MA 374 - Financial Engineering Lab08

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Q1

Formula used for calculating the Put and Call option price in the classical BSM framework using Black-Scholes-Merton PDE is:

$$\begin{aligned} C(s,t) &= sN(d_1) - Ke^{-r(T-t)}N(d_2) \\ P(s,t) &= Ke^{-r(T-t)}N(-d_2) - sN(-d_1) \end{aligned}$$ where,

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

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

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

Part – a

Historical Volatility from last 1 month (calculated using the log returns):

From basedata1:

Stock Name	Volatility
^BSESN	0.142612
ADANIPORTS.BO	0.333897
RELIANCE.BO	0.166238
BAJFINANCE.BO	0.194607
HDFCBANK.BO	0.191
TATAMOTORS.BO	0.248975
TCS.BO	0.220531
ITC.BO	0.18071
ICICIBANK.BO	0.218732
SBIN.BO	0.242258
TECHM.BO	0.261585
FEDERALBNK.BO	0.437484
DLF.BO	0.317877
BHARATFORG.BO	0.327732
VOLTAS.BO	0.225468
GAIL.BO	0.267733
ACC.BO	0.289281
NAUKRI.BO	0.275741
TATAPOWER.BO	0.346154
BANKBARODA.BO	0.420928
AMBUJACEM.BO	0.40812

From nsedata1:

Stock Name	Volatility
^NSEI	0.132233
ICICIBANK.NS	0.184463
INFY.NS	0.23567
AXISBANK.NS	0.228235
WIPRO.NS	0.183749
HDFCBANK.NS	0.18878
BHARTIARTL.NS	0.177678
CIPLA.NS	0.201046
TCS.NS	0.232786
BRITANNIA.NS	0.136333
NESTLEIND.NS	0.160851
INDUSTOWER.NS	0.161444
BANKBARODA.NS	0.4094
NAUKRI.NS	0.28545
HAVELLS.NS	0.204287
GODREJCP.NS	0.20706
ACC.NS	0.261263
DMART.NS	0.320411
GAIL.NS	0.265362
INDIGO.NS	0.326784
DLF.NS	0.266465

Part – b

Using the final value of the stock price from the dataset as S0 and taking r = 5%, K = A*S0, BSM price of six-month European Call and Put option are calculated for different values of A as **shown for some of the stocks of both BSE and NSE index:**

Prices for BSE data

Prices for ^BSESN with volatility for 1 month = 0.1554717621106569

Strike Price	Call Price	Put Price
0.5*S0	31421.7	2.22998e-08
0.6*S0	25440.2	0.000537045
0.7*S0	19459.1	0.363817
0.8*S0	13501.9	24.6709
0.9*S0	7860.18	364.467
1.0*S0	3480.62	1966.4
1.1*S0	1103.04	5570.32
1.2000000000000002*S0	249.423	10698.2
1.3*S0	41.5966	16471.9
1.4*S0	5.35357	22417.1
1.5*S0	0.55622	28393.8

Prices for ADANIPORTS.BO with volatility for 1 month = 0.32965948540406526

Strike Price	Call Price	Put Price
0.5*S0	422.697	0.0382393
0.6*S0	342.739	0.537782
0.7*S0	265.105	3.36272
0.8*S0	193.727	12.4422
0.9*S0	133.164	32.3375
1.0*S0	86.2146	65.8465
1.1*S0	52.8493	112.939
1.2000000000000002*S0	30.891	171.439
1.3*S0	17.346	238.352
1.4*S0	9.42324	310.888
1.5*S0	4.98387	386.907

Prices for RELIANCE.BO with volatility for 1 month = 0.2500453834076143

Strike Price	Call Price	Put Price
0.5*S0	1304.94	0.00170018
0.6*S0	1056.65	0.117739
0.7*S0	810.157	2.03737
0.8*S0	574.144	14.4354
0.9*S0	367.737	56.4394
1.0*S0	210.414	147.529
1.1*S0	107.662	293.188
1.2000000000000002*S0	49.7327	483.67
1.3*S0	21.0201	703.369
1.4*S0	8.24433	939.004
1.5*S0	3.04026	1182.21

Prices for BAJFINANCE.BO with volatility for 1 month = 0.2988012083444412

Strike Price	Call Price	Put Price
0.5*S0	3363.63	0.0838654
0.6*S0	2725.15	1.89198
0.7*S0	2098.99	16.029
0.8*S0	1514.82	72.1489
0.9*S0	1014.94	212.561
1.0*S0	630.365	468.274
1.1*S0	364.629	842.829
1.2000000000000002*S0	198.035	1316.53
1.3*S0	101.926	1860.71
1.4*S0	50.1658	2449.24
1.5*S0	23.8051	3063.17

Prices for TATAMOTORS.BO with volatility for 1 month = 0.2927246655523704

Strike Price	Call Price	Put Price
0.5*S0	200.331	0.00371194
0.6*S0	162.286	0.093529
0.7*S0	124.908	0.850487
0.8*S0	89.9289	4.00583
0.9*S0	59.934	12.1455
1.0*S0	36.8898	27.236
1.1*S0	21.0642	49.545
1.2000000000000002*S0	11.2512	77.8666
1.3*S0	5.67639	110.426
1.4*S0	2.73085	145.615
1.5*S0	1.26369	182.283

Prices for TCS.BO with volatility for 1 month = 0.2213638016303931

Strike Price	Call Price	Put Price
0.5*S0	1683.05	0.000161014
0.6*S0	1362.7	0.0310554
0.7*S0	1043.3	1.02632
0.8*S0	732.789	10.9032
0.9*S0	456.03	54.5339
1.0*S0	245.519	164.412
1.1*S0	113.766	353.049
1.2000000000000002*S0	45.8112	605.483
1.3*S0	16.3064	896.367
1.4*S0	5.22896	1205.68
1.5*S0	1.53814	1522.38

Prices for HDFCBANK.BO with volatility for 1 month = 0.20540797474483166

Strike Price	Call Price	Put Price
0.5*S0	842.039	1.1962e-05
0.6*S0	681.752	0.0049408
0.7*S0	521.718	0.263606
0.8*S0	364.933	3.76999
0.9*S0	223.397	22.5271
1.0*S0	115.649	75.0706
1.1*S0	50.0645	169.779
1.2000000000000002*S0	18.2879	298.294
1.3*S0	5.74894	446.047
1.4*S0	1.59112	602.182
1.5*S0	0.396318	761.279

