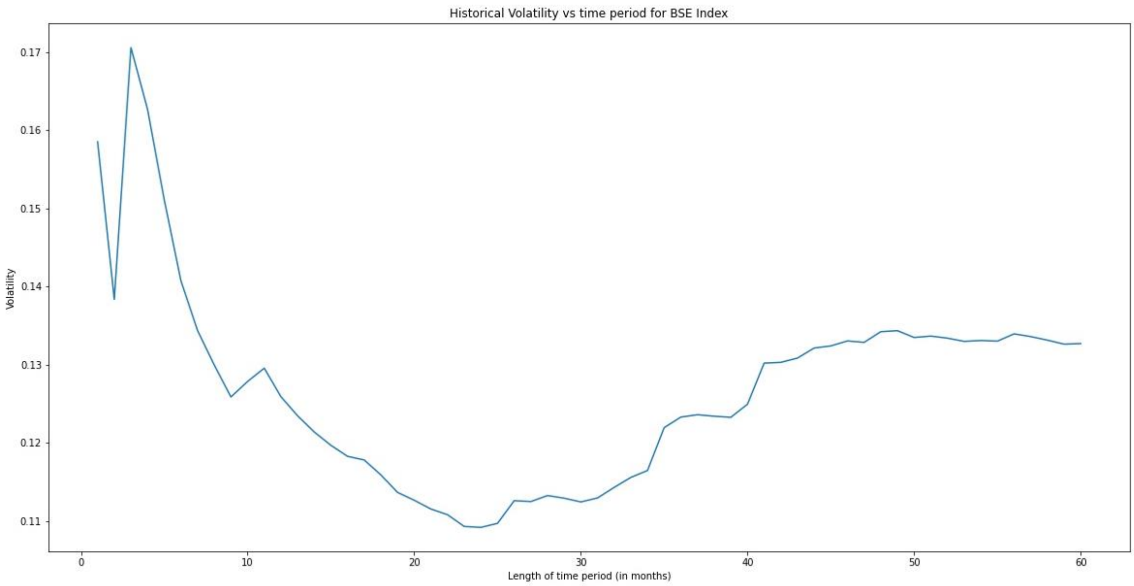
xi) BSE Index



Call Option for BSE Index with K = 0.5*S0
Call Option for BSE Index with K = 0.6*S0
Call Option for BSE Index with K = 0.7*S0
Call Option for BSE Index with K = 0.8*S0
Call Option for BSE Index with K = 0.9*S0
Call Option for BSE Index with K = 1.0*S0
European Call Option Price
Length of time period (in months)



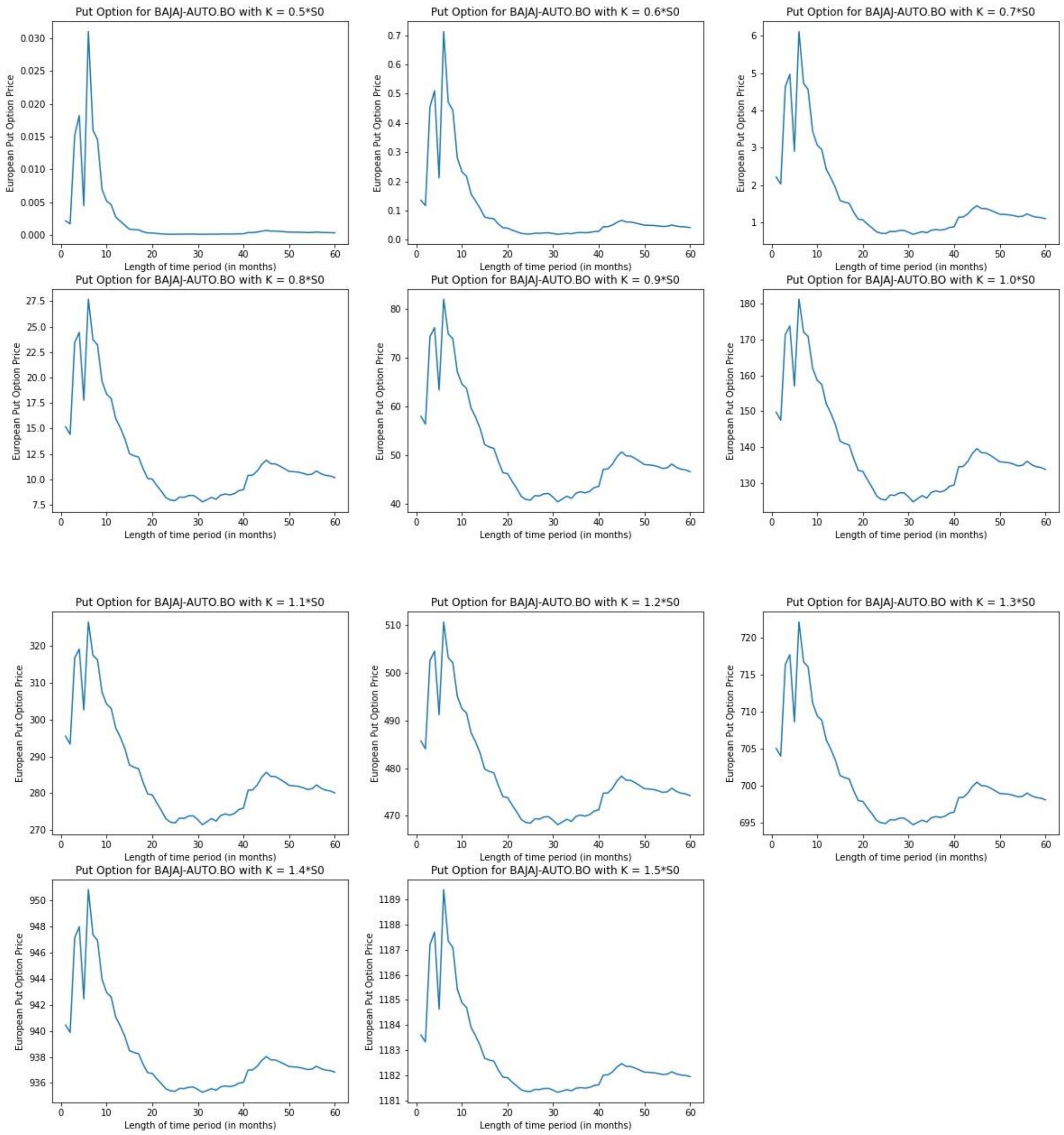
Call Option for BSE Index with K = 1.1*S0
Call Option for BSE Index with K = 1.2*S0
Call Option for BSE Index with K = 1.3*S0
Call Option for BSE Index with K = 1.4*S0
Call Option for BSE Index with K = 1.5*S0
European Call Option Price
Length of time period (in months)



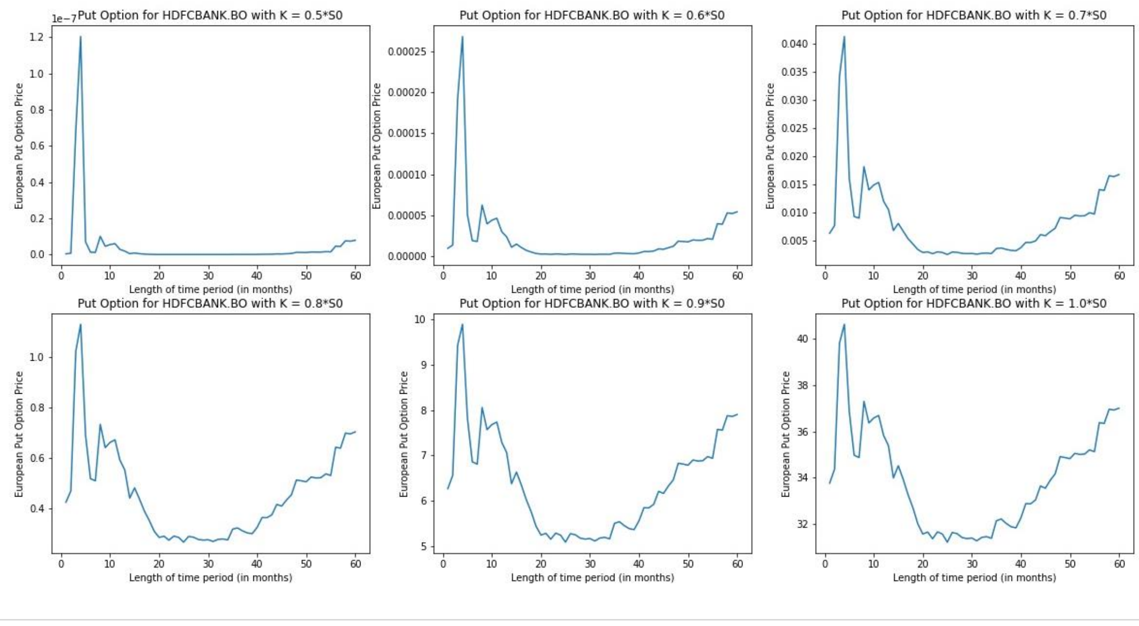
Historical Volatility vs time period for BSE Index
Volatility
Length of time period (in months)

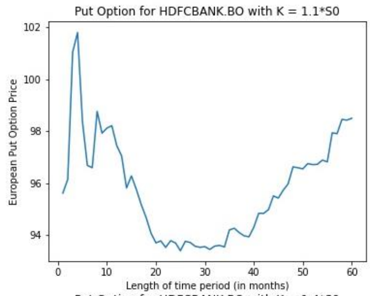
ii. Plots for Put Option - stocks in nsedata1:

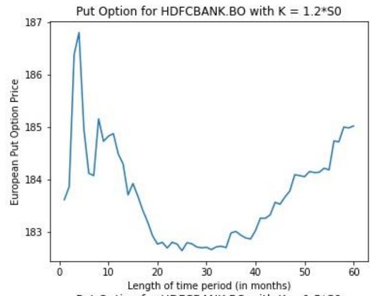
i) BAJA-AUTO.BO

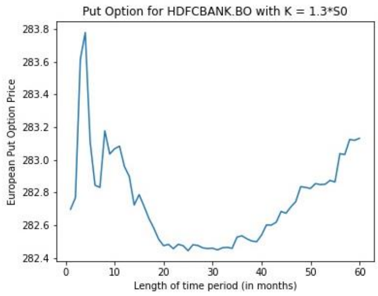


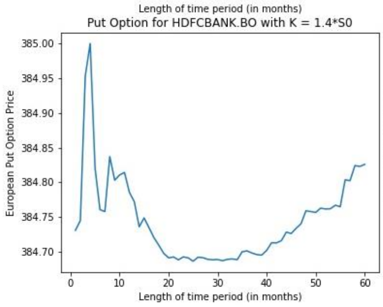
ii) HDFCBANK.BO

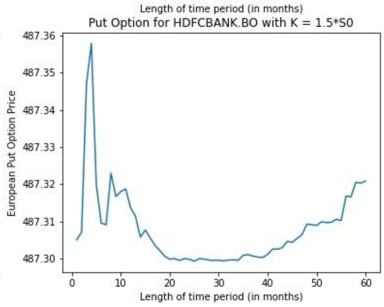




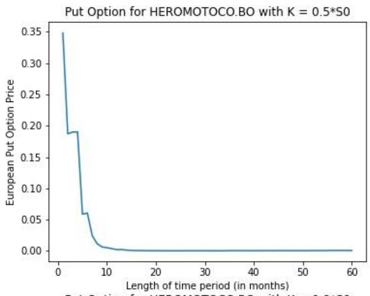


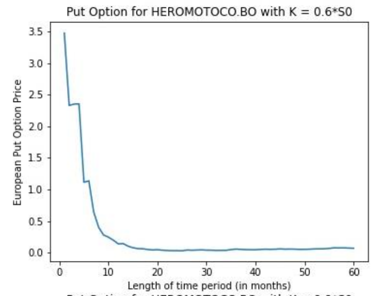


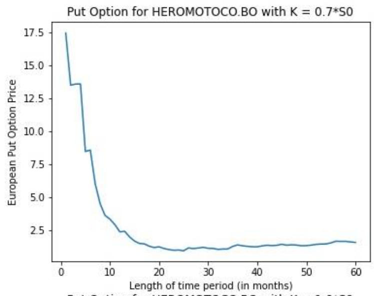


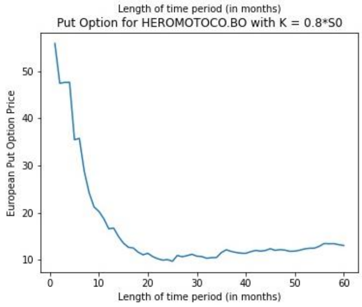


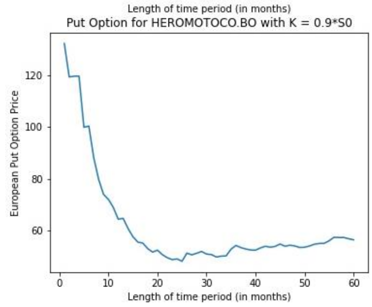
iii) HEROMOTOCO.BO

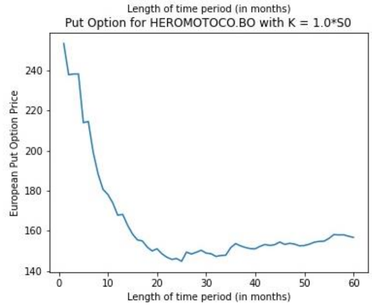


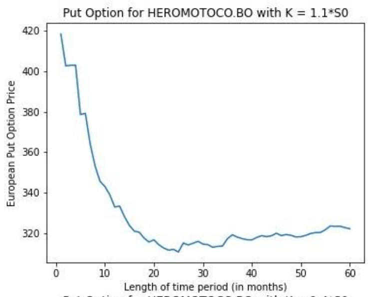


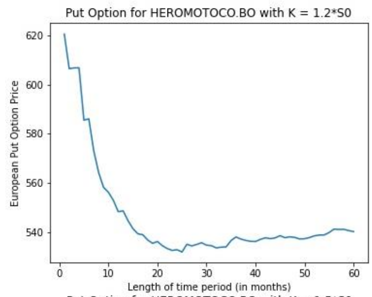


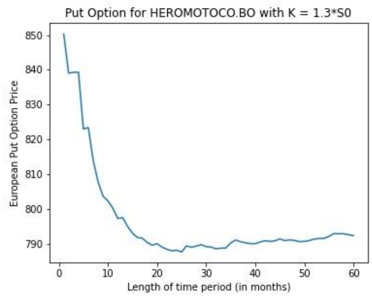


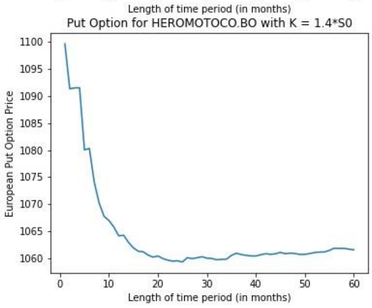


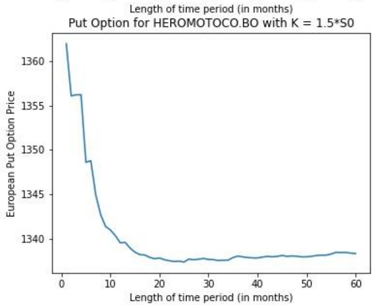




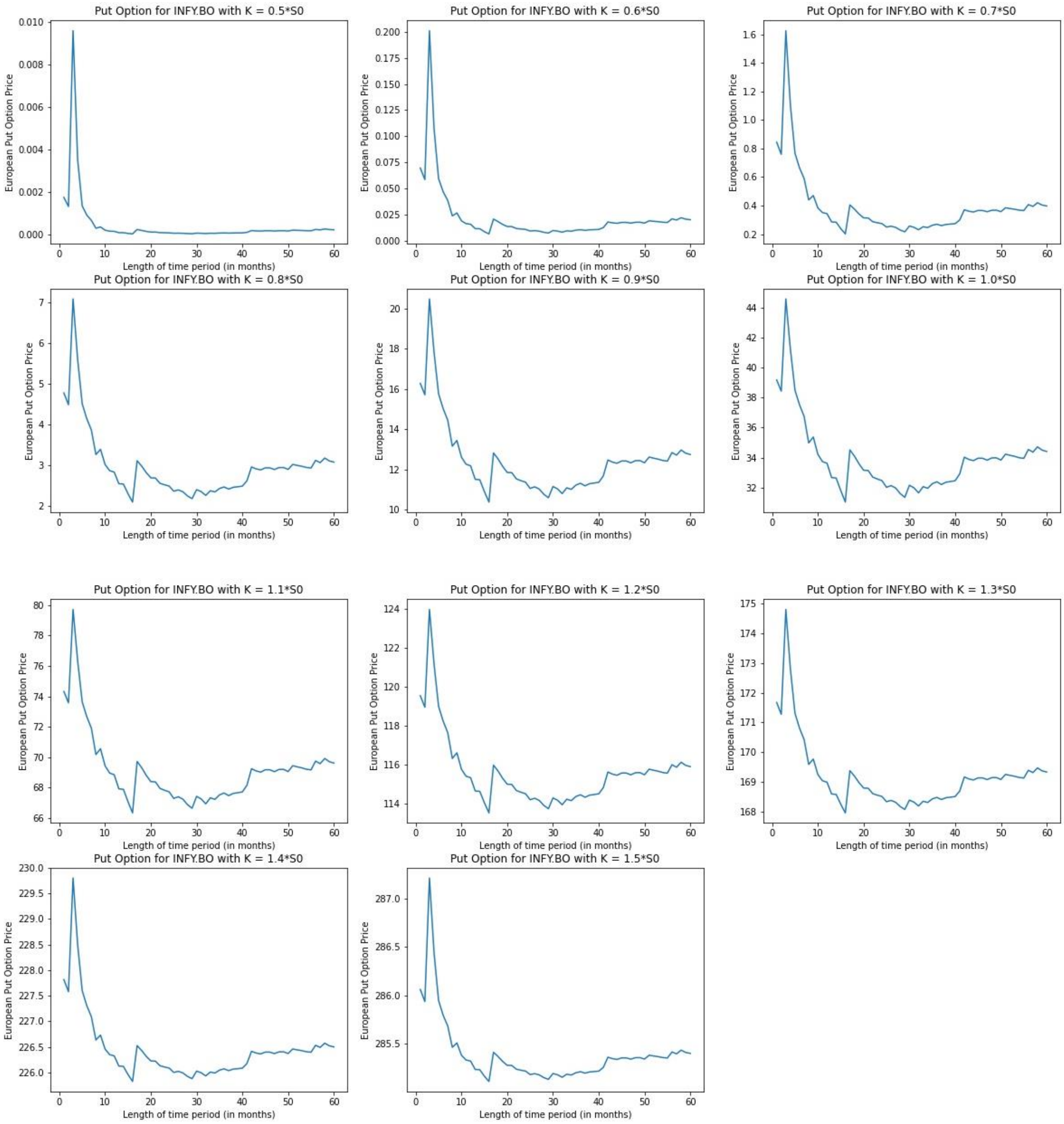




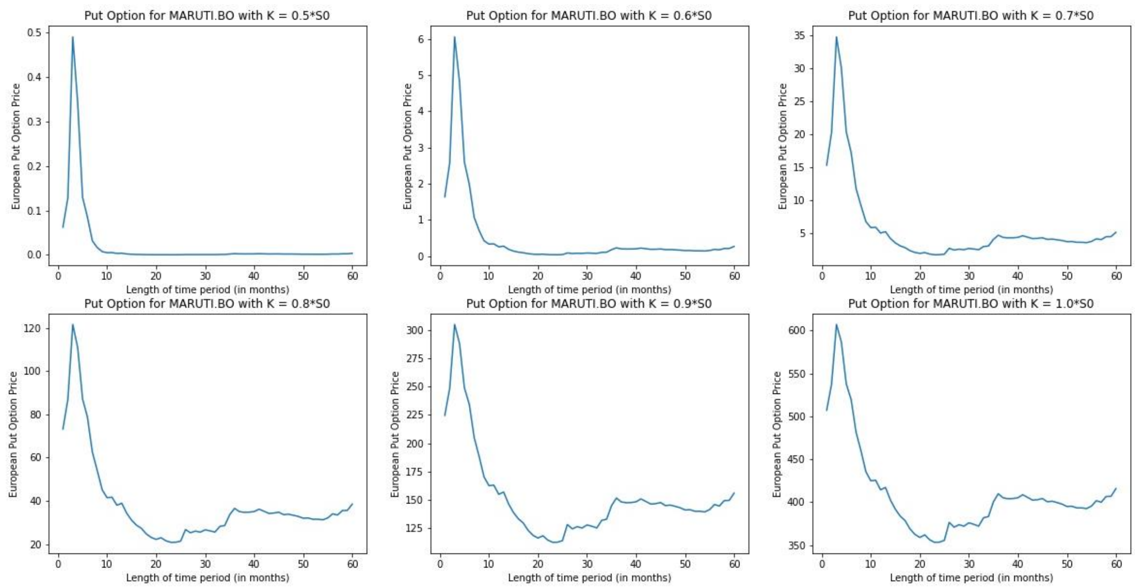


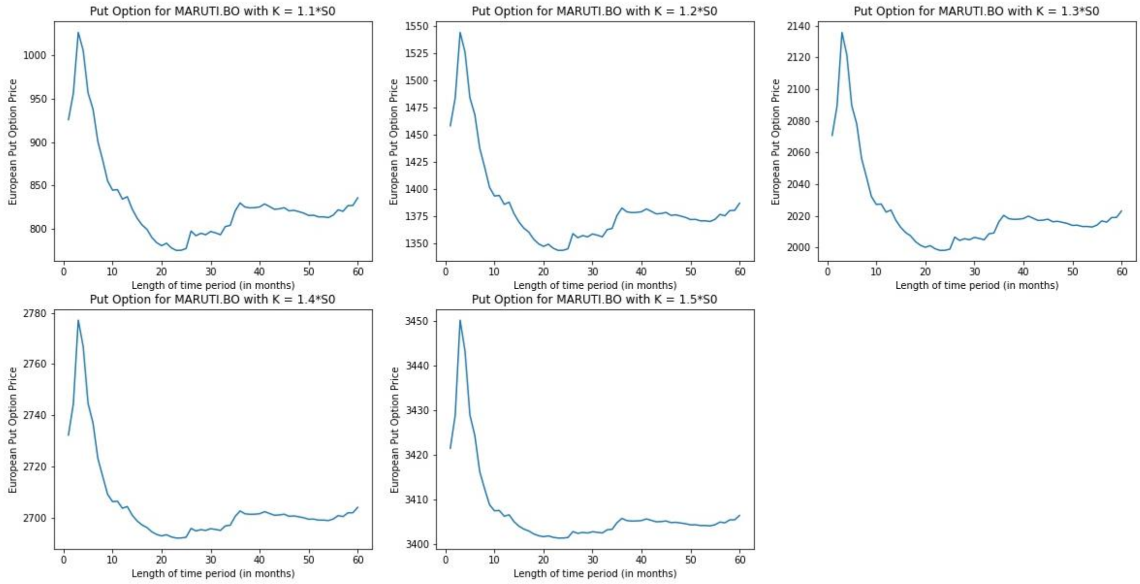


iv) INFY.BO

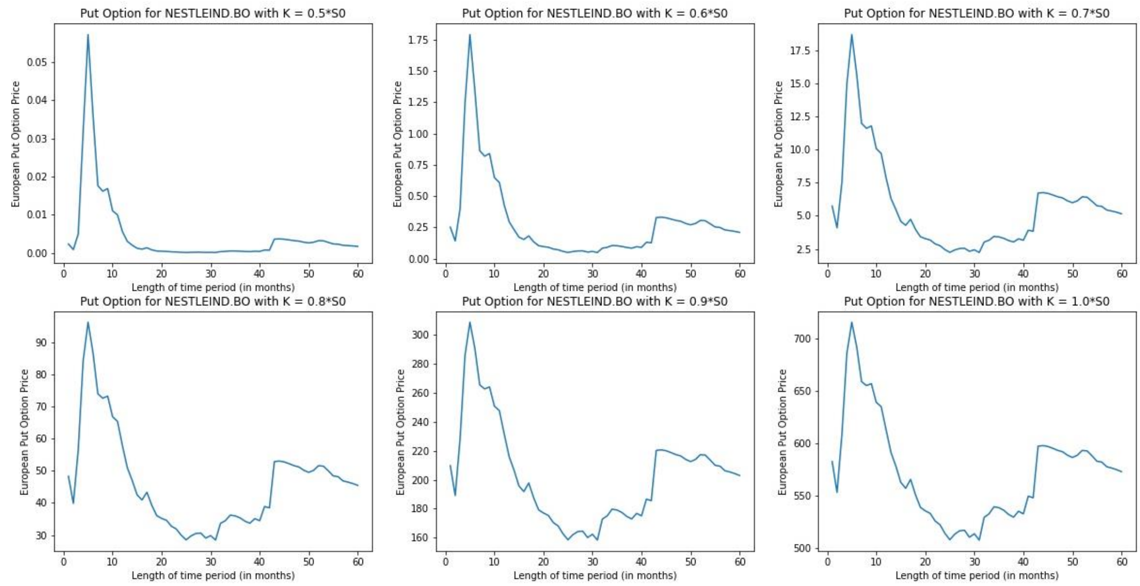


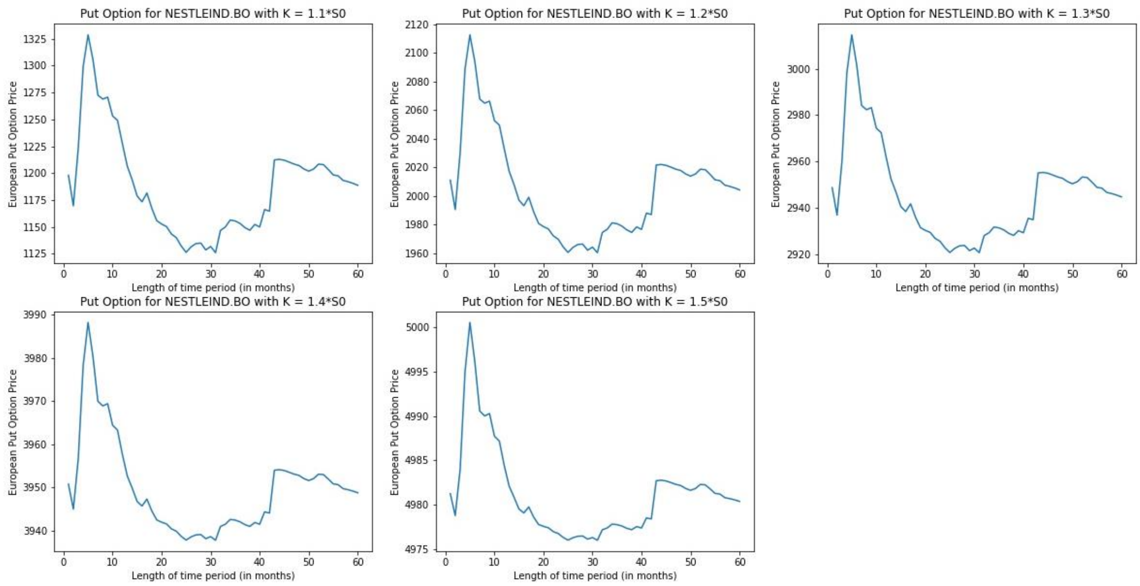
v) MARUTI.BO



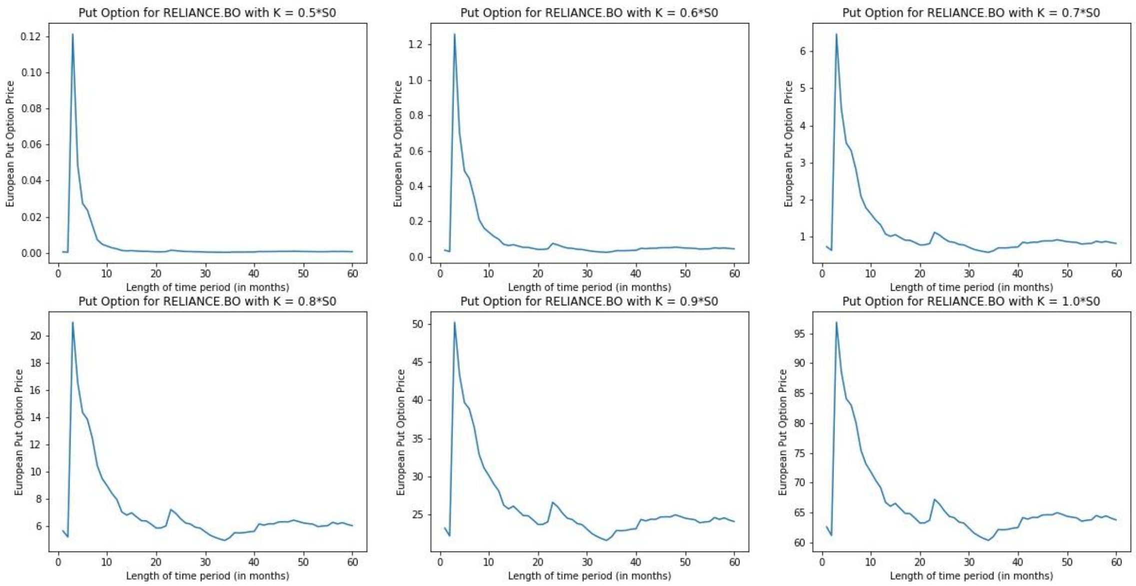


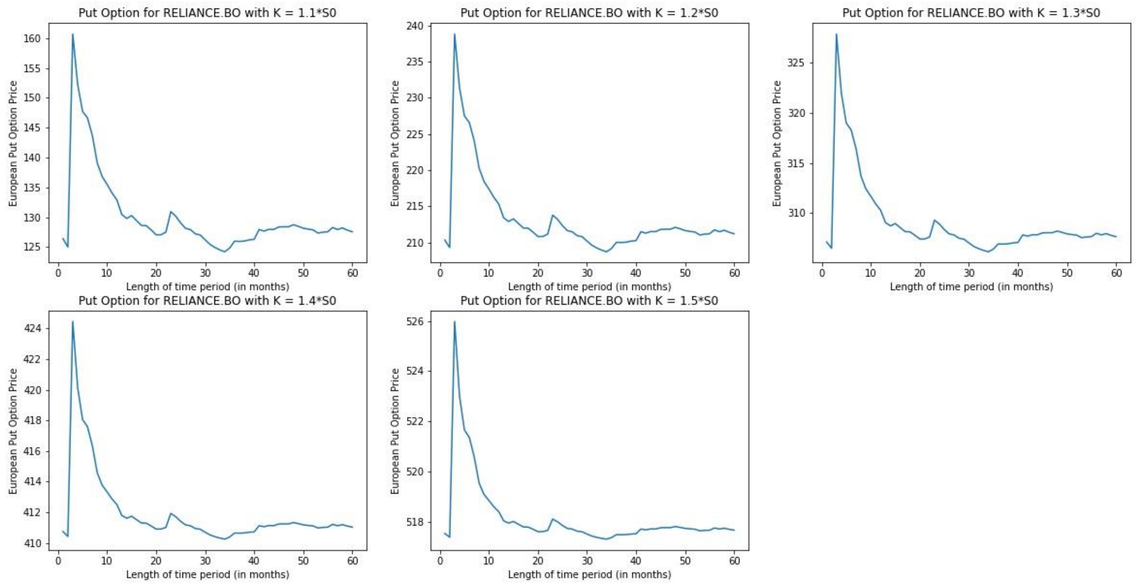
vi) NESTLEIND.BO



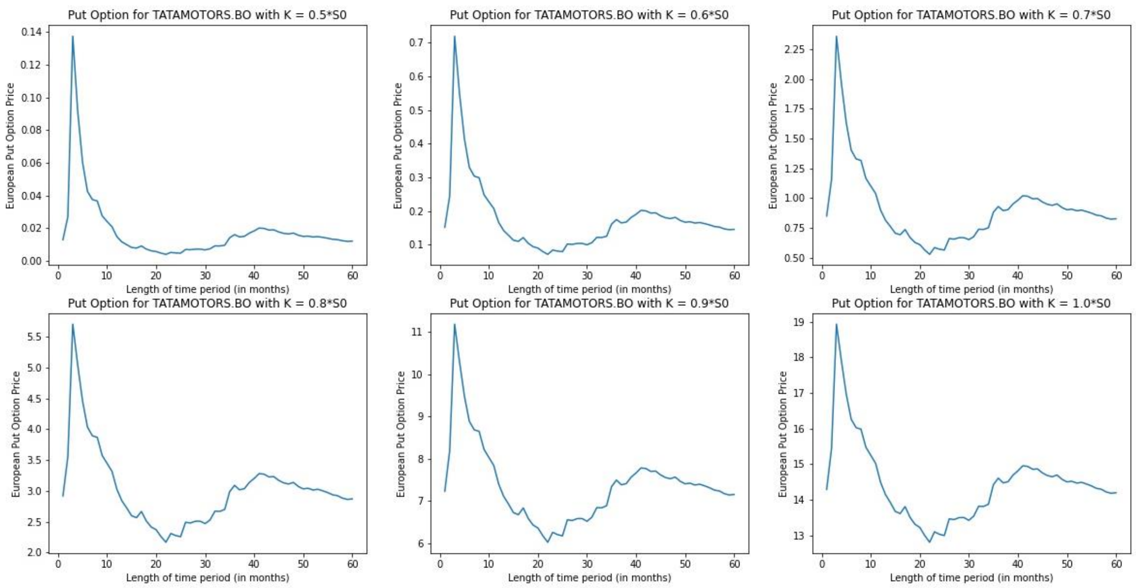


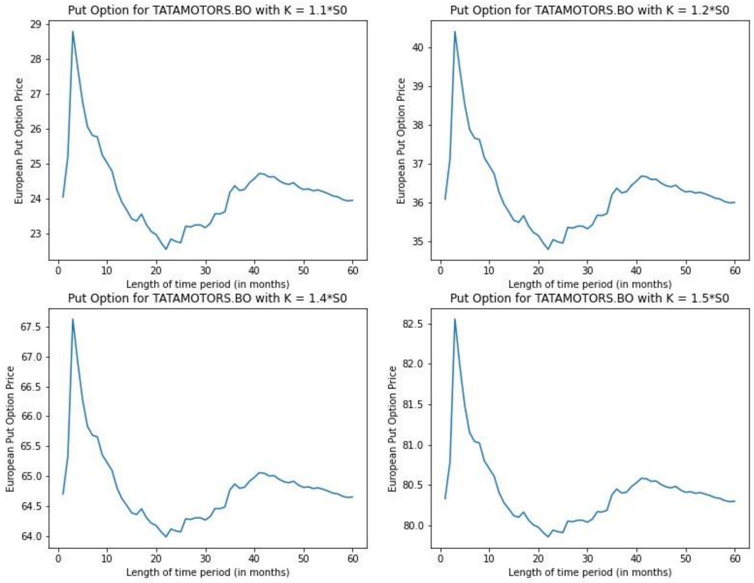
vii) RELIANCE.BO



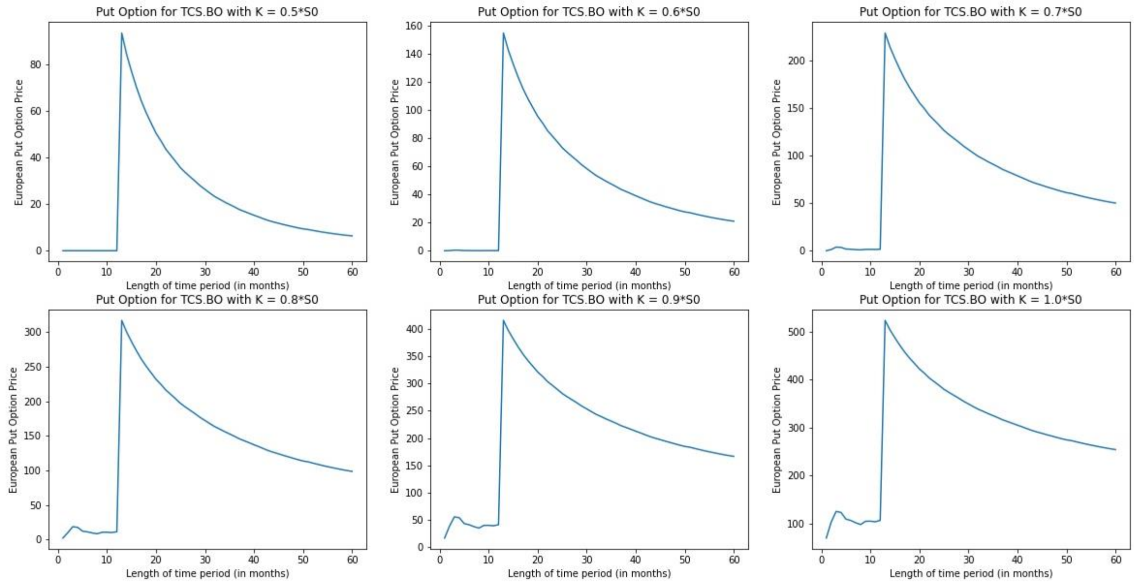


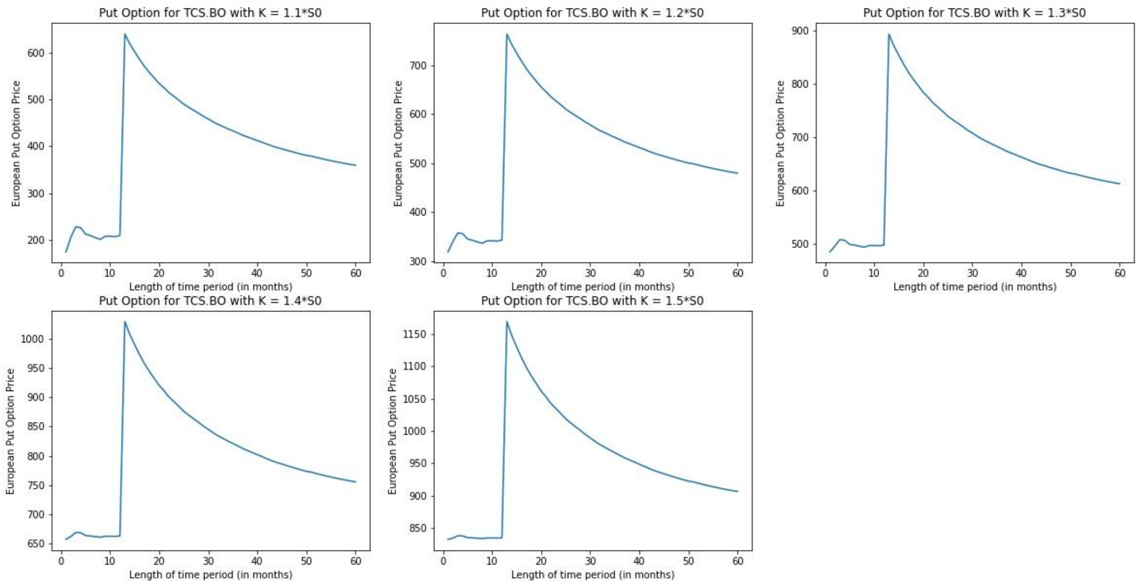
viii) TATAMOTORS.BO



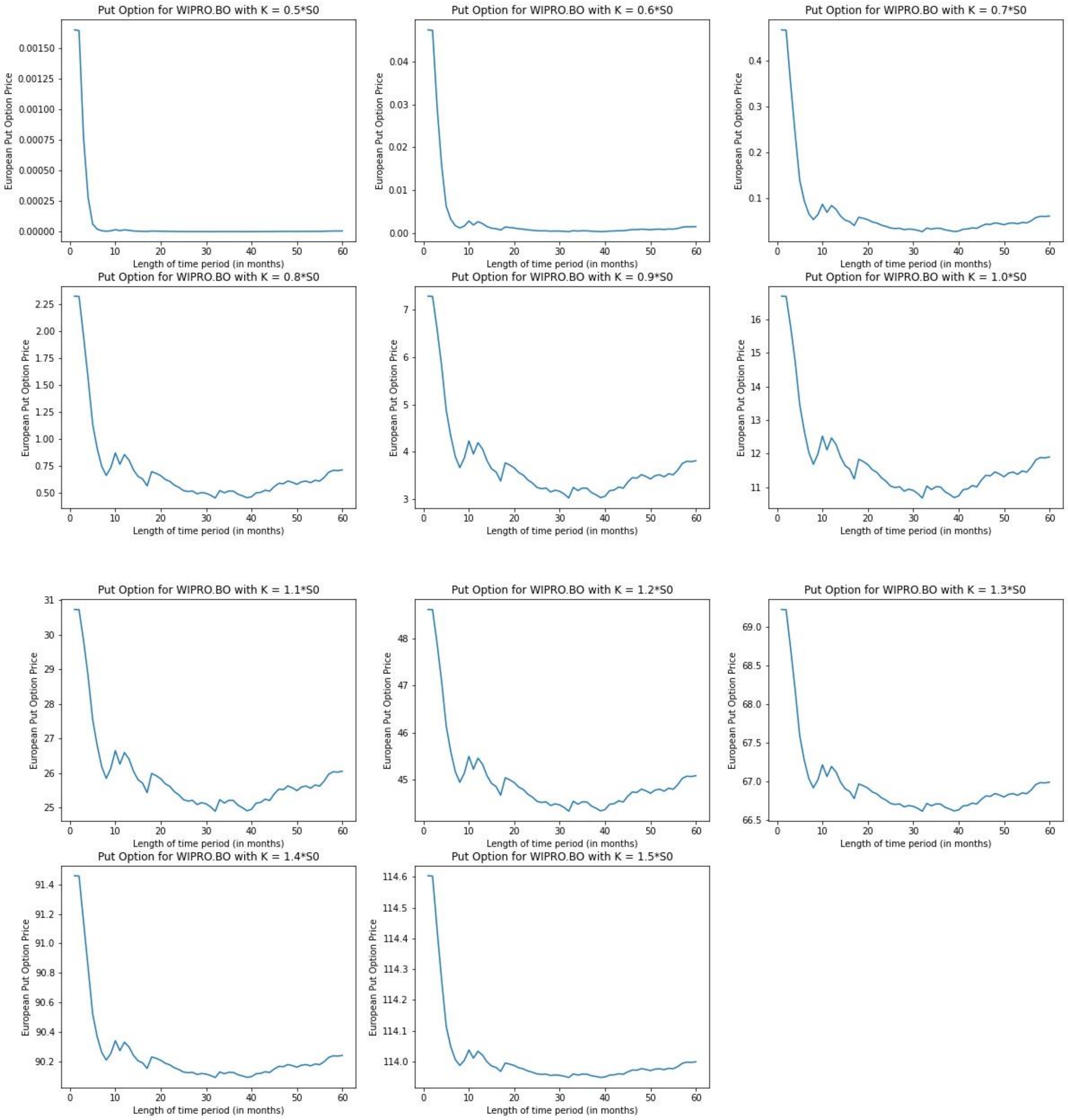

Put Option for TATAMOTORS.BO with K = 1.1*S0
Put Option for TATAMOTORS.BO with K = 1.2*S0
Put Option for TATAMOTORS.BO with K = 1.3*S0
Put Option for TATAMOTORS.BO with K = 1.4*S0
Put Option for TATAMOTORS.BO with K = 1.5*S0
European Put Option Price
Length of time period (in months)