Prices for ITC.BO with volatility for 1 month = 0.19483306463607578

Strike Price	Call Price	Put Price
0.5*S0	171.764	5.38289e-07
0.6*S0	139.067	0.000409105
0.7*S0	106.401	0.0320002
0.8*S0	74.2515	0.579639
0.9*S0	44.9585	3.98388
1.0*S0	22.6207	14.3434
1.1*S0	9.2992	33.7191
1.2000000000000002*S0	3.14889	60.2661
1.3*S0	0.897605	90.712
1.4*S0	0.221056	122.733
1.5*S0	0.0482327	155.257

Prices for ICICIBANK.BO with volatility for 1 month = 0.2237819359954012

Strike Price	Call Price	Put Price
0.5*S0	465.235	5.75143e-05
0.6*S0	376.682	0.0100215
0.7*S0	288.42	0.310658
0.8*S0	202.717	3.17127
0.9*S0	126.468	15.485
1.0*S0	68.4692	46.0494
1.1*S0	32.0265	98.1697
1.2000000000000002*S0	13.0686	167.775
1.3*S0	4.73043	248
1.4*S0	1.54721	333.379
1.5*S0	0.465381	420.861

Prices for SBIN.BO with volatility for 1 month = 0.24290587790116172

Strike Price	Call Price	Put Price
0.5*S0	315.451	0.000232135
0.6*S0	255.421	0.02007
0.7*S0	195.751	0.399689
0.8*S0	138.395	3.09355
0.9*S0	88.02	12.7685
1.0*S0	49.6571	34.4554
1.1*S0	24.8461	69.6943
1.2000000000000002*S0	11.133	116.031
1.3*S0	4.53112	169.479
1.4*S0	1.70061	226.698
1.5*S0	0.596994	285.644

Prices for NSE data:

Prices for ^NSEI with volatility for 1 month = 0.15297145612974186

Strike Price	Call Price	Put Price
0.5*S0	9354.96	3.13663e-09
0.6*S0	7574.13	0.000103298
0.7*S0	5793.39	0.085042
0.8*S0	4018.97	6.49191
0.9*S0	2334.26	102.614
1.0*S0	1023.89	573.071
1.1*S0	317.582	1647.59
1.2000000000000002*S0	69.345	3180.18
1.3*S0	11.029	4902.69
1.4*S0	1.33944	6673.83
1.5*S0	0.130183	8453.45

Prices for ICICIBANK.NS with volatility for 1 month = 0.21858748394703986

Strike Price	Call Price	Put Price
0.5*S0	465.466	3.28533e-05
0.6*S0	376.866	0.00714984
0.7*S0	288.507	0.254959
0.8*S0	202.485	2.83986
0.9*S0	125.652	14.6141
1.0*S0	67.2091	44.7782
1.1*S0	30.7999	96.9758
1.2000000000000002*S0	12.2094	166.992
1.3*S0	4.26038	247.65
1.4*S0	1.33448	333.331
1.5*S0	0.382297	420.986

Prices for INFY.NS with volatility for 1 month = 0.26006040890632415

Strike Price	Call Price	Put Price
0.5*S0	782.865	0.00211646
0.6*S0	633.946	0.110602
0.7*S0	486.409	1.60084
0.8*S0	345.915	10.1337
0.9*S0	223.715	36.961
1.0*S0	130.437	92.711
1.1*S0	68.7158	180.017
1.2000000000000002*S0	33.0147	293.343
1.3*S0	14.6463	424.002
1.4*S0	6.07667	564.46
1.5*S0	2.38601	709.796

Prices for AXISBANK.NS with volatility for 1 month = 0.26177832529214257

Strike Price	Call Price	Put Price
0.5*S0	482.246	0.00146646
0.6*S0	390.517	0.0732522
0.7*S0	299.673	1.03029
0.8*S0	213.246	6.40475
0.9*S0	138.14	23.0996
1.0*S0	80.7941	57.5545
1.1*S0	42.7665	111.328
1.2000000000000002*S0	20.6787	181.041
1.3*S0	9.24567	261.409
1.4*S0	3.87088	347.836
1.5*S0	1.53532	437.301

Prices for WIPRO.NS with volatility for 1 month = 0.2300584395559867

Strike Price	Call Price	Put Price
0.5*S0	201.352	4.67749e-05
0.6*S0	163.028	0.00635334
0.7*S0	124.861	0.16832
0.8*S0	87.9204	1.55781
0.9*S0	55.2018	7.16897
1.0*S0	30.3099	20.6067
1.1*S0	14.5136	43.1401
1.2000000000000002*S0	6.12001	73.0762
1.3*S0	2.30878	107.595
1.4*S0	0.792809	144.408
1.5*S0	0.251888	182.197

Prices for HDFCBANK.NS with volatility for 1 month = 0.206138626174279

Strike Price	Call Price	Put Price
0.5*S0	842.808	1.31851e-05
0.6*S0	682.374	0.00523909
0.7*S0	522.203	0.272802
0.8*S0	365.335	3.8432
0.9*S0	223.813	22.7597
1.0*S0	116.083	75.4682
1.1*S0	50.4218	170.245
1.2000000000000002*S0	18.5085	298.77
1.3*S0	5.85483	446.555
1.4*S0	1.63254	602.771
1.5*S0	0.410078	761.987

Prices for BHARTIARTL.NS with volatility for 1 month = 0.21956456001886865

Strike Price	Call Price	Put Price
0.5*S0	422.531	3.32324e-05
0.6*S0	342.104	0.00692785
0.7*S0	261.904	0.240442
0.8*S0	183.863	2.63341
0.9*S0	114.211	13.4151
1.0*S0	61.2307	40.8688
1.1*S0	28.1706	88.2425
1.2000000000000002*S0	11.2296	151.735
1.3*S0	3.94629	224.886
1.4*S0	1.24647	302.62
1.5*S0	0.360464	382.168

Prices for CIPLA.NS with volatility for 1 month = 0.22023861187177443

Strike Price	Call Price	Put Price
0.5*S0	560.992	4.75066e-05
0.6*S0	454.21	0.00961714
0.7*S0	347.737	0.327666
0.8*S0	244.165	3.54768
0.9*S0	151.774	17.948
1.0*S0	81.498	54.4636
1.1*S0	37.5961	117.353
1.2000000000000002*S0	15.0441	201.593
1.3*S0	5.31237	298.653
1.4*S0	1.68756	401.819
1.5*S0	0.491169	507.415