ix) <u>TCS.BO</u>

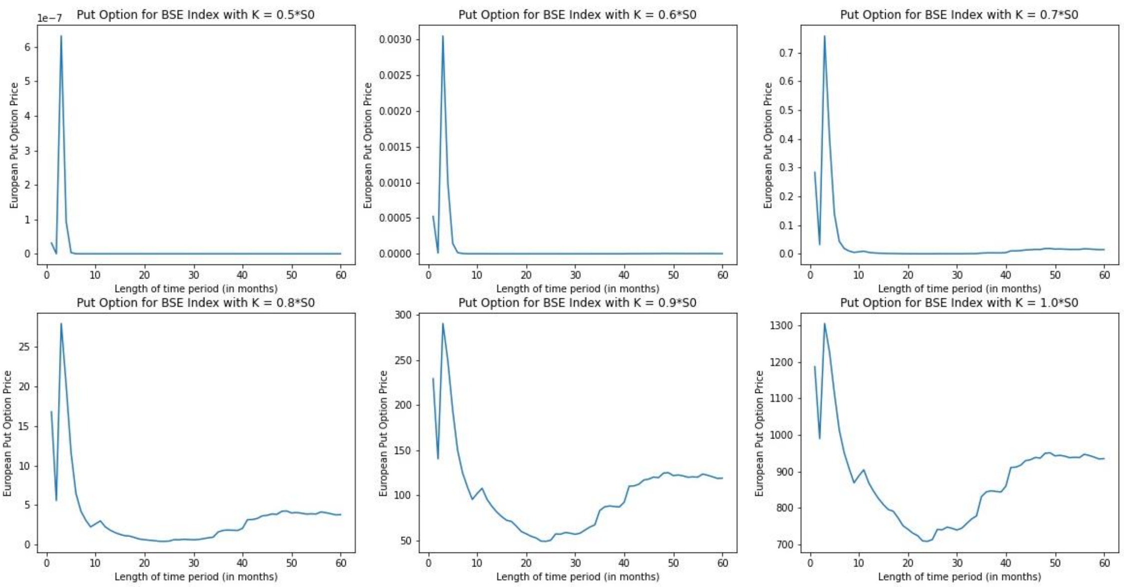

Put Option for TCS.BO with K = 0.5*S0
Put Option for TCS.BO with K = 0.6*S0
Put Option for TCS.BO with K = 0.7*S0
Put Option for TCS.BO with K = 0.8*S0
Put Option for TCS.BO with K = 0.9*S0
Put Option for TCS.BO with K = 1.0*S0
European Put Option Price
Length of time period (in months)

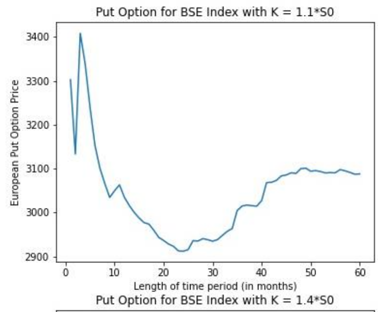

Put Option for TCS.BO with K = 1.1*S0
Put Option for TCS.BO with K = 1.2*S0
Put Option for TCS.BO with K = 1.3*S0
Put Option for TCS.BO with K = 1.4*S0
Put Option for TCS.BO with K = 1.5*S0
European Put Option Price
Length of time period (in months)

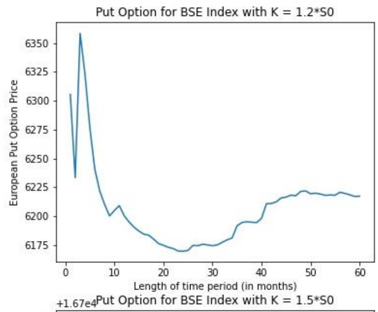
x) WIPRO.BO

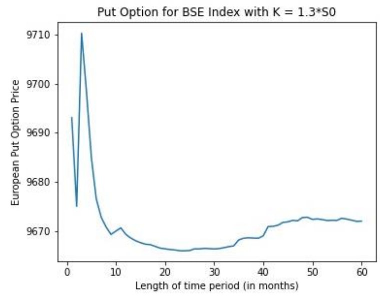


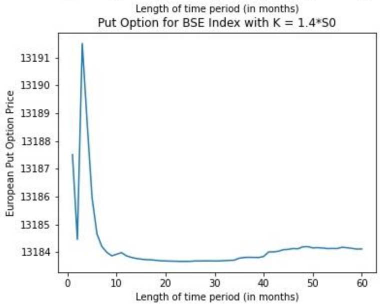
xi) BSE Index

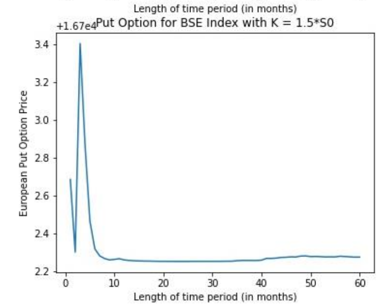



Put Option for BSE Index with K = 1.1*S0
European Put Option Price
Length of time period (in months)


Put Option for BSE Index with K = 1.2*S0
European Put Option Price
Length of time period (in months)

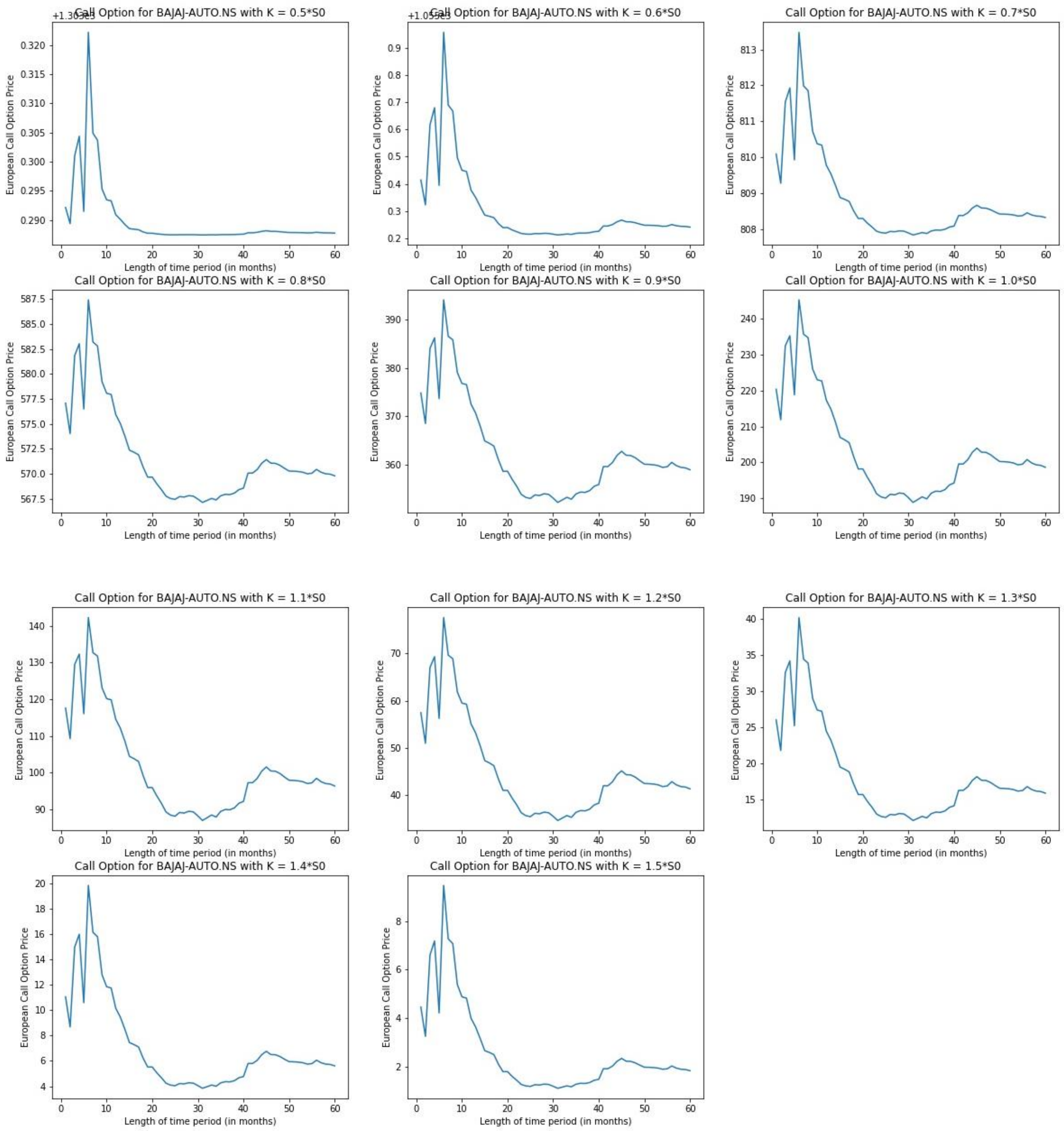

Put Option for BSE Index with K = 1.3*S0
European Put Option Price
Length of time period (in months)

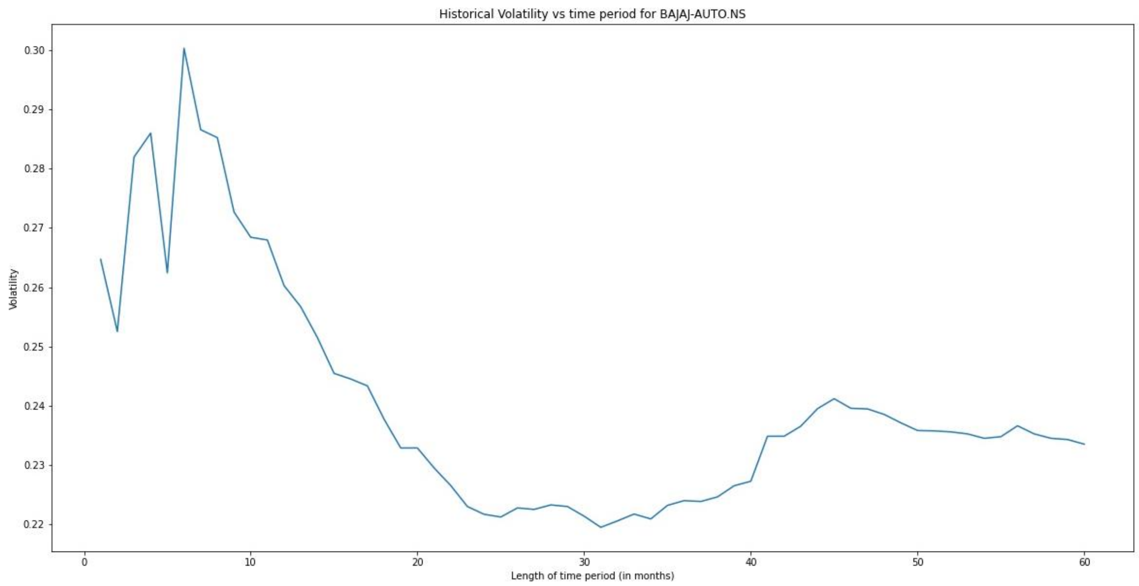

Put Option for BSE Index with K = 1.4*S0
European Put Option Price
Length of time period (in months)


+1.67e4
Put Option for BSE Index with K = 1.5*S0
European Put Option Price
Length of time period (in months)

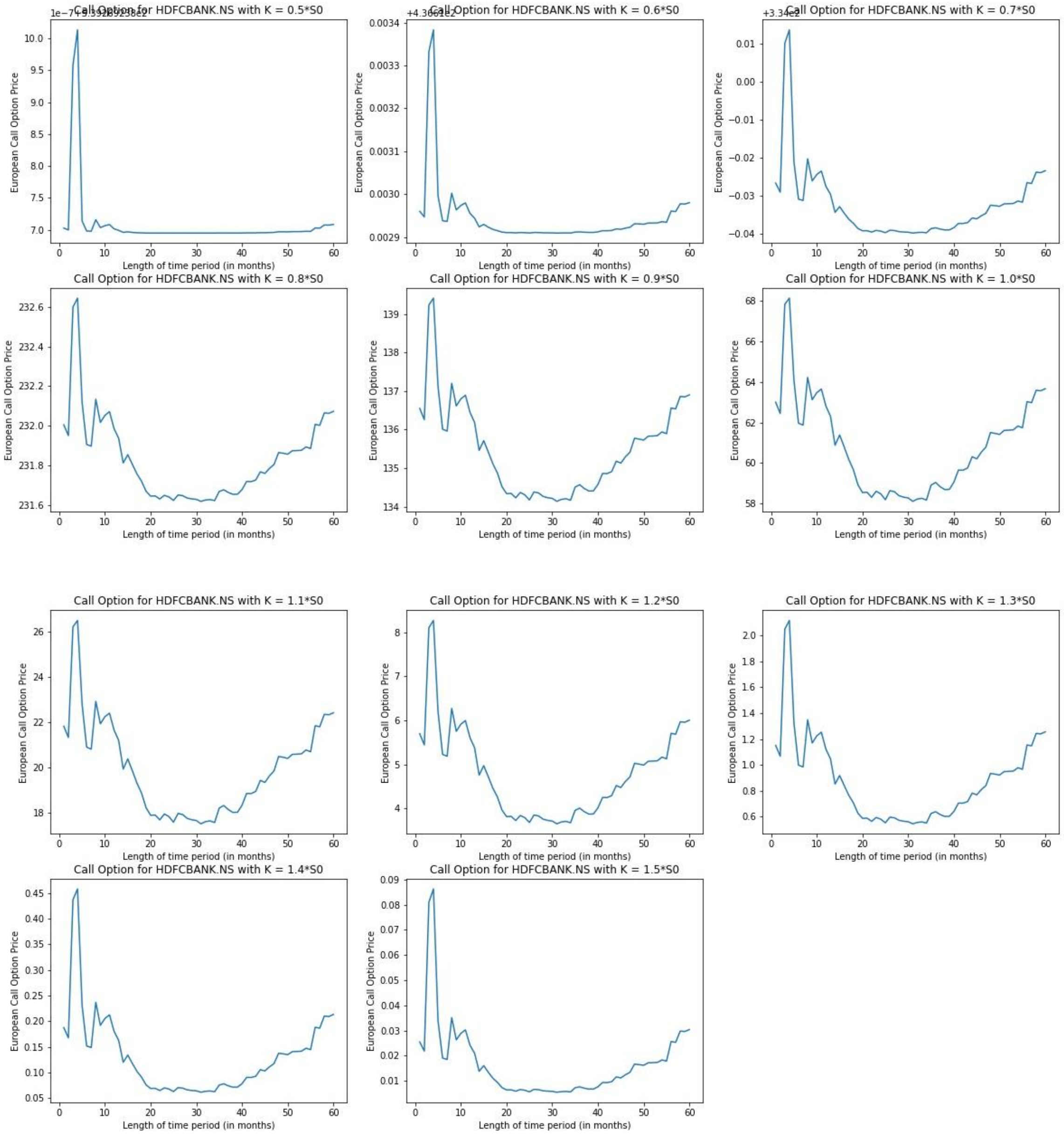
iii. Plots for Call Option and Volatility - stocks in nsedata1:

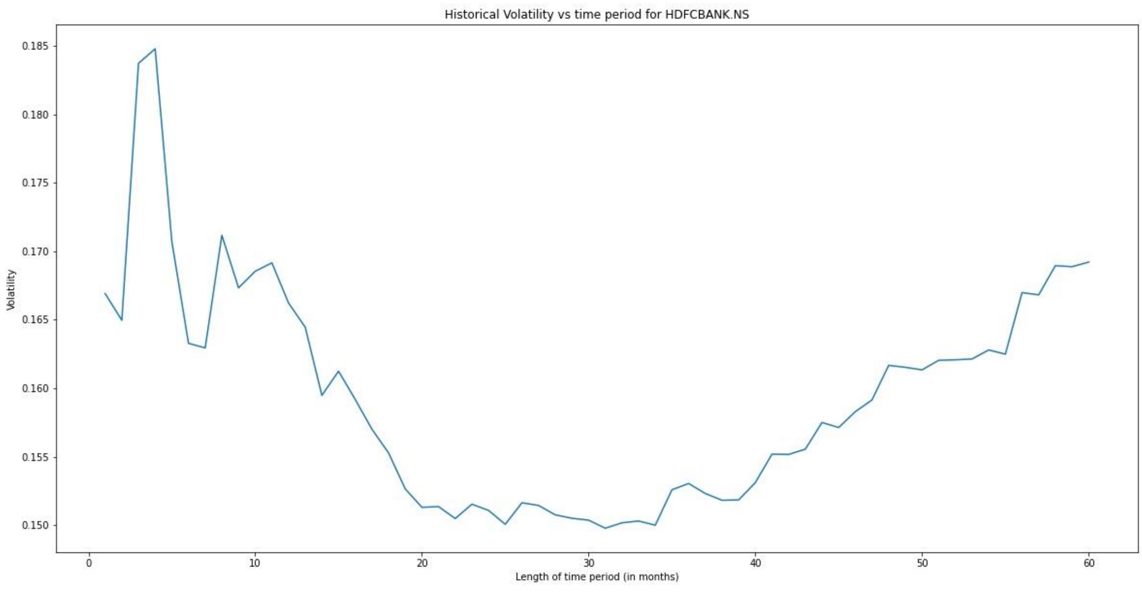
i) BAJAJ-AUTO.NS



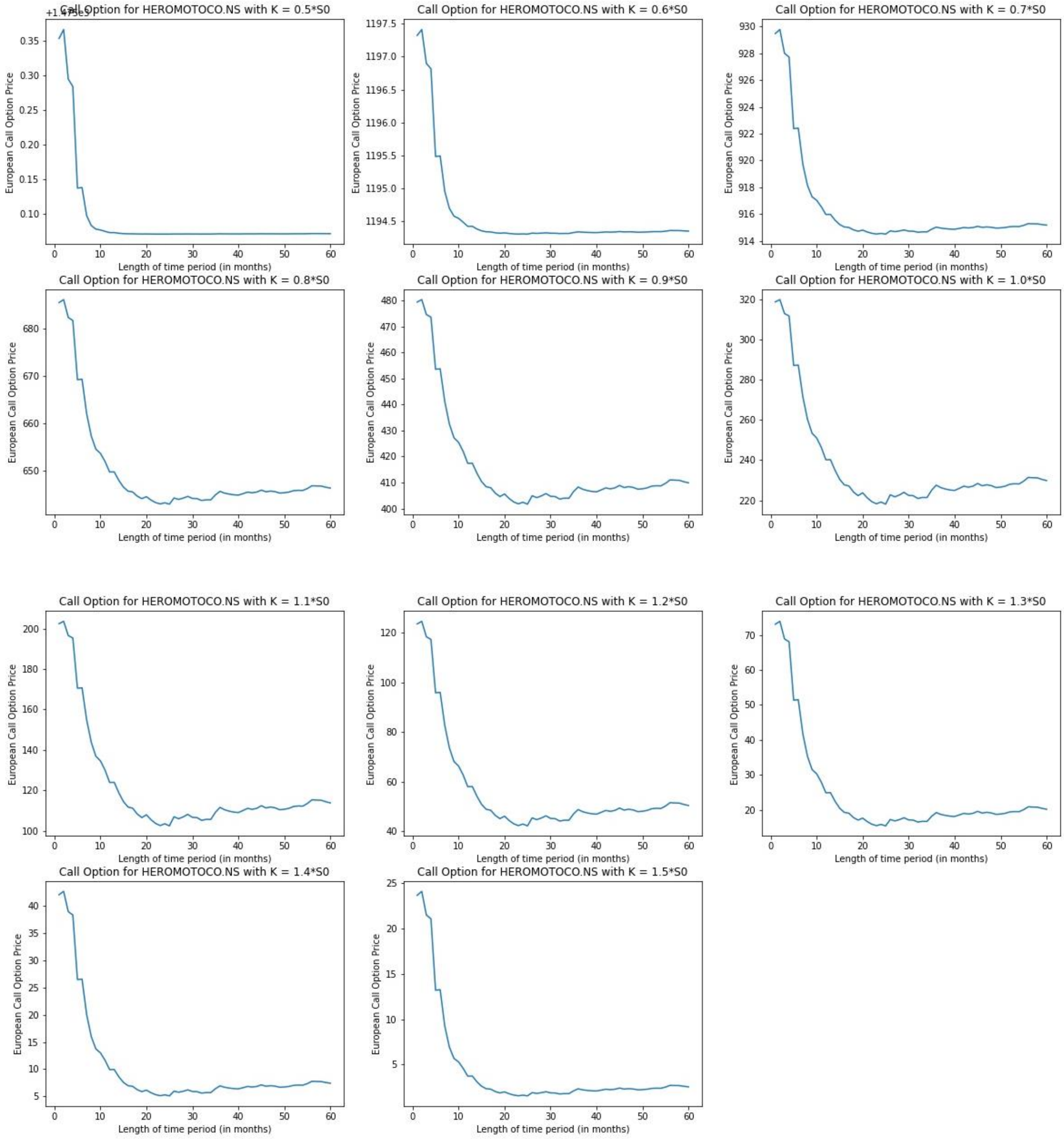


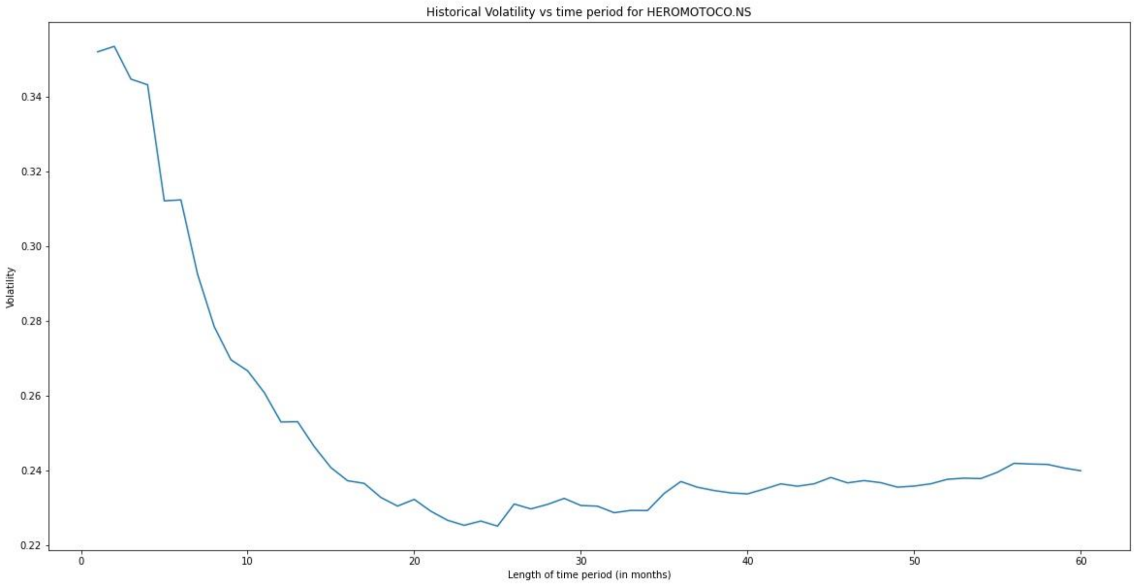
ii) HDFCBANK.NS



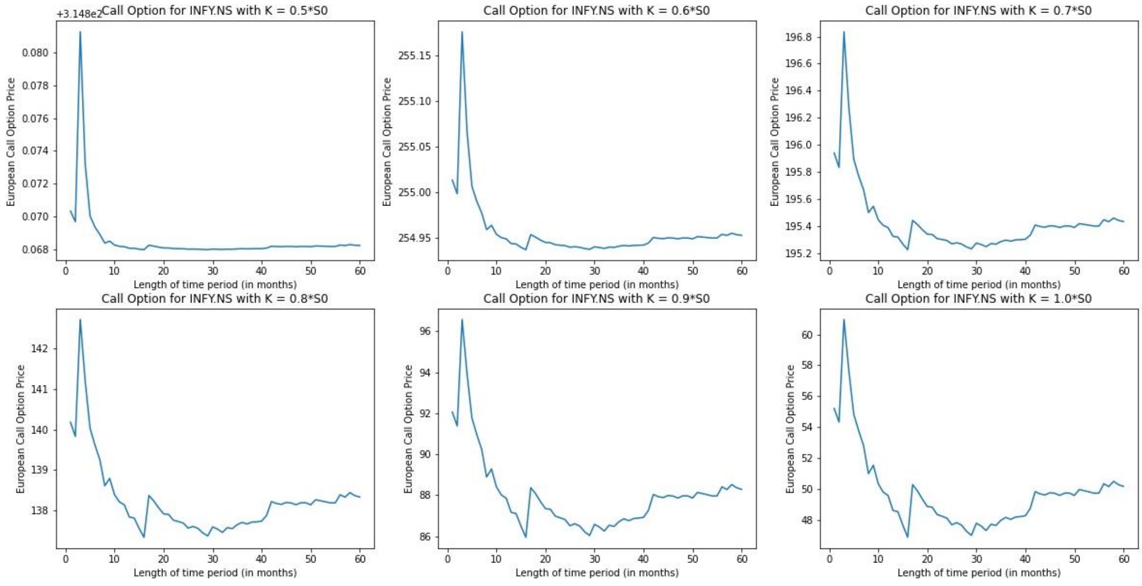


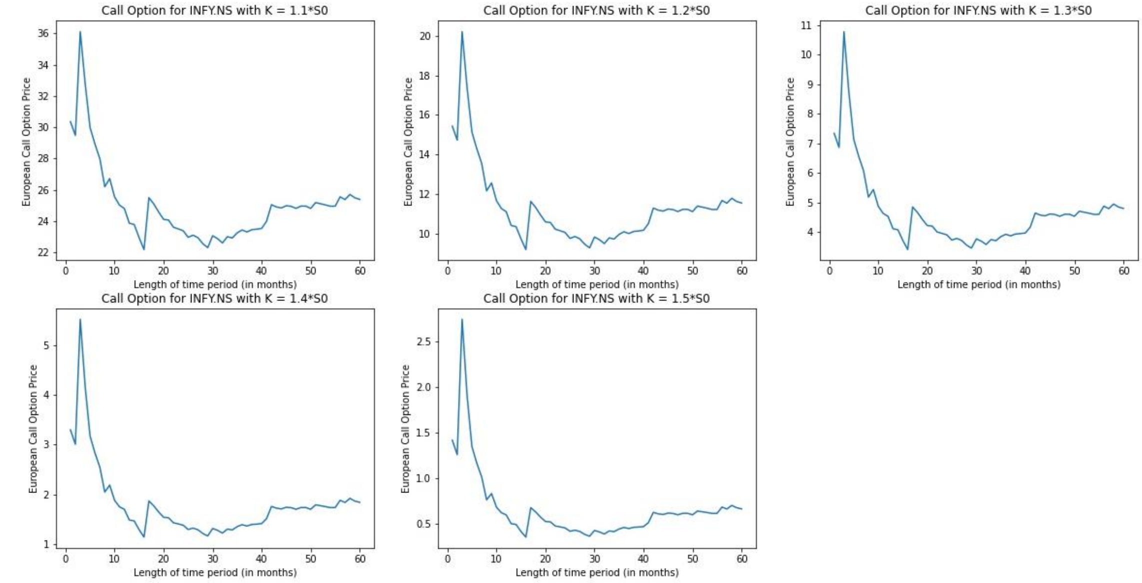
iii) HEROMOTOCO.NS

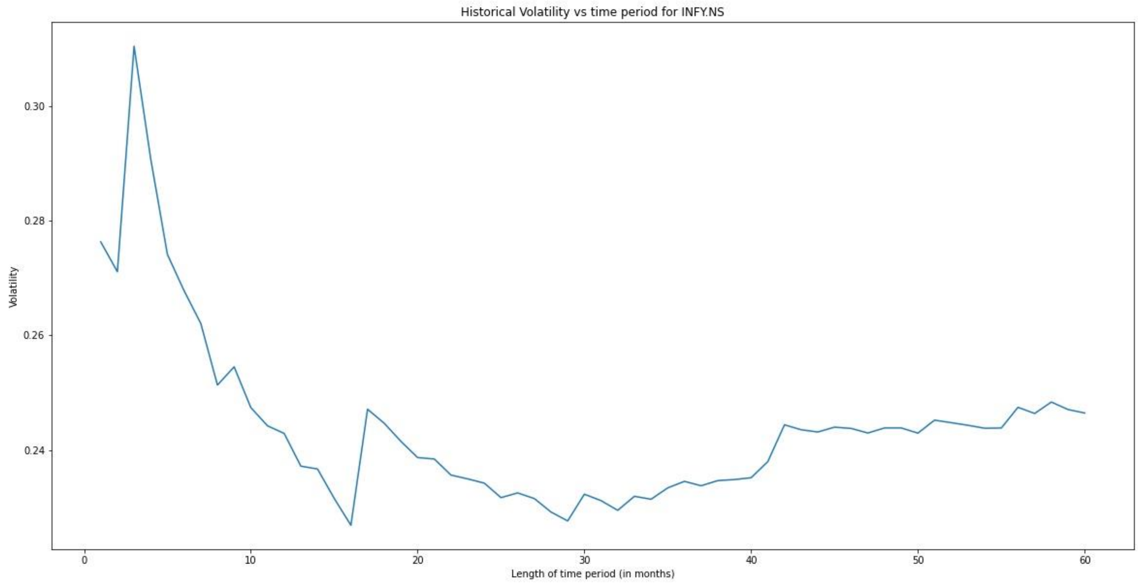




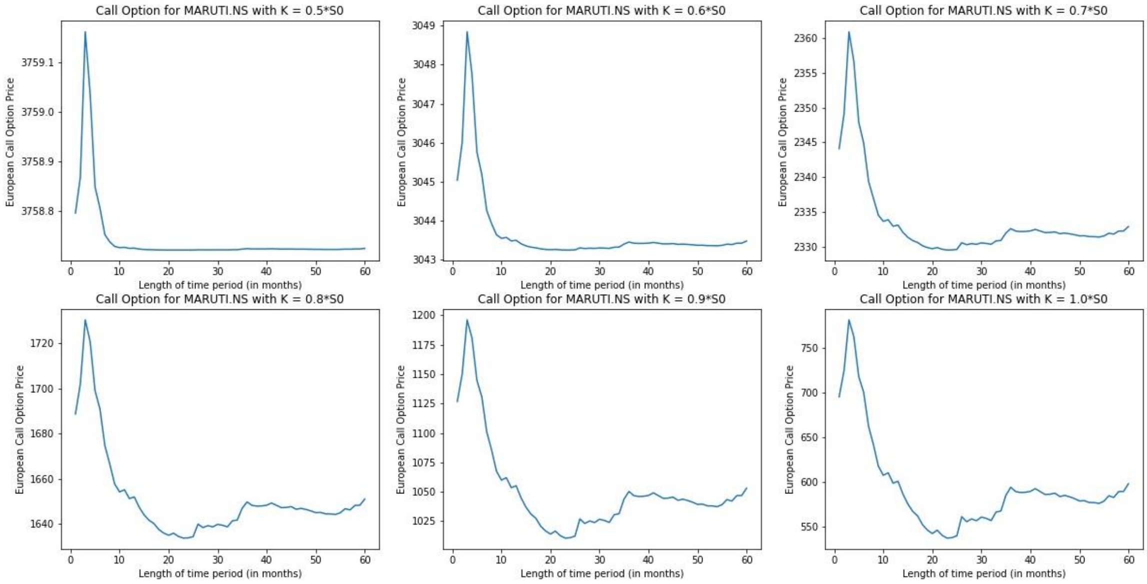
iv) INFY.NS

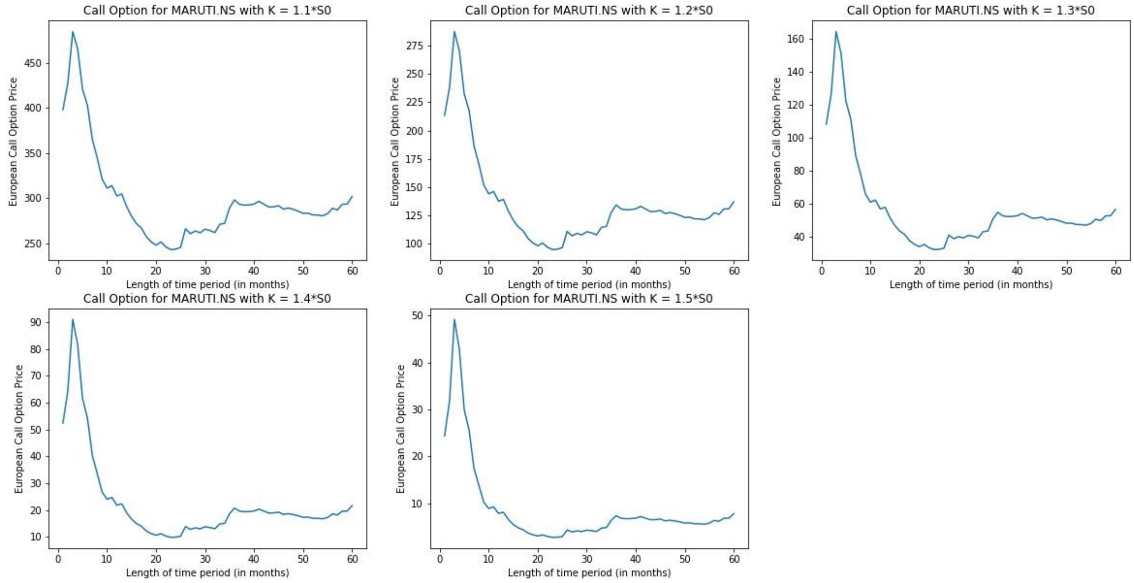

Call Option for INFY.NS with K = 0.5*S0
+3.148e2
Call Option for INFY.NS with K = 0.6*S0
Call Option for INFY.NS with K = 0.7*S0
Call Option for INFY.NS with K = 0.8*S0
Call Option for INFY.NS with K = 0.9*S0
Call Option for INFY.NS with K = 1.0*S0
European Call Option Price
Length of time period (in months)

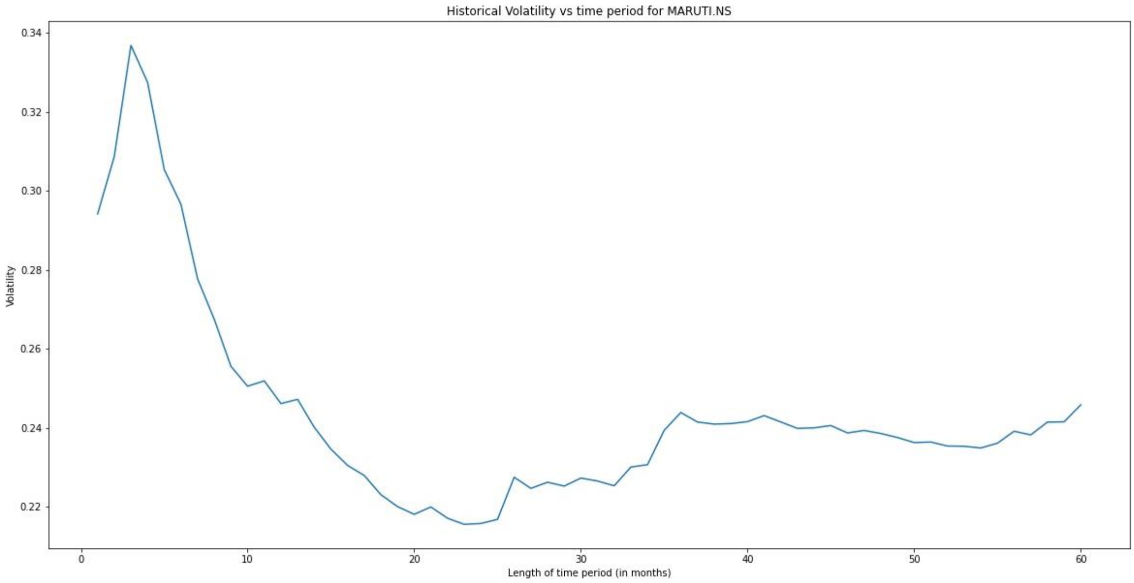

Call Option for INFY.NS with K = 1.1*S0
Call Option for INFY.NS with K = 1.2*S0
Call Option for INFY.NS with K = 1.3*S0
Call Option for INFY.NS with K = 1.4*S0
Call Option for INFY.NS with K = 1.5*S0
European Call Option Price
Length of time period (in months)


Historical Volatility vs time period for INFY.NS
Volatility
Length of time period (in months)

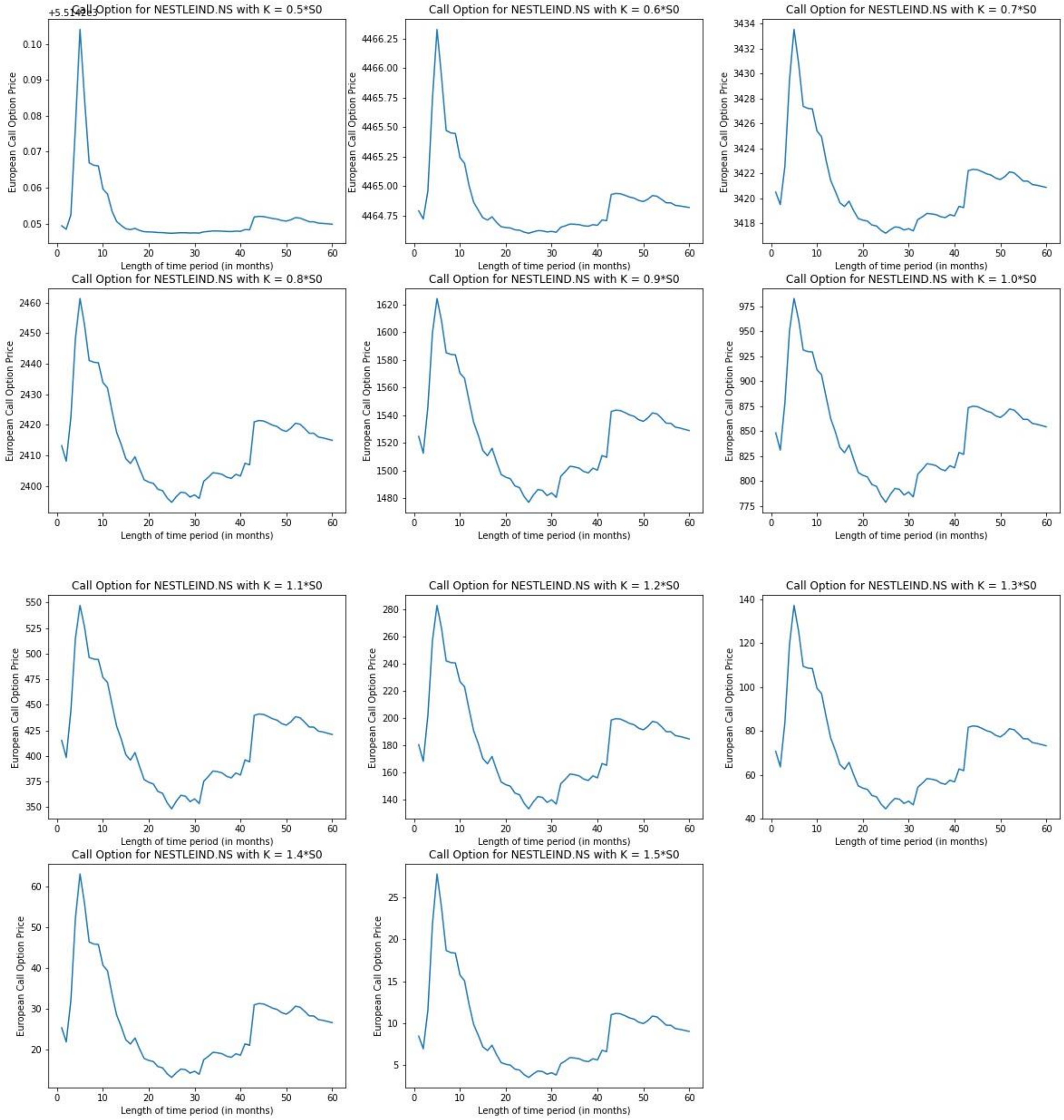
v) MARUTI.NS

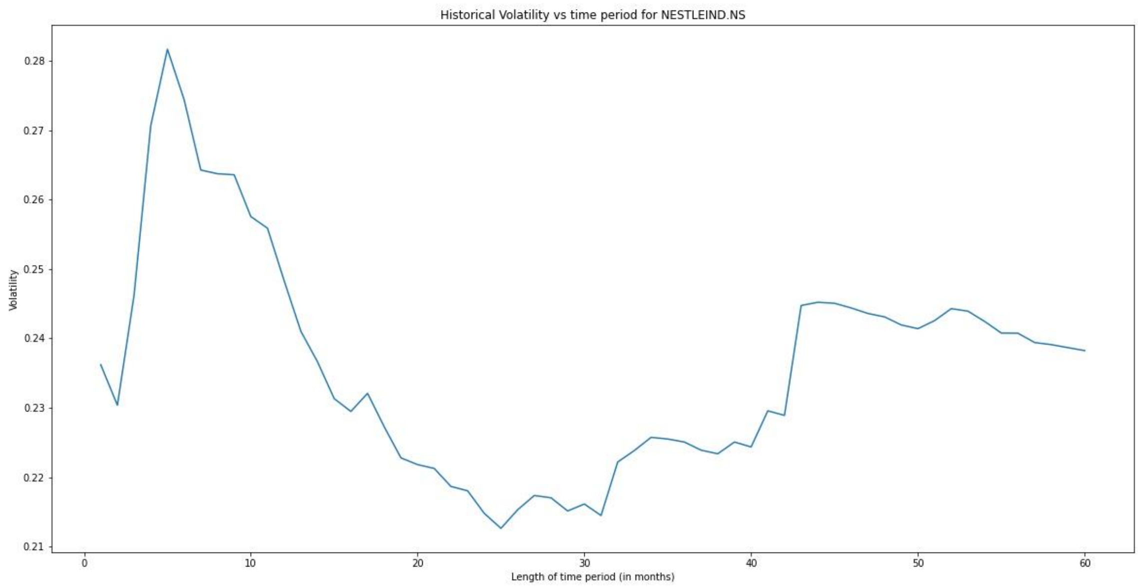

Call Option for MARUTI.NS with K = 0.5*S0
Call Option for MARUTI.NS with K = 0.6*S0
Call Option for MARUTI.NS with K = 0.7*S0
Call Option for MARUTI.NS with K = 0.8*S0
Call Option for MARUTI.NS with K = 0.9*S0
Call Option for MARUTI.NS with K = 1.0*S0
European Call Option Price
Length of time period (in months)


Call Option for MARUTI.NS with K = 1.1*S0
Call Option for MARUTI.NS with K = 1.2*S0
Call Option for MARUTI.NS with K = 1.3*S0
Call Option for MARUTI.NS with K = 1.4*S0
Call Option for MARUTI.NS with K = 1.5*S0
European Call Option Price
Length of time period (in months)

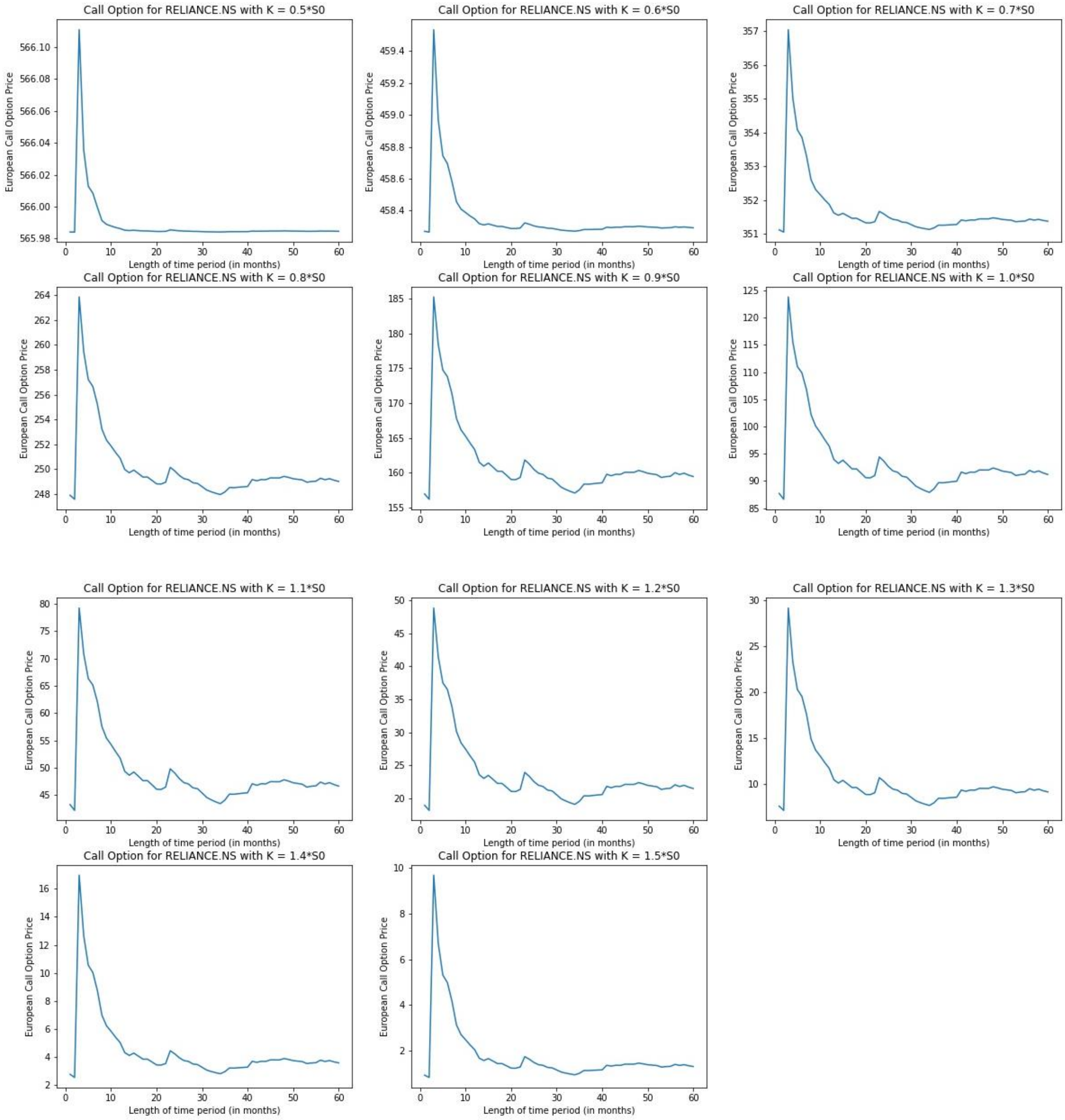

Historical Volatility vs time period for MARUTI.NS
Volatility
Length of time period (in months)