Prices for TCS.NS with volatility for 1 month = 0.2339500869282435

Strike Price	Call Price	Put Price
0.5*S0	1683.59	0.000564952
0.6*S0	1363.17	0.0664052
0.7*S0	1044.21	1.6058
0.8*S0	736.154	14.0372
0.9*S0	464.024	62.3994
1.0*S0	256.944	175.812
1.1*S0	124.752	364.111
1.2000000000000002*S0	53.628	613.479
1.3*S0	20.7261	901.068
1.4*S0	7.32186	1208.16
1.5*S0	2.4016	1523.73

Prices for BRITANNIA.NS with volatility for 1 month = 0.2296413769826725

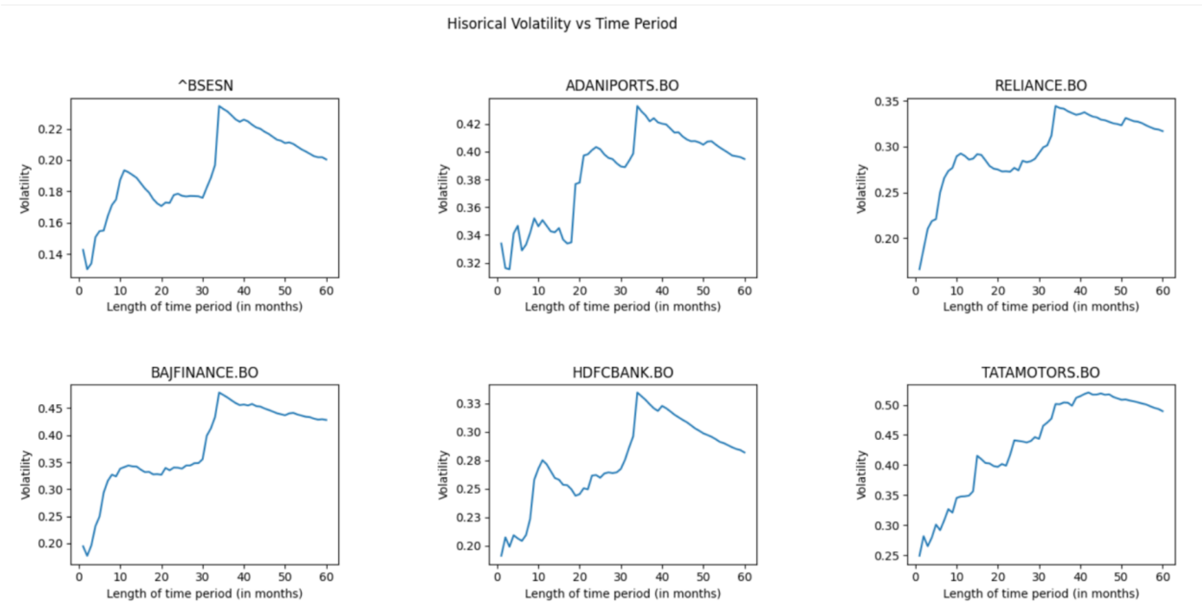
Strike Price	Call Price	Put Price
0.5*S0	2231.37	0.000497814
0.6*S0	1806.67	0.0687025
0.7*S0	1383.67	1.83853
0.8*S0	974.187	17.1229
0.9*S0	611.396	79.0991
1.0*S0	335.394	227.864
1.1*S0	160.357	477.593
1.2000000000000002*S0	67.4758	809.479
1.3*S0	25.3878	1192.16
1.4*S0	8.69073	1600.23
1.5*S0	2.75152	2019.06

Part – c

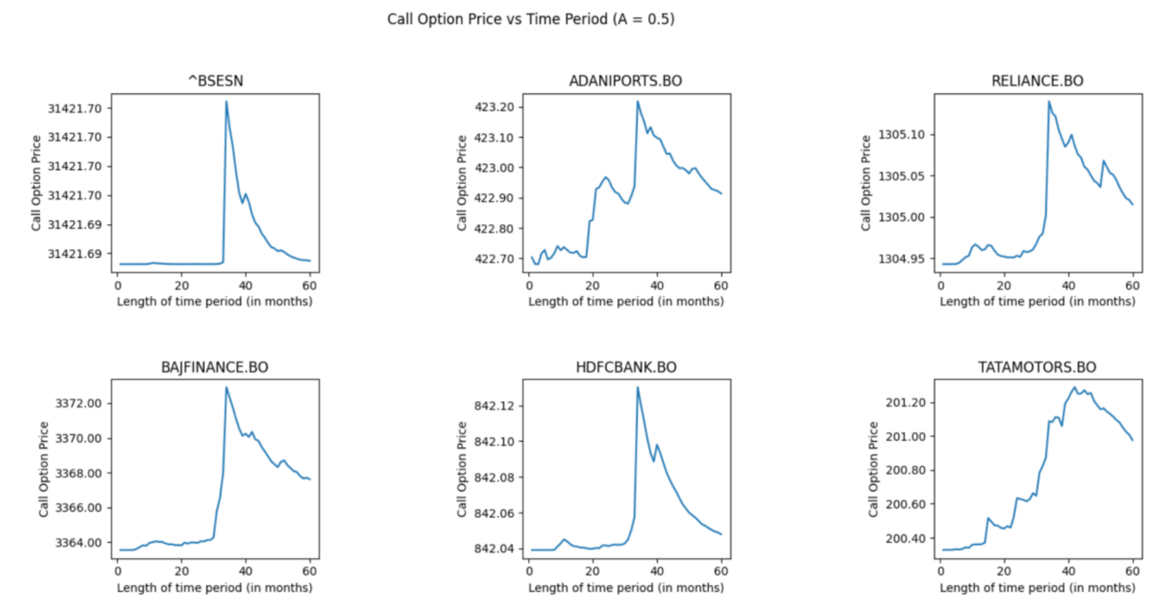
Plots for Option Prices and Volatility for some of the stocks:

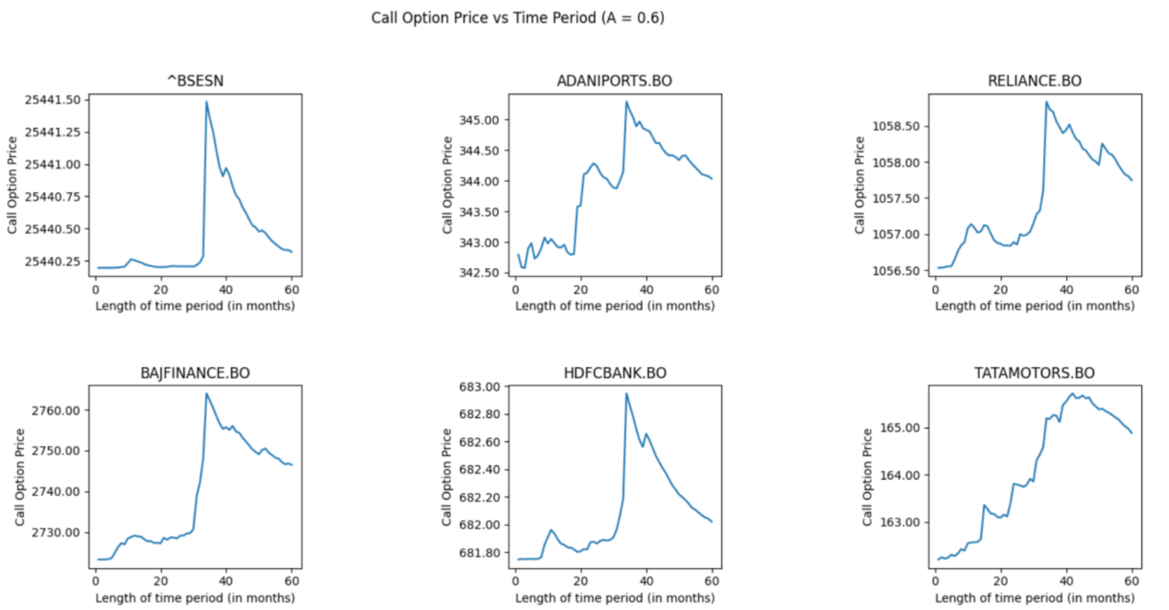
bsedata1:

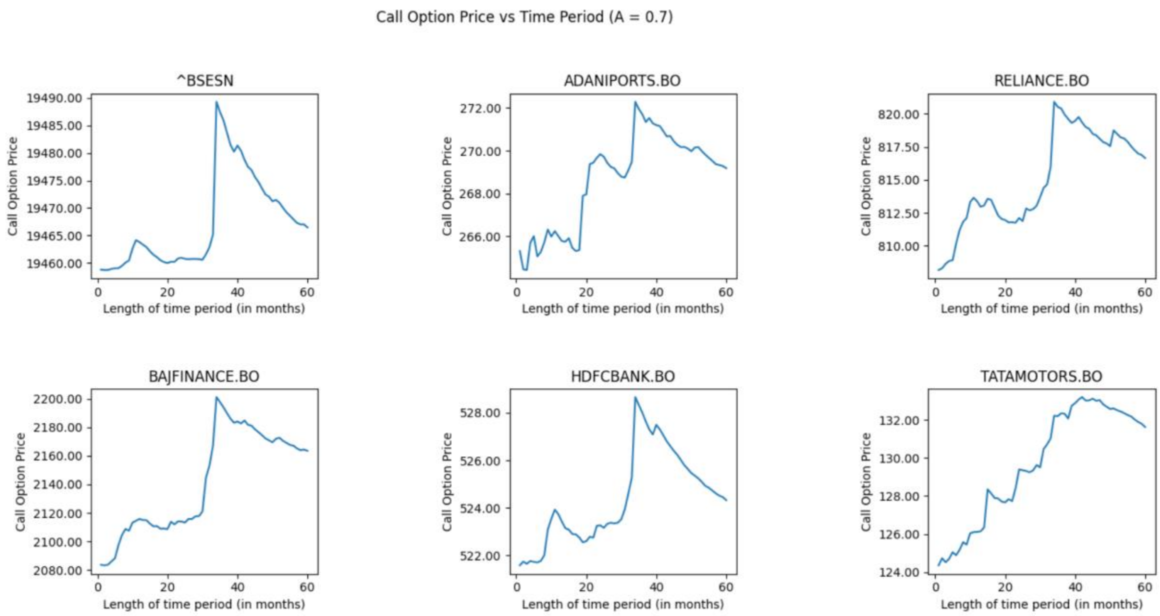
Volatility Plots

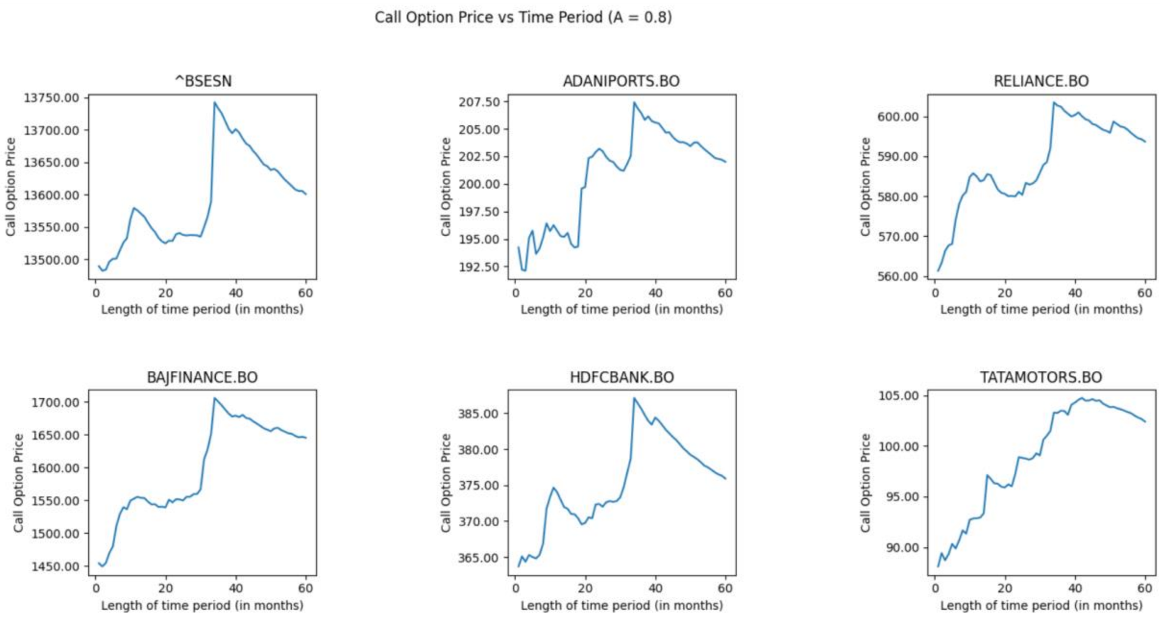


Call Option Price Plots

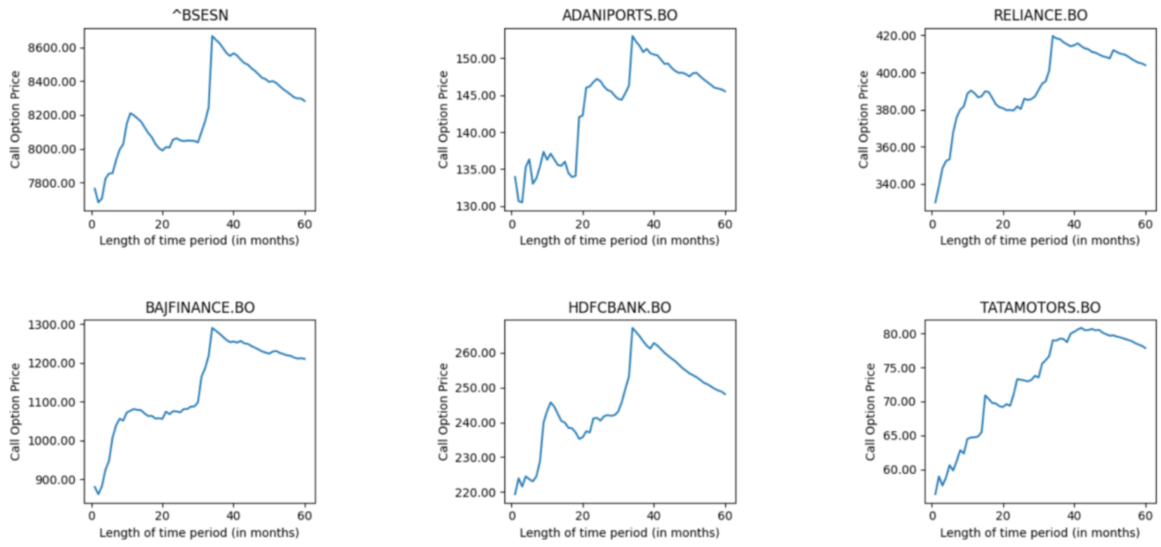

Call Option Price vs Time Period (A = 0.5)
^BSESN
ADANIPORTS.BO
RELIANCE.BO
BAJFINANCE.BO
HDFCBANK.BO
TATAMOTORS.BO
Call Option Price
Length of time period (in months)


Call Option Price vs Time Period (A = 0.6)
^BSESN
ADANIPORTS.BO
RELIANCE.BO
BAJFINANCE.BO
HDFCBANK.BO
TATAMOTORS.BO
Call Option Price
Length of time period (in months)

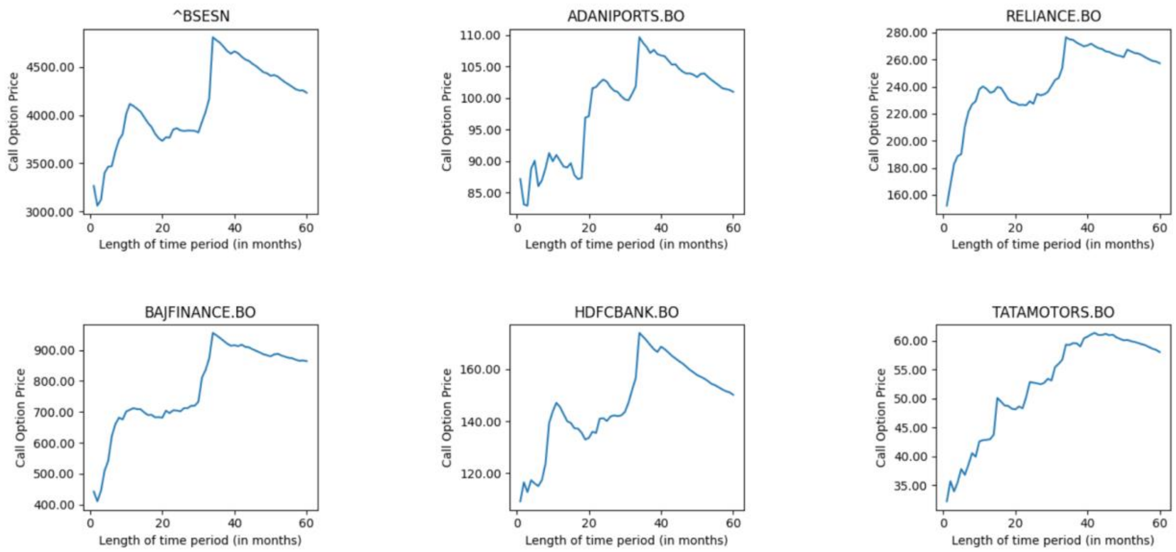

Call Option Price vs Time Period (A = 0.7)
^BSESN
ADANIPORTS.BO
RELIANCE.BO
BAJFINANCE.BO
HDFCBANK.BO
TATAMOTORS.BO
Call Option Price
Length of time period (in months)


Call Option Price vs Time Period (A = 0.8)
^BSESN
ADANIPORTS.BO
RELIANCE.BO
BAJFINANCE.BO
HDFCBANK.BO
TATAMOTORS.BO
Call Option Price
Length of time period (in months)

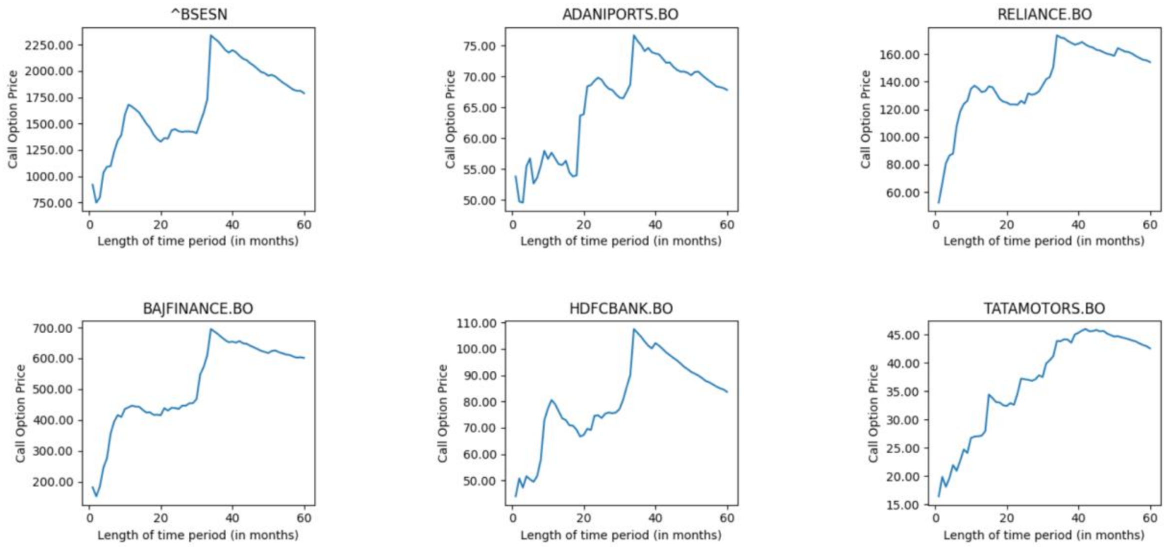
Call Option Price vs Time Period (A = 0.9)