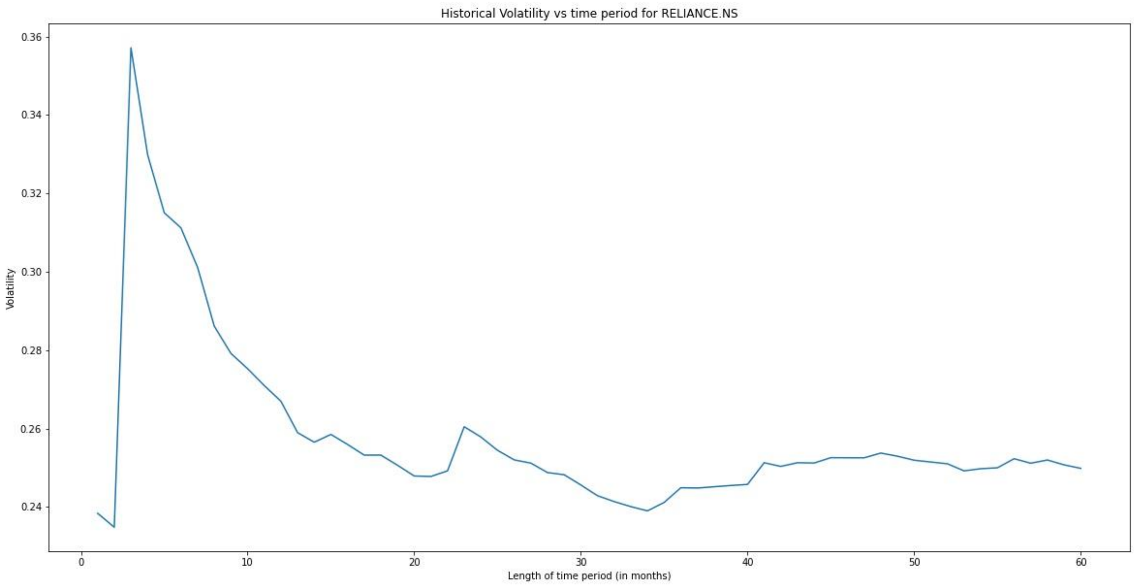
vi) <u>NESTLEIND.NS</u>



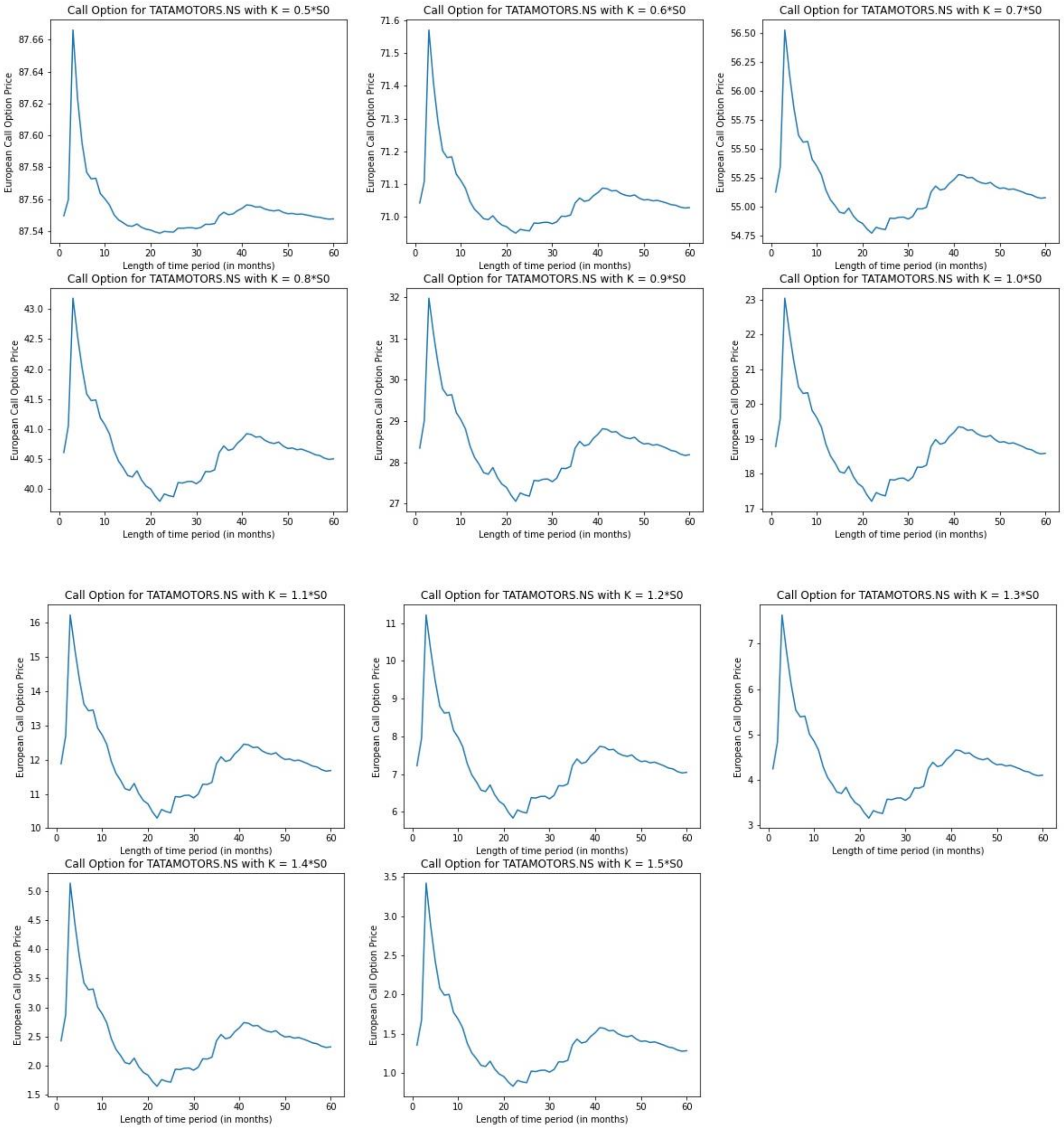


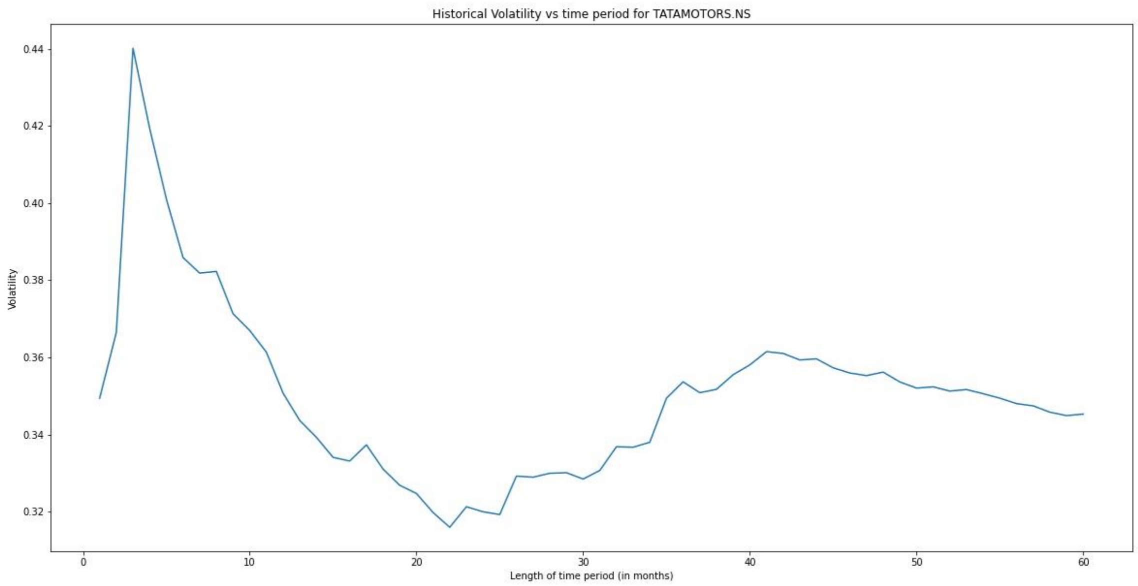
vii) RELIANCE.NS



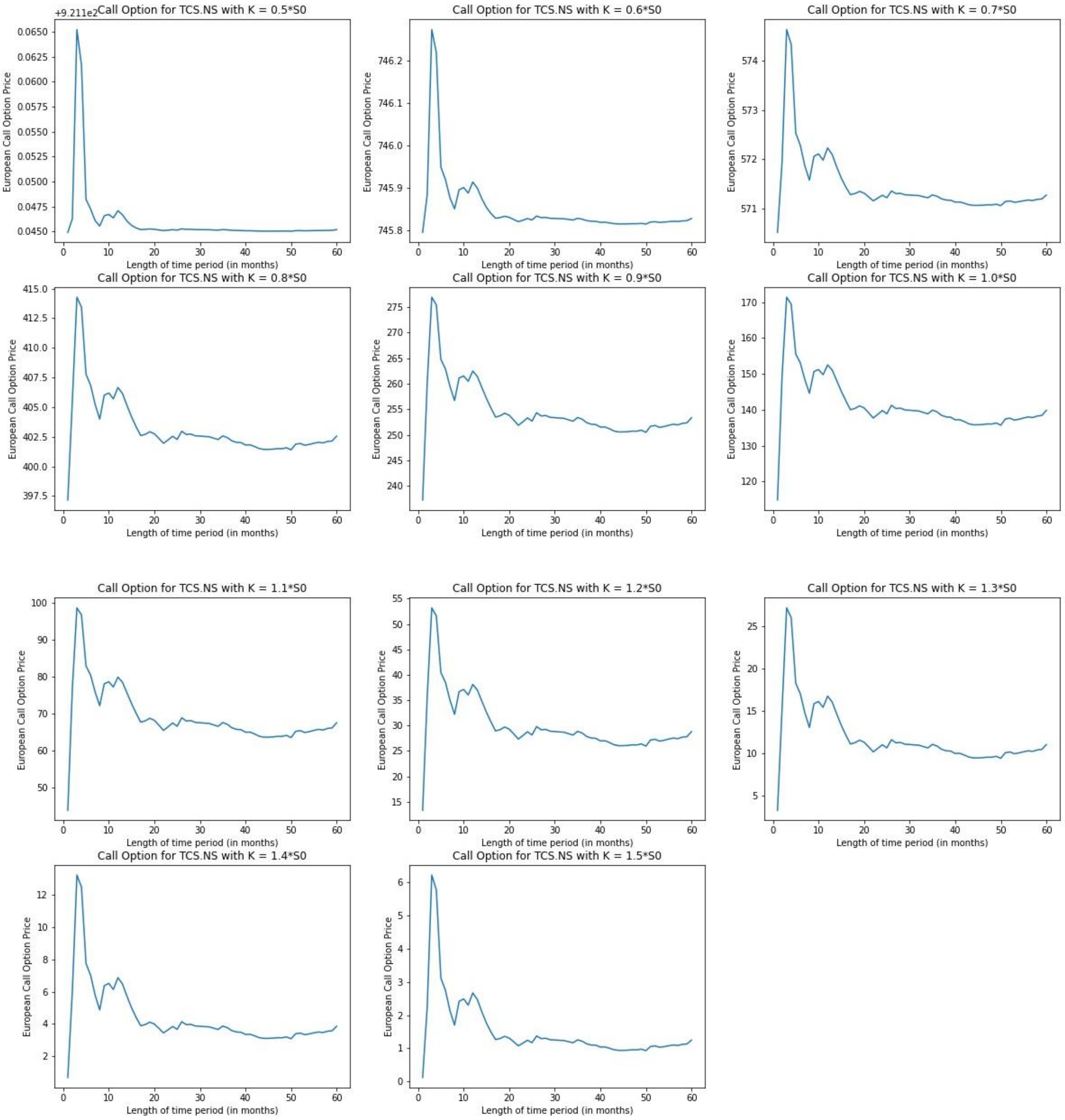


viii) TATAMOTORS.NS

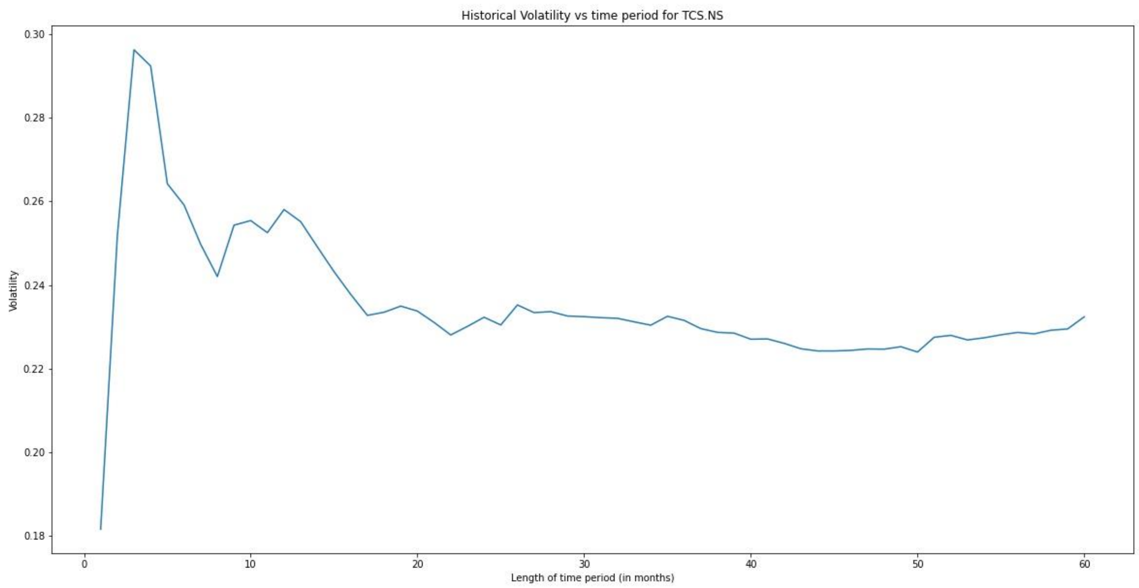




ix) TCS.NS

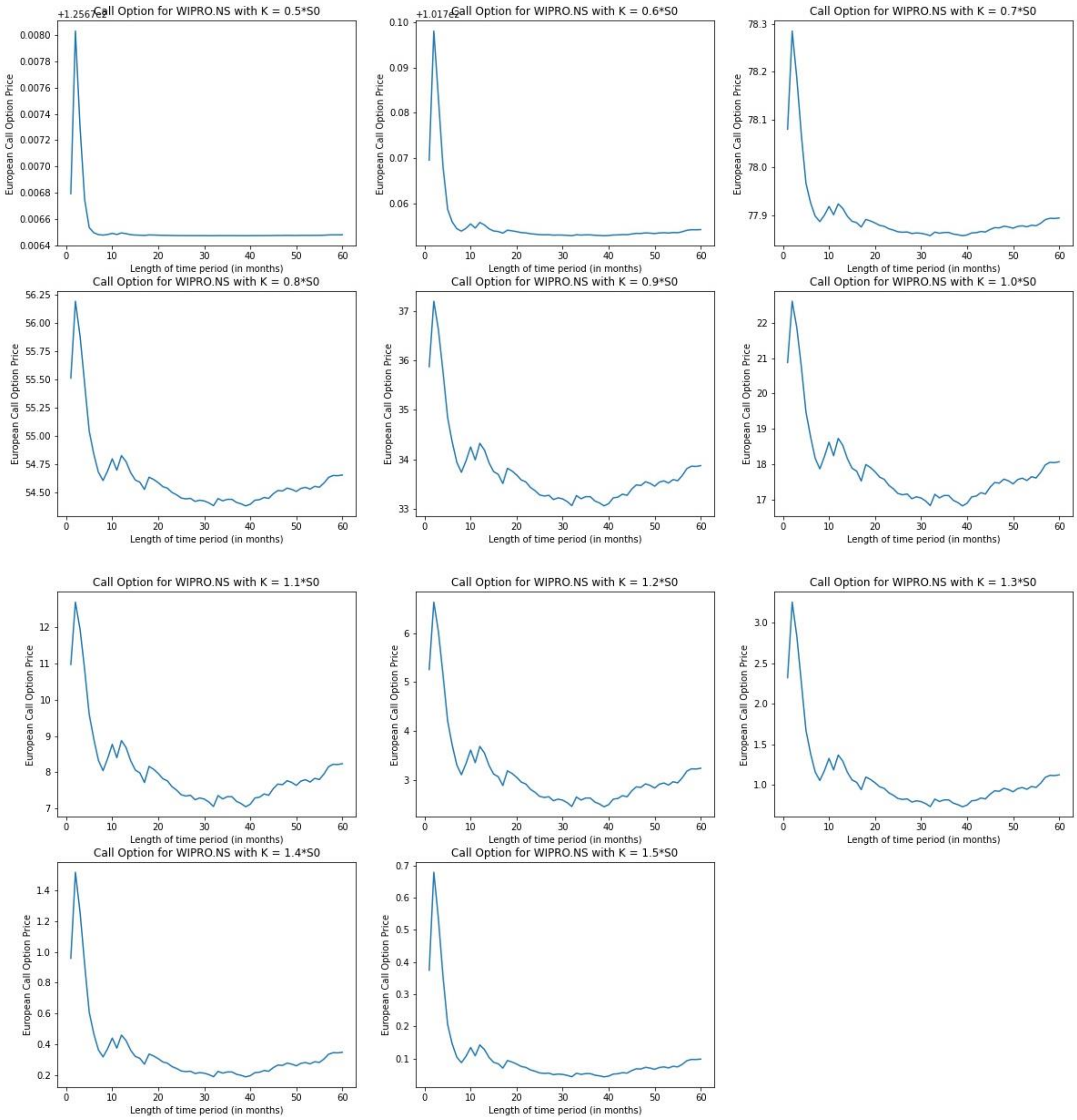


Call Option for TCS.NS with K = 0.5*S0
Call Option for TCS.NS with K = 0.6*S0
Call Option for TCS.NS with K = 0.7*S0
Call Option for TCS.NS with K = 0.8*S0
Call Option for TCS.NS with K = 0.9*S0
Call Option for TCS.NS with K = 1.0*S0
Call Option for TCS.NS with K = 1.1*S0
Call Option for TCS.NS with K = 1.2*S0
Call Option for TCS.NS with K = 1.3*S0
Call Option for TCS.NS with K = 1.4*S0
Call Option for TCS.NS with K = 1.5*S0
European Call Option Price
Length of time period (in months)
+9.211e2

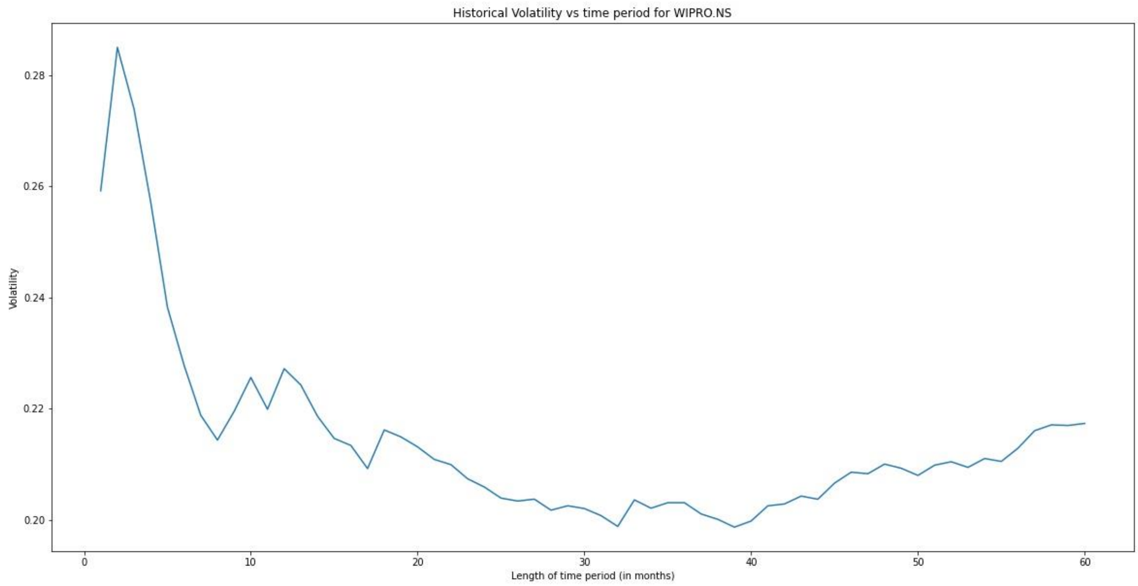


Historical Volatility vs time period for TCS.NS
Volatility
Length of time period (in months)

x) WIPRO.NS

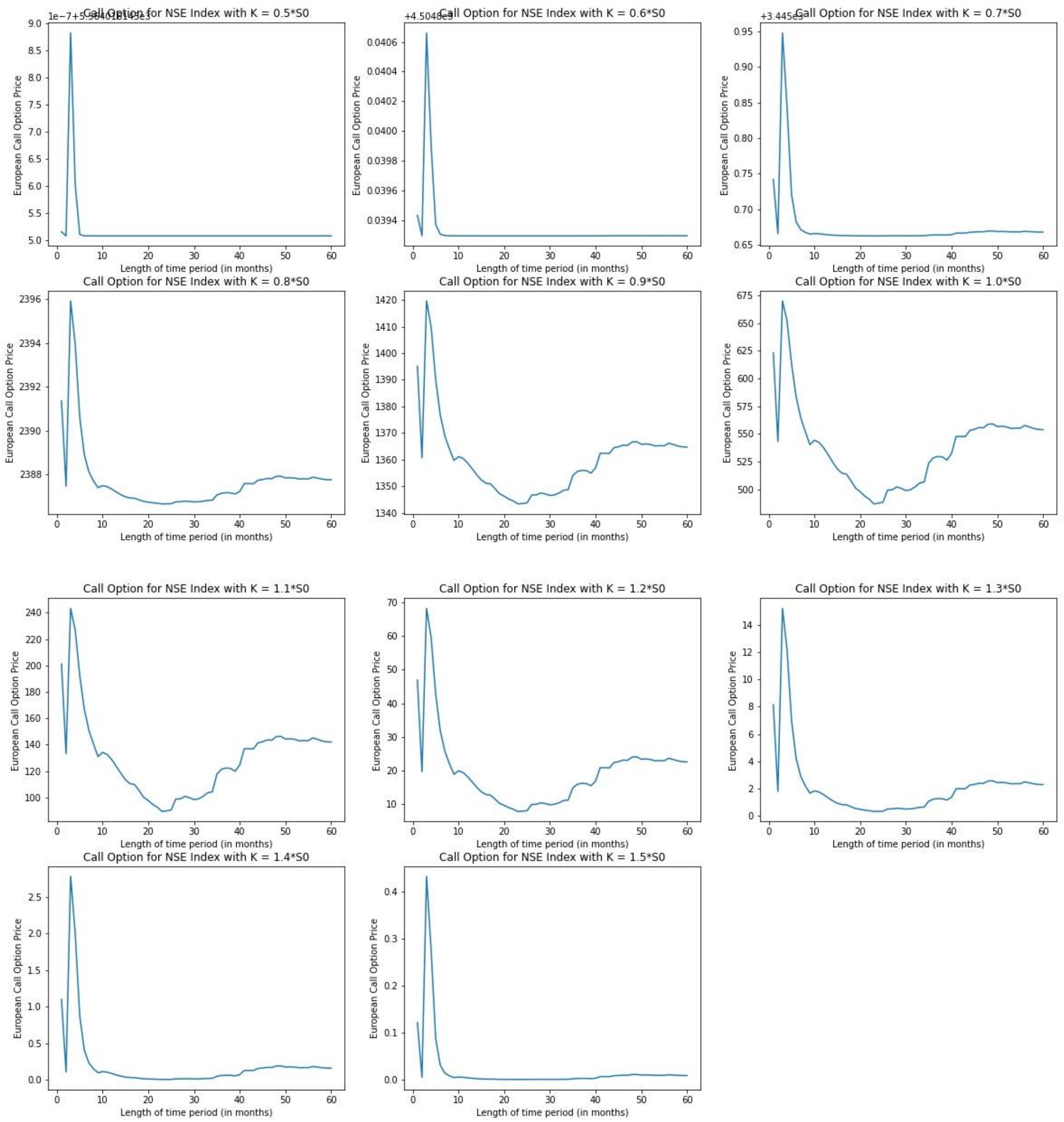


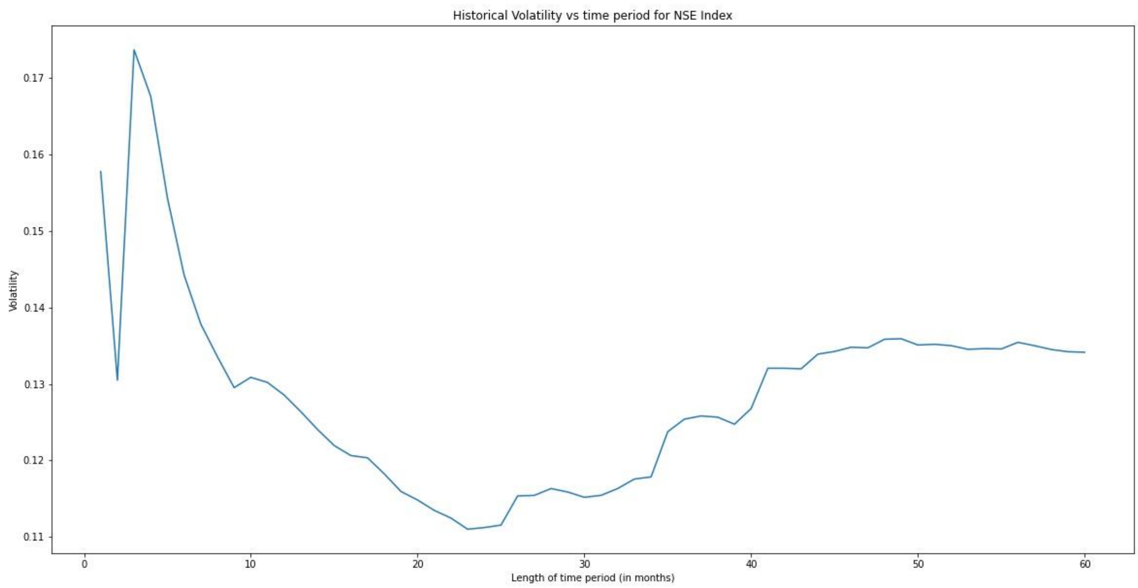
+1.2567e2
Call Option for WIPRO.NS with K = 0.5*S0
+1.017e2
Call Option for WIPRO.NS with K = 0.6*S0
Call Option for WIPRO.NS with K = 0.7*S0
Call Option for WIPRO.NS with K = 0.8*S0
Call Option for WIPRO.NS with K = 0.9*S0
Call Option for WIPRO.NS with K = 1.0*S0
Call Option for WIPRO.NS with K = 1.1*S0
Call Option for WIPRO.NS with K = 1.2*S0
Call Option for WIPRO.NS with K = 1.3*S0
Call Option for WIPRO.NS with K = 1.4*S0
Call Option for WIPRO.NS with K = 1.5*S0
European Call Option Price
Length of time period (in months)



Historical Volatility vs time period for WIPRO.NS
Volatility
Length of time period (in months)

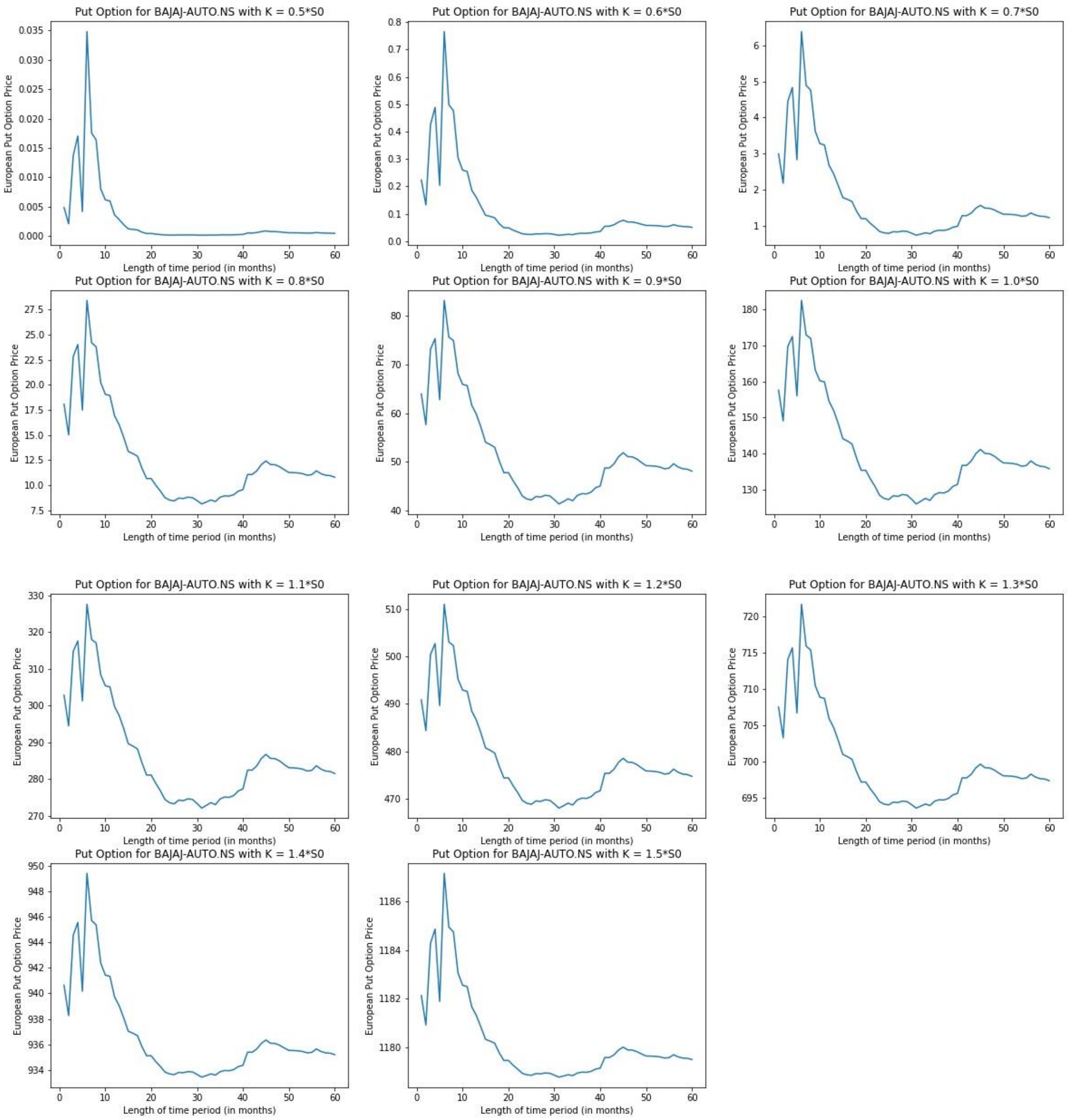
xi) NSE Index


Call Option for NSE Index with K = 0.5*S0
Call Option for NSE Index with K = 0.6*S0
Call Option for NSE Index with K = 0.7*S0
Call Option for NSE Index with K = 0.8*S0
Call Option for NSE Index with K = 0.9*S0
Call Option for NSE Index with K = 1.0*S0
Call Option for NSE Index with K = 1.1*S0
Call Option for NSE Index with K = 1.2*S0
Call Option for NSE Index with K = 1.3*S0
Call Option for NSE Index with K = 1.4*S0
Call Option for NSE Index with K = 1.5*S0
European Call Option Price
Length of time period (in months)

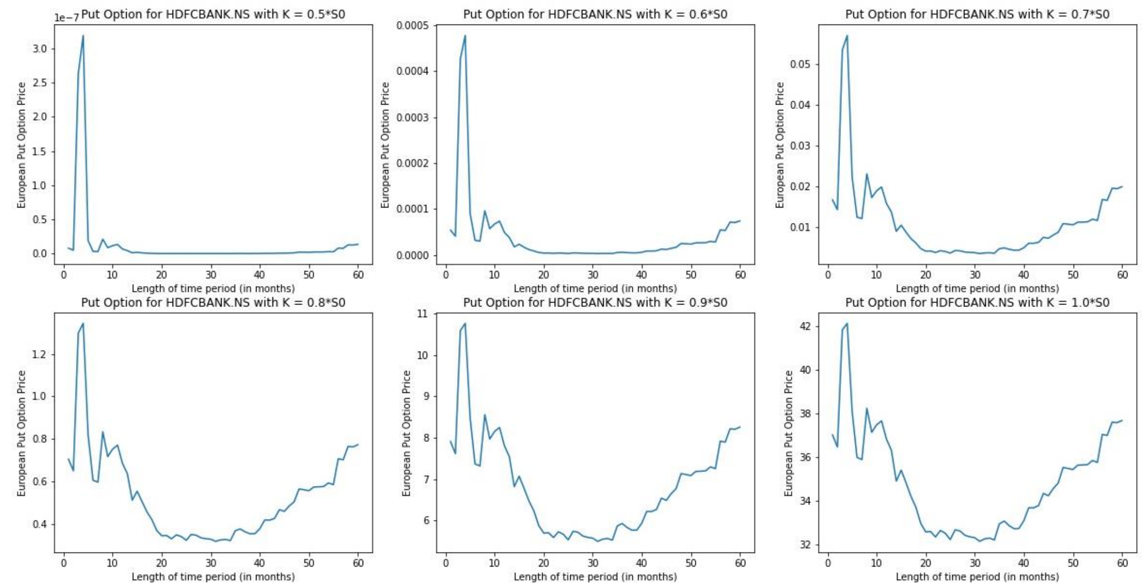

Historical Volatility vs time period for NSE Index
Volatility
Length of time period (in months)

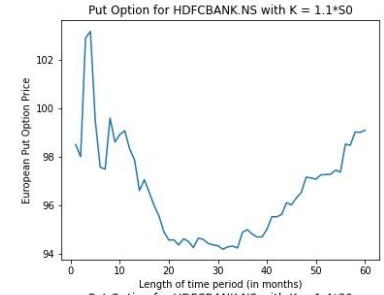
iv. Plots for Put Option - stocks in nsedata1:

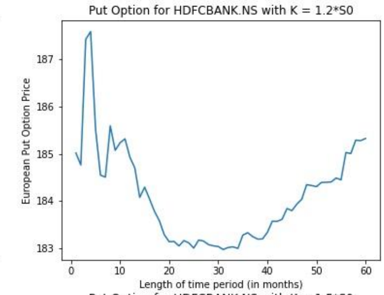
i) BAJAJ-AUTO.NS

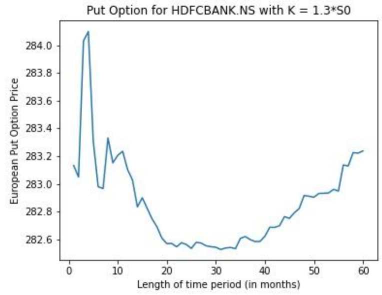


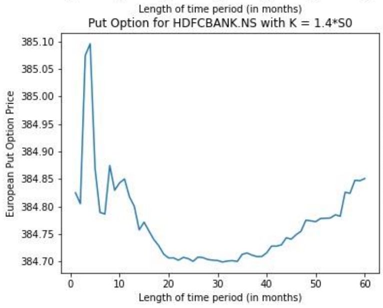
ii) HDFCBANK.NS

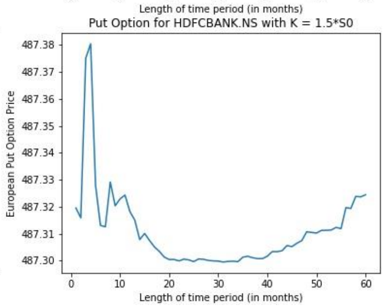




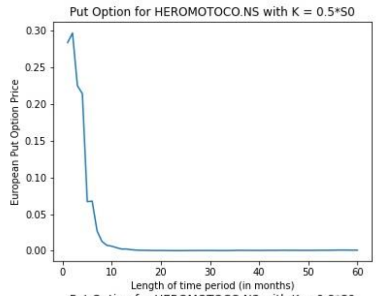


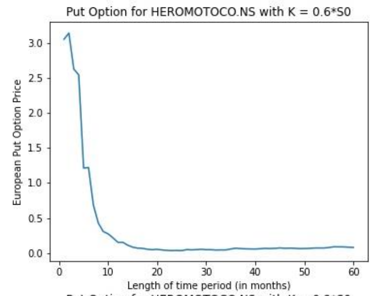


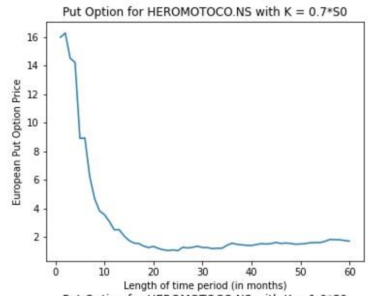


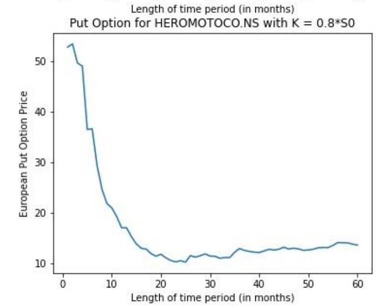


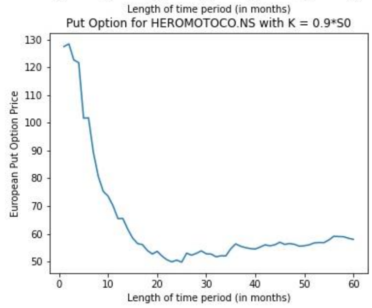
iii) HEROMOTOCO.NS

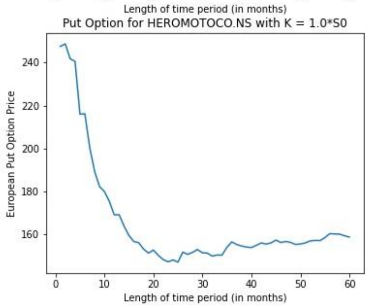


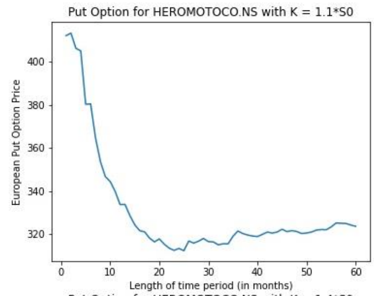


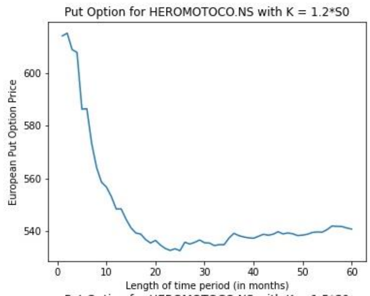


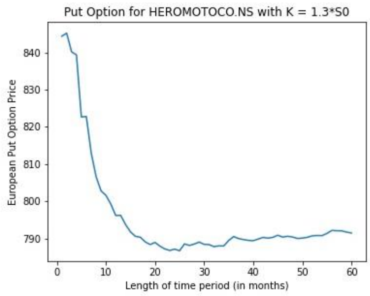


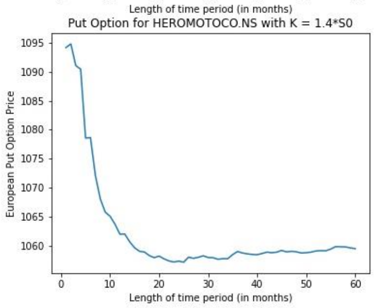


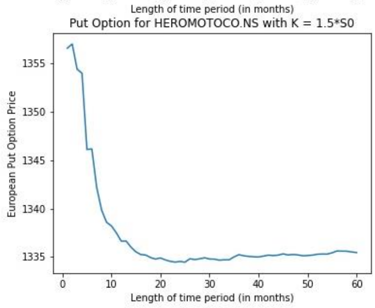




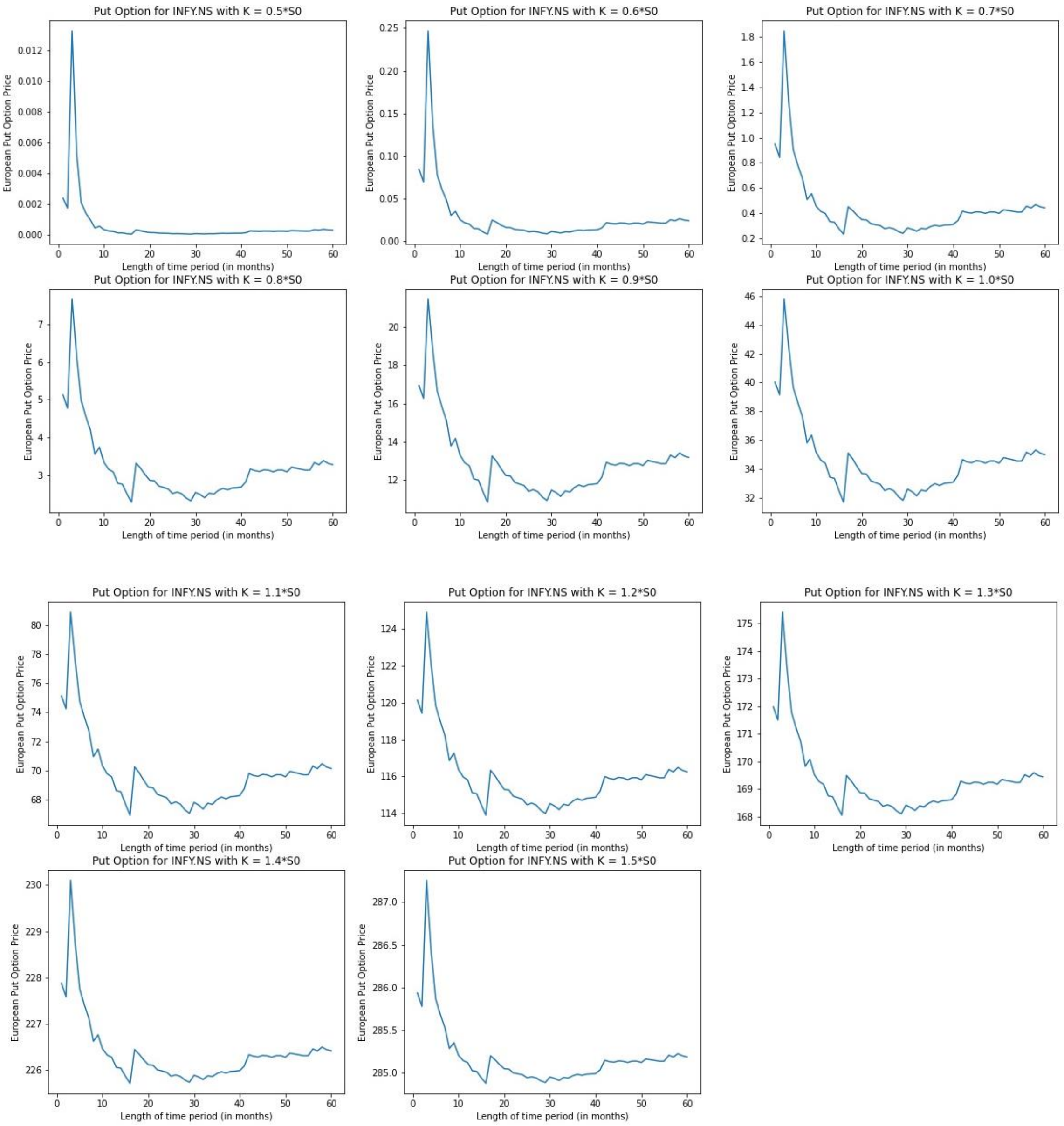




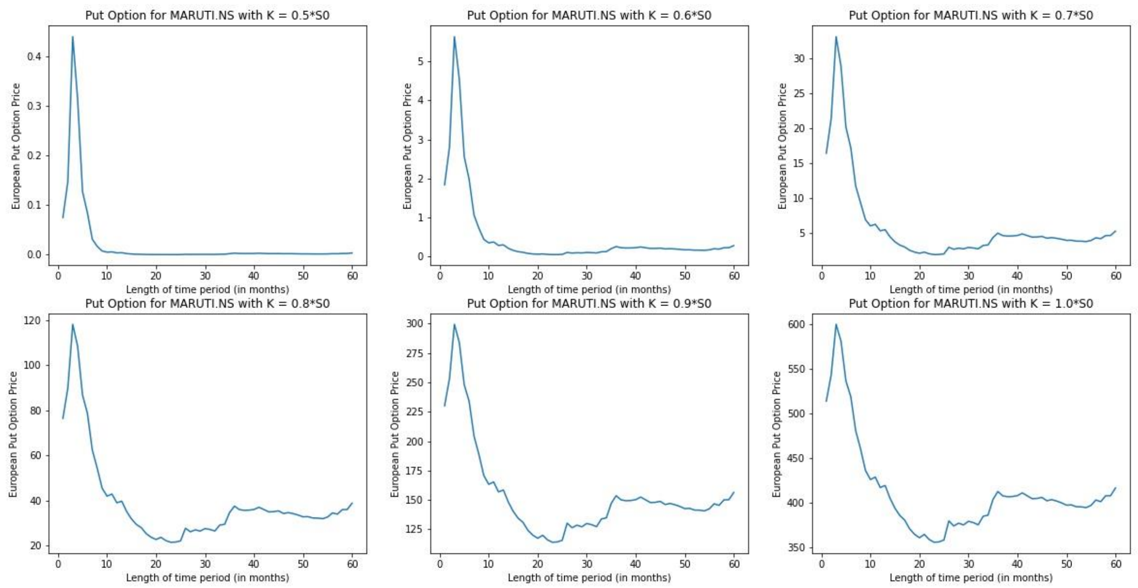


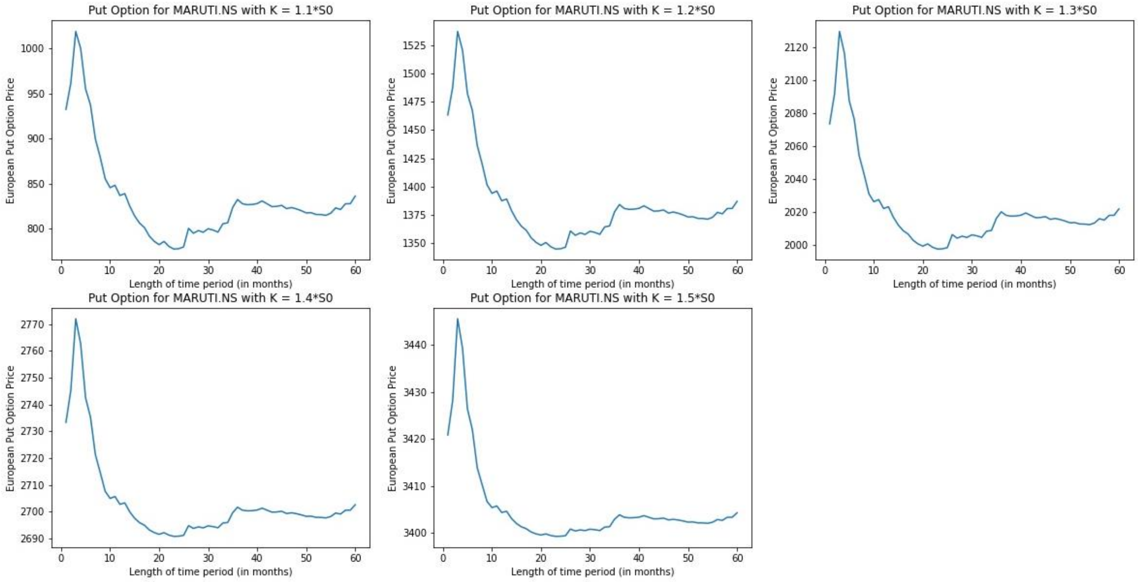


iv) INFY.NS

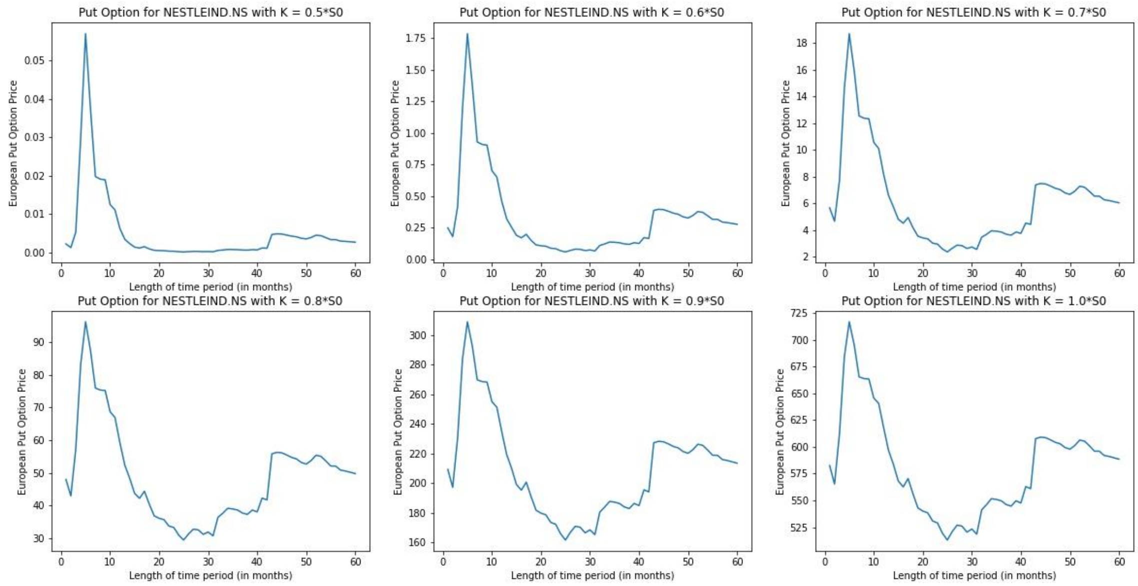


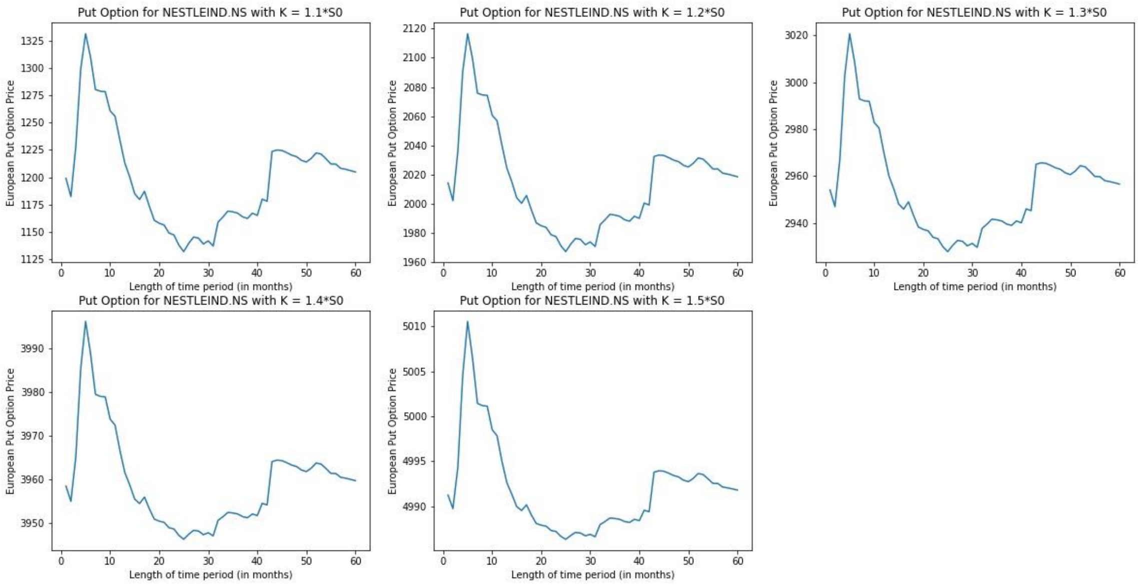
v) MARUTI.NS



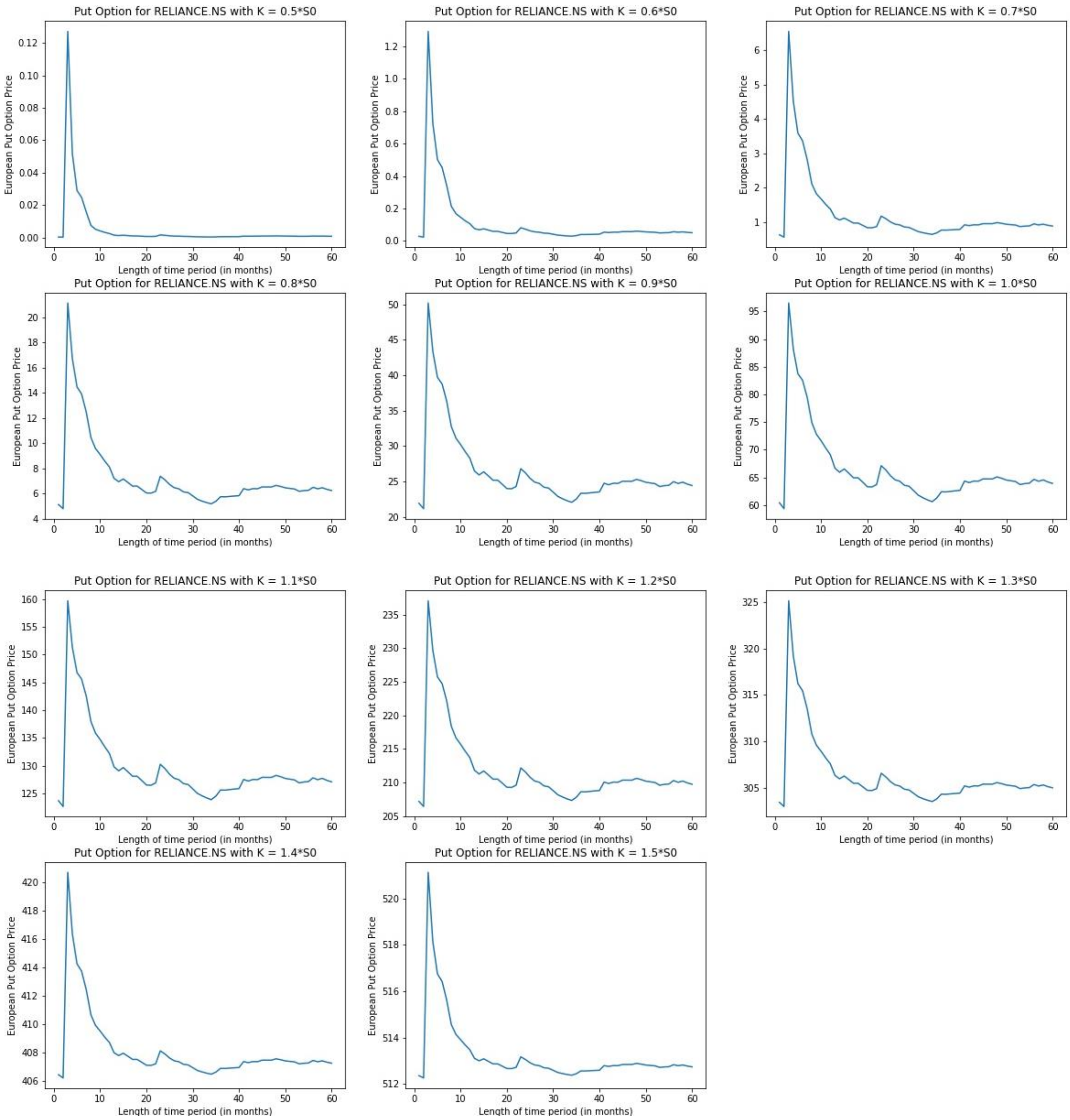


vi) NESTLEIND.NS

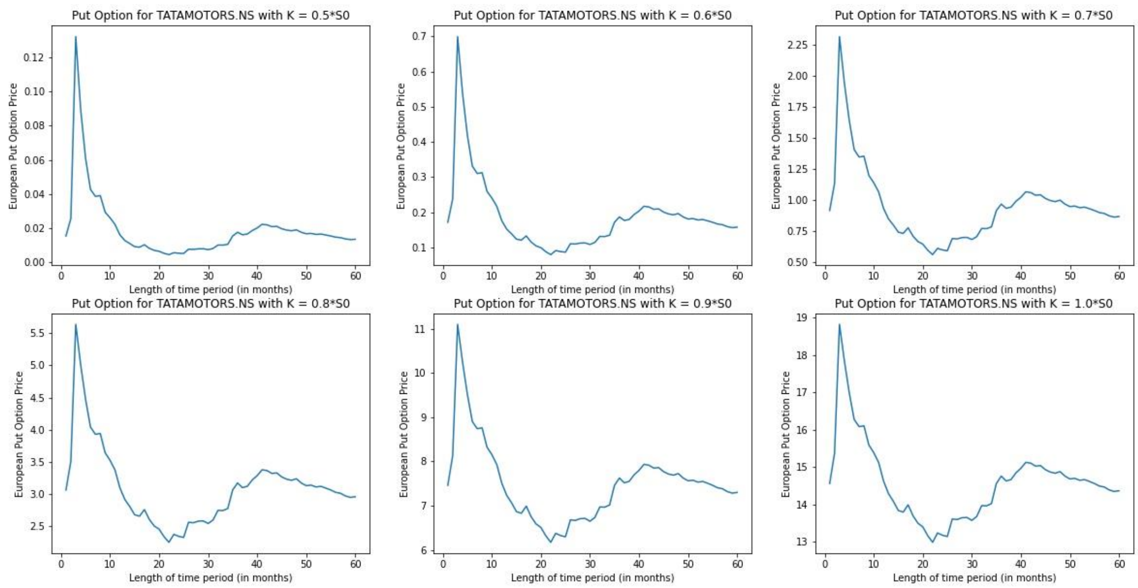


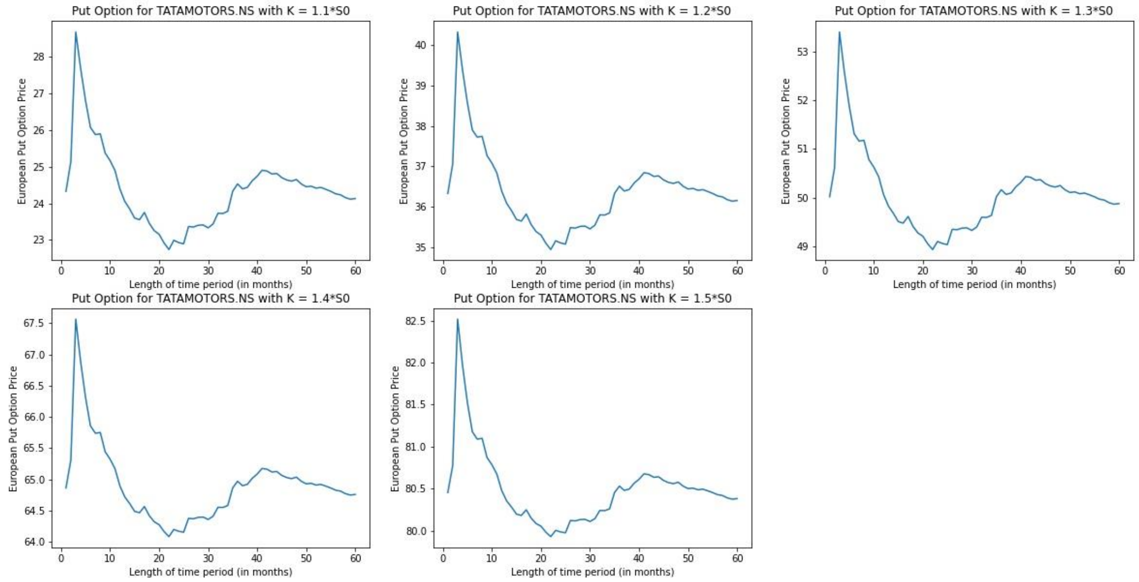


vii) RELIANCE.NS

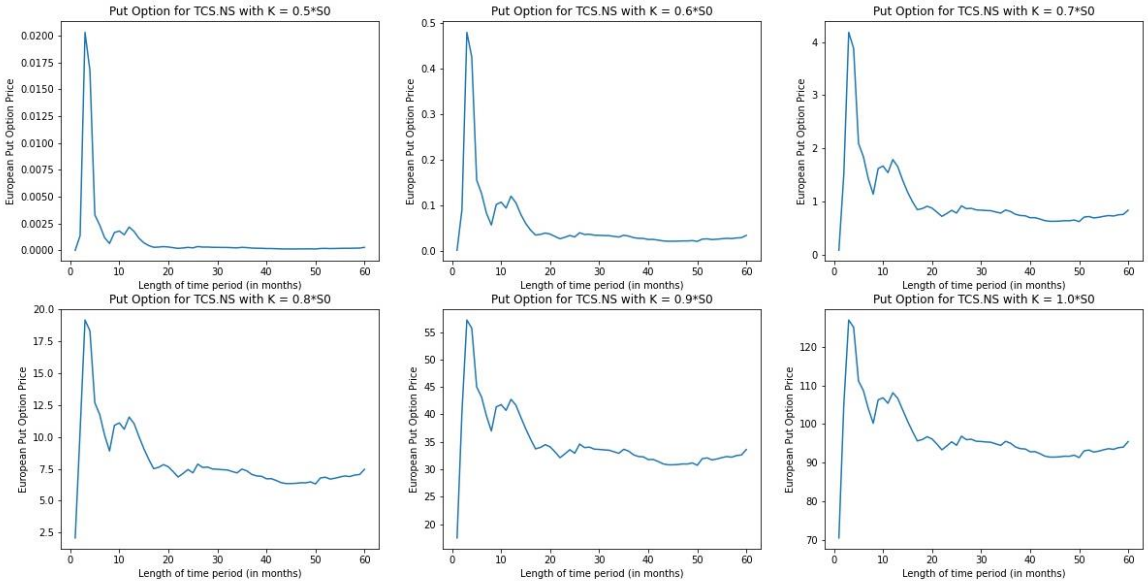


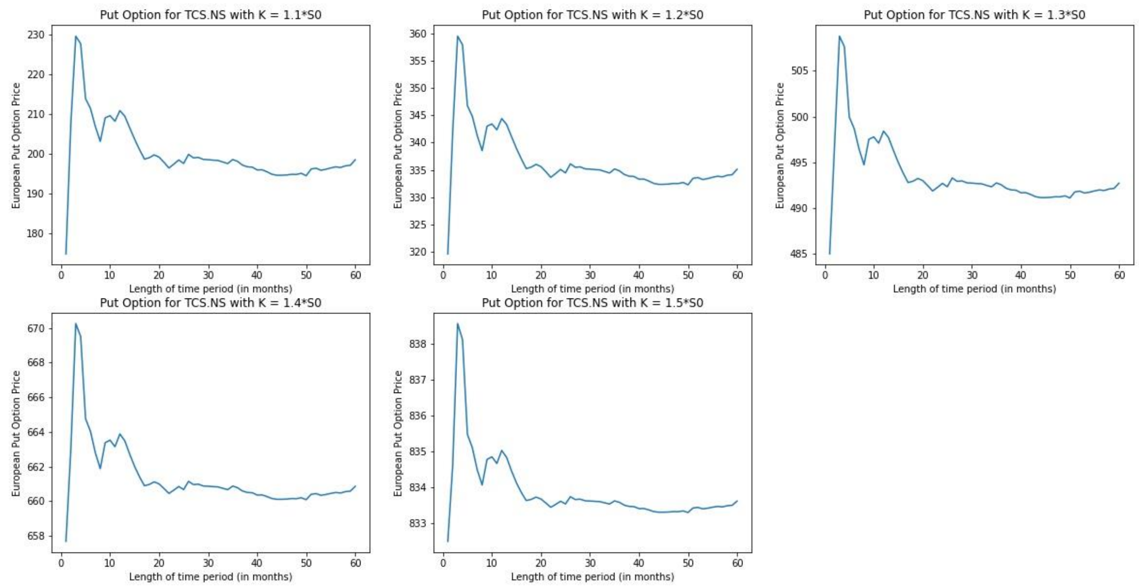
viii) TATAMOTORS.NS



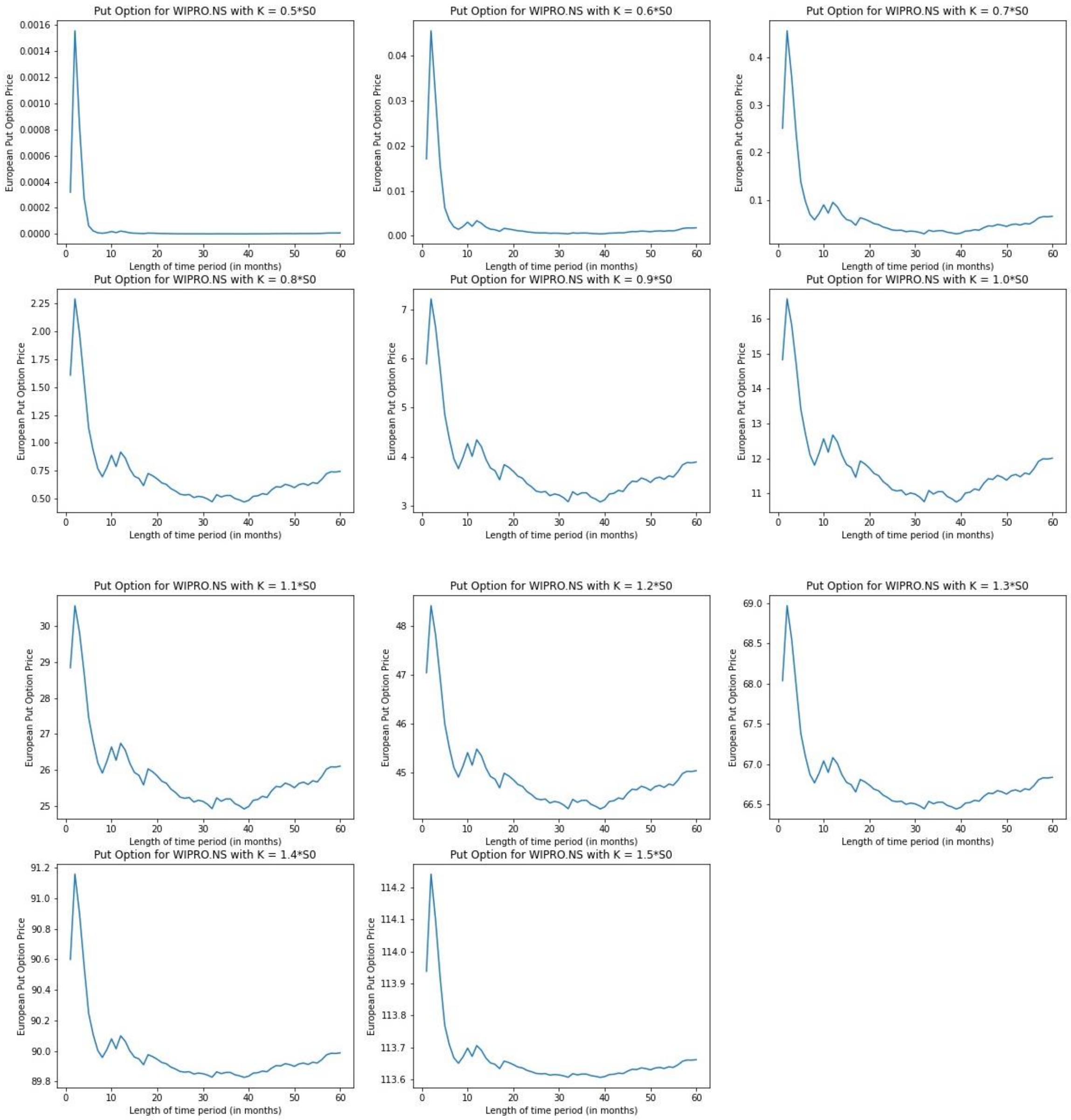

Put Option for TATAMOTORS.NS with K = 1.1*S0