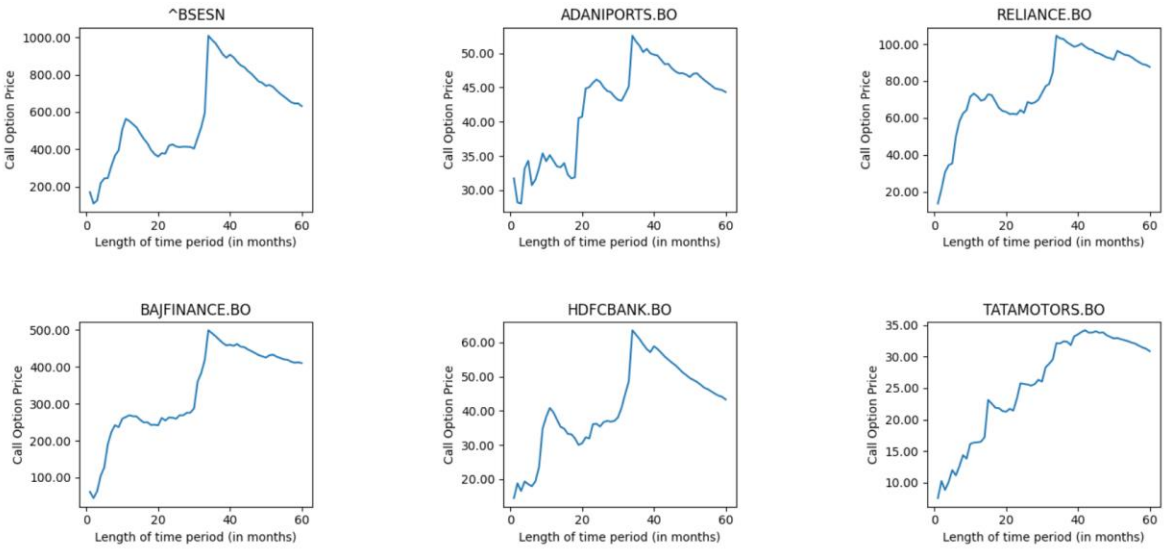
Call Option Price vs Time Period (A = 1.0)

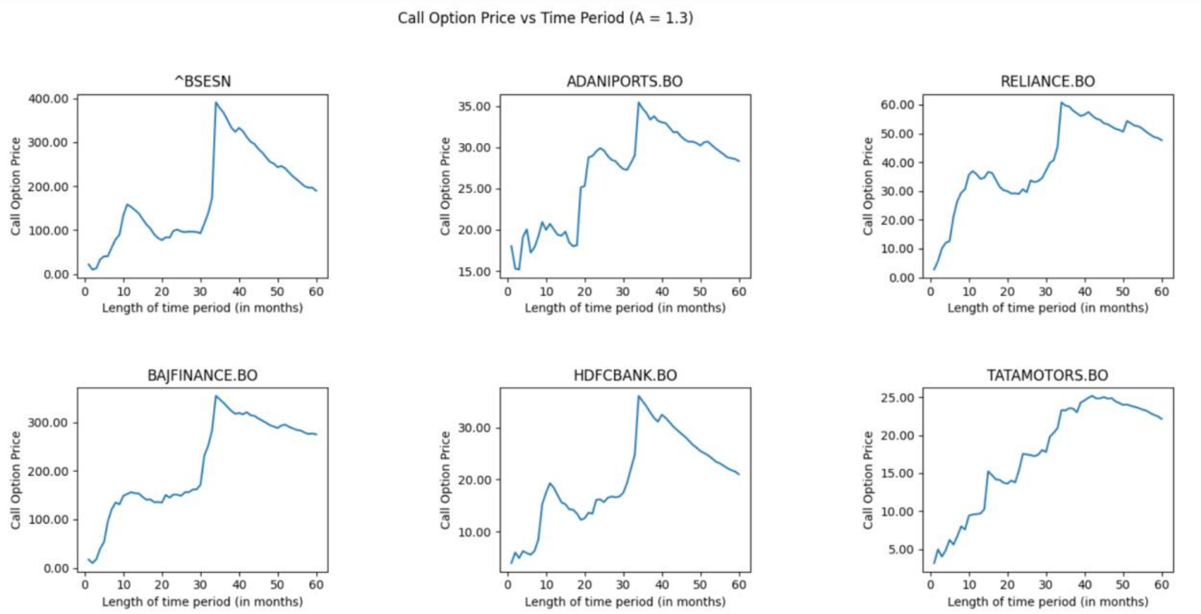


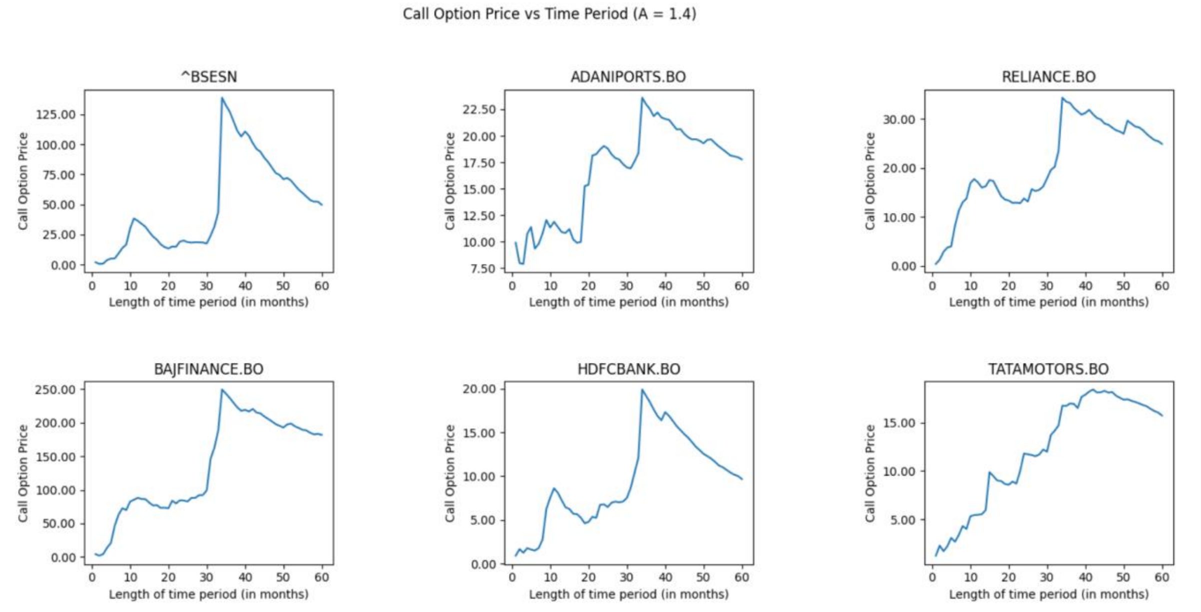
Call Option Price vs Time Period (A = 1.1)

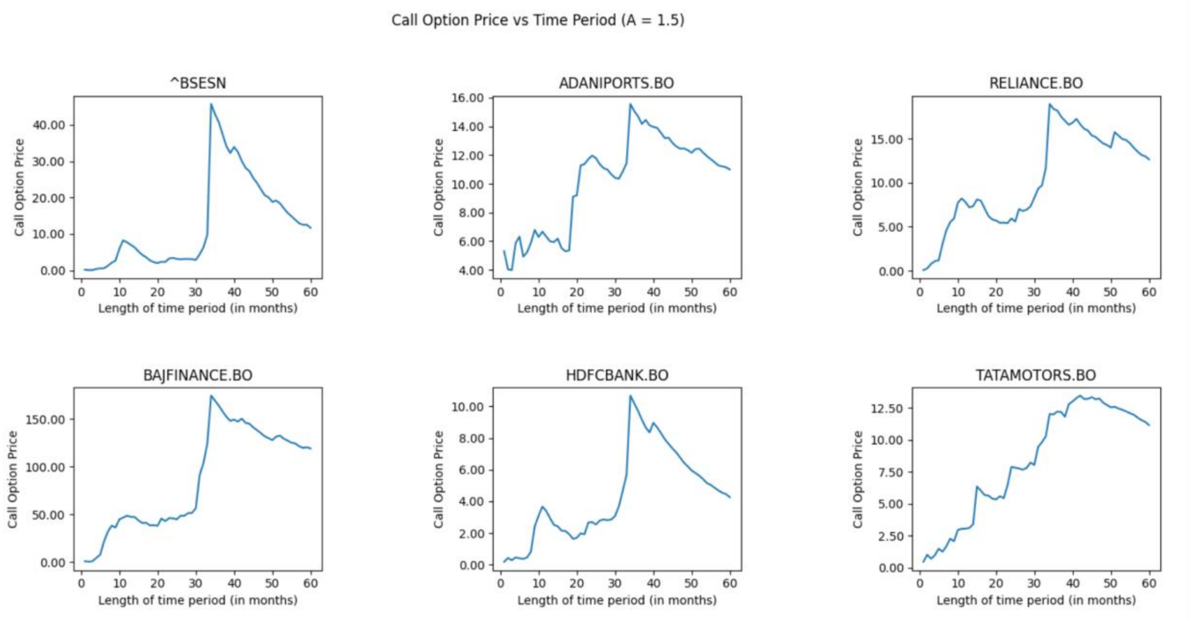


Call Option Price vs Time Period (A = 1.2)



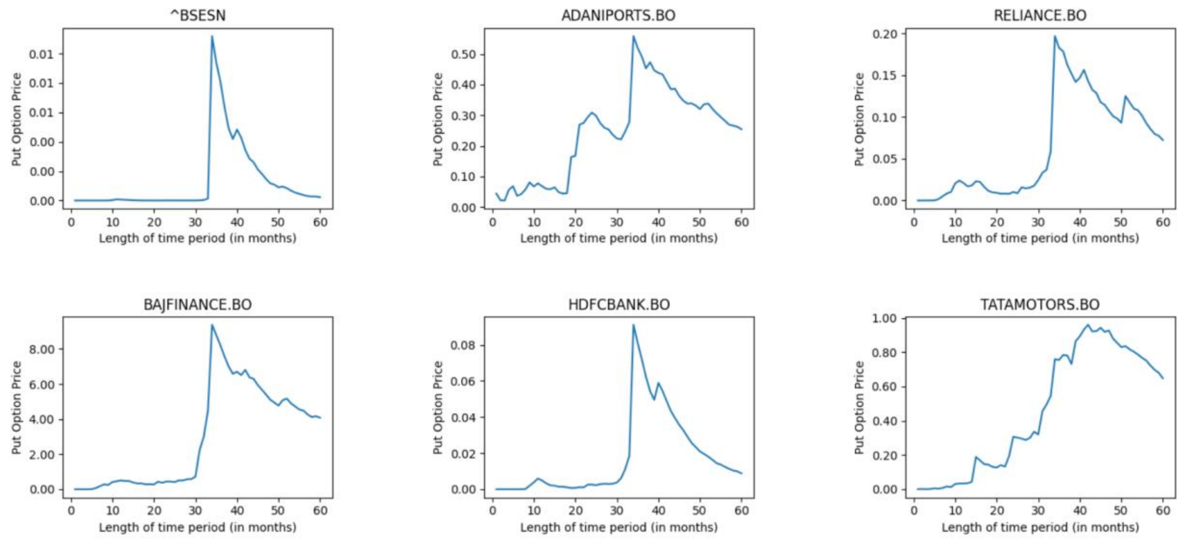

Call Option Price vs Time Period (A = 1.3)
^BSESN
ADANIPORTS.BO
RELIANCE.BO
BAJFINANCE.BO
HDFCBANK.BO
TATAMOTORS.BO
Call Option Price
Length of time period (in months)


Call Option Price vs Time Period (A = 1.4)
^BSESN
ADANIPORTS.BO
RELIANCE.BO
BAJFINANCE.BO
HDFCBANK.BO
TATAMOTORS.BO
Call Option Price
Length of time period (in months)