Put Option for TATAMOTORS.NS with K = 1.2*S0
Put Option for TATAMOTORS.NS with K = 1.3*S0
Put Option for TATAMOTORS.NS with K = 1.4*S0
Put Option for TATAMOTORS.NS with K = 1.5*S0
European Put Option Price
Length of time period (in months)

ix) TCS.NS

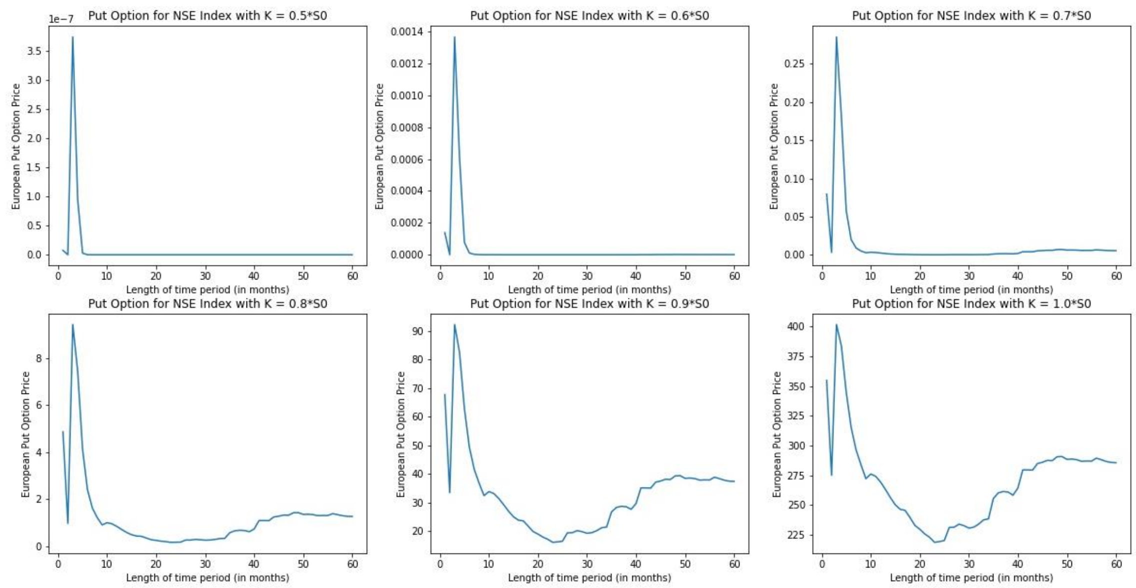

Put Option for TCS.NS with K = 0.5*S0
Put Option for TCS.NS with K = 0.6*S0
Put Option for TCS.NS with K = 0.7*S0
Put Option for TCS.NS with K = 0.8*S0
Put Option for TCS.NS with K = 0.9*S0
Put Option for TCS.NS with K = 1.0*S0
European Put Option Price
Length of time period (in months)

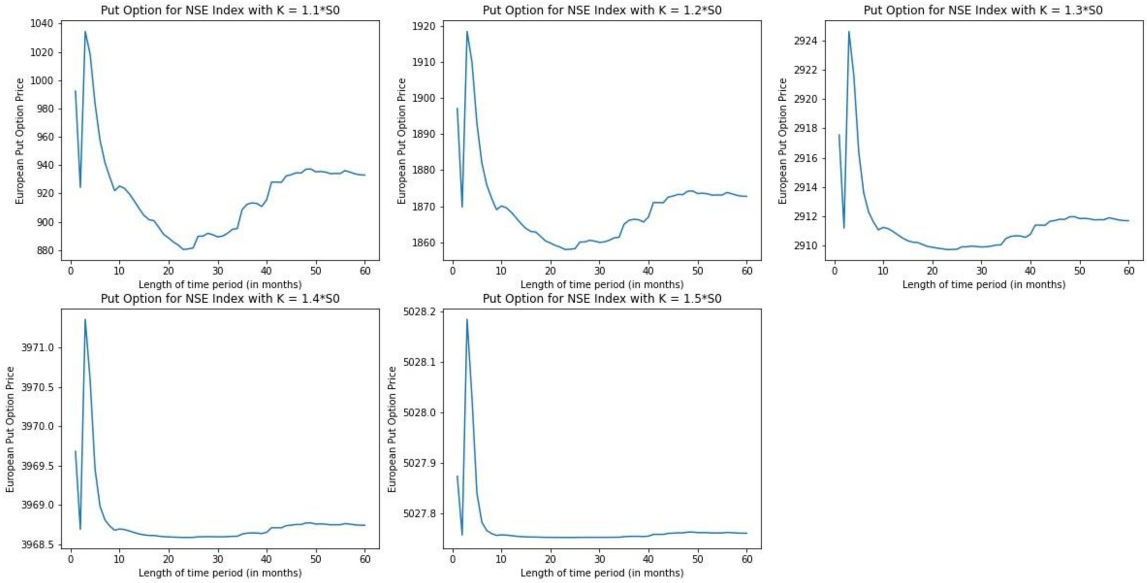

Put Option for TCS.NS with K = 1.1*S0
Put Option for TCS.NS with K = 1.2*S0
Put Option for TCS.NS with K = 1.3*S0
Put Option for TCS.NS with K = 1.4*S0
Put Option for TCS.NS with K = 1.5*S0
European Put Option Price
Length of time period (in months)

x) WIPRO.NS



xi) NSE Index





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:

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

where,

$$d_1 = \frac{\log\left(\frac{x}{K}\right) + (r + \frac{1}{2}\sigma^2)(T-t)}{\sigma\sqrt{T-t}}$$
$$d_2 = \frac{\log\left(\frac{x}{K}\right) + (r - \frac{1}{2}\sigma^2)(T-t)}{\sigma\sqrt{T-t}}$$
$$N(x) = \frac{1}{\sqrt{2\pi}}\int_{-\infty}^{x} e^{-\frac{1}{2}y^2}\,dy$$

- 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