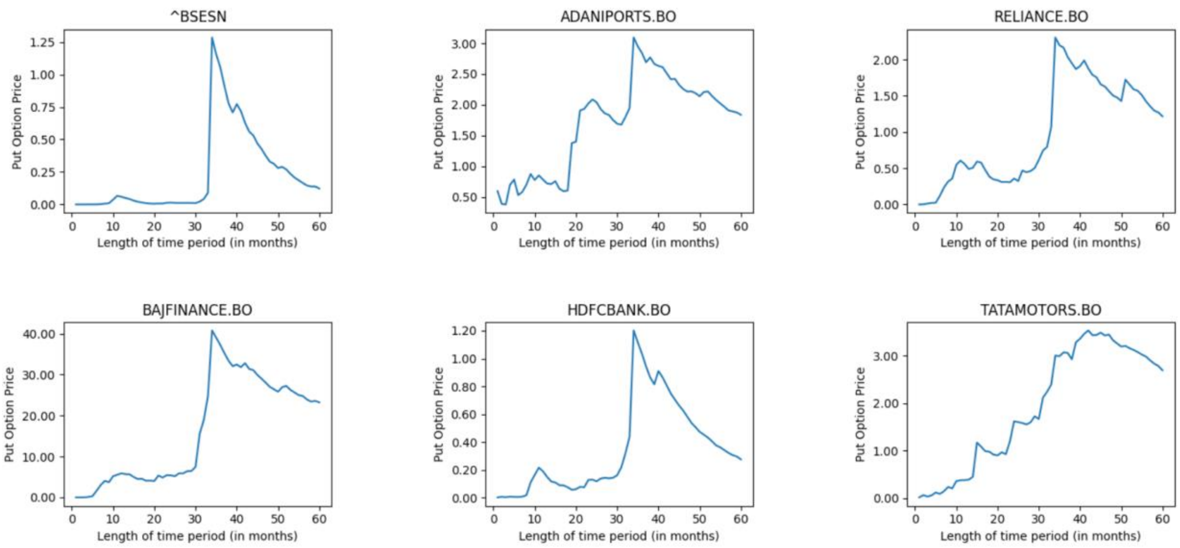


Put Option Price Plots

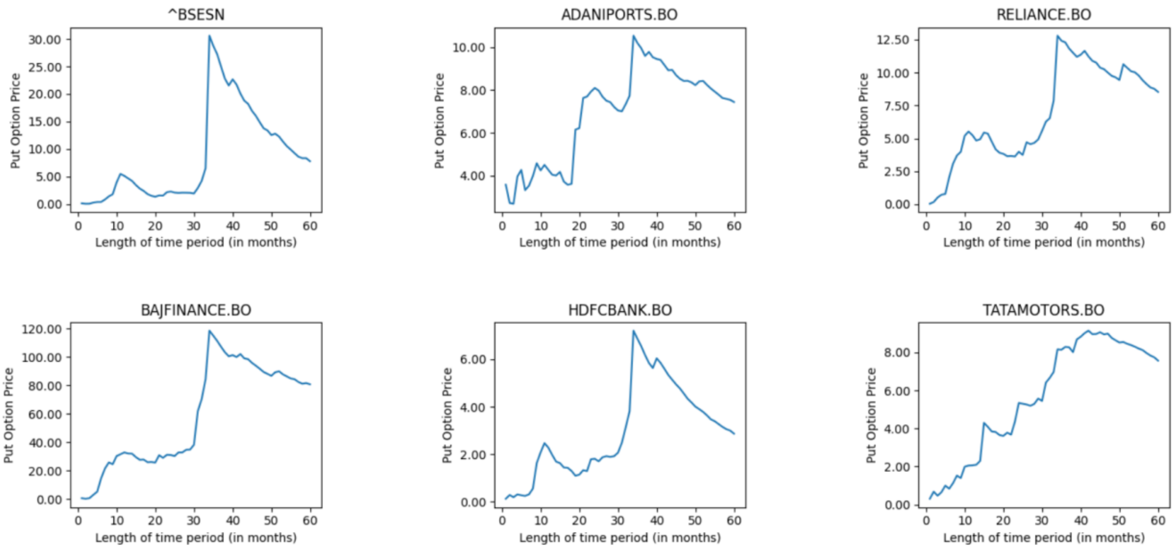
Put Option Price vs Time Period (A = 0.5)



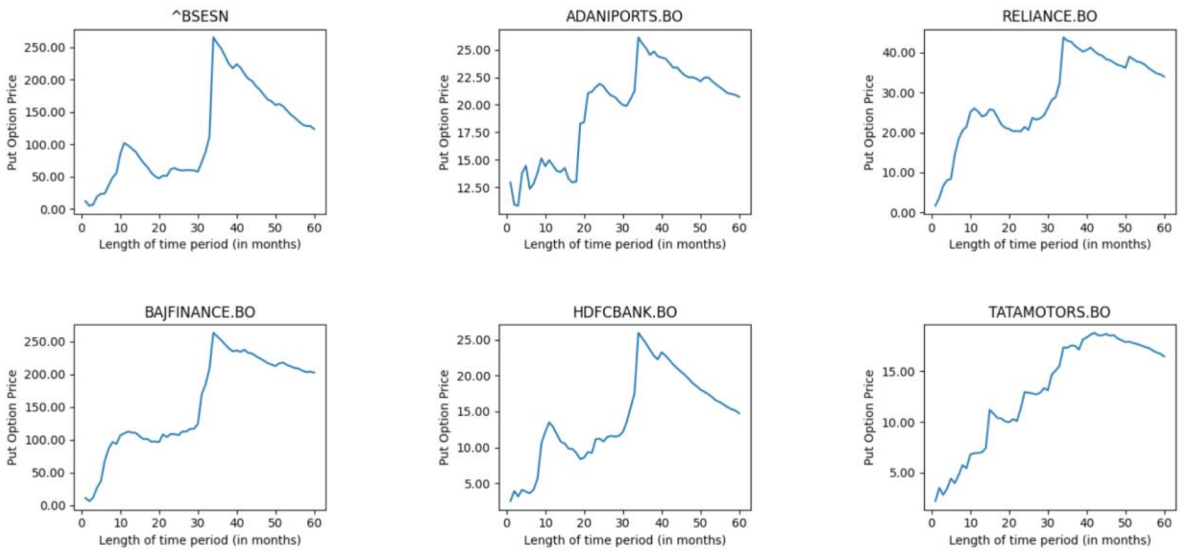
Put Option Price vs Time Period (A = 0.6)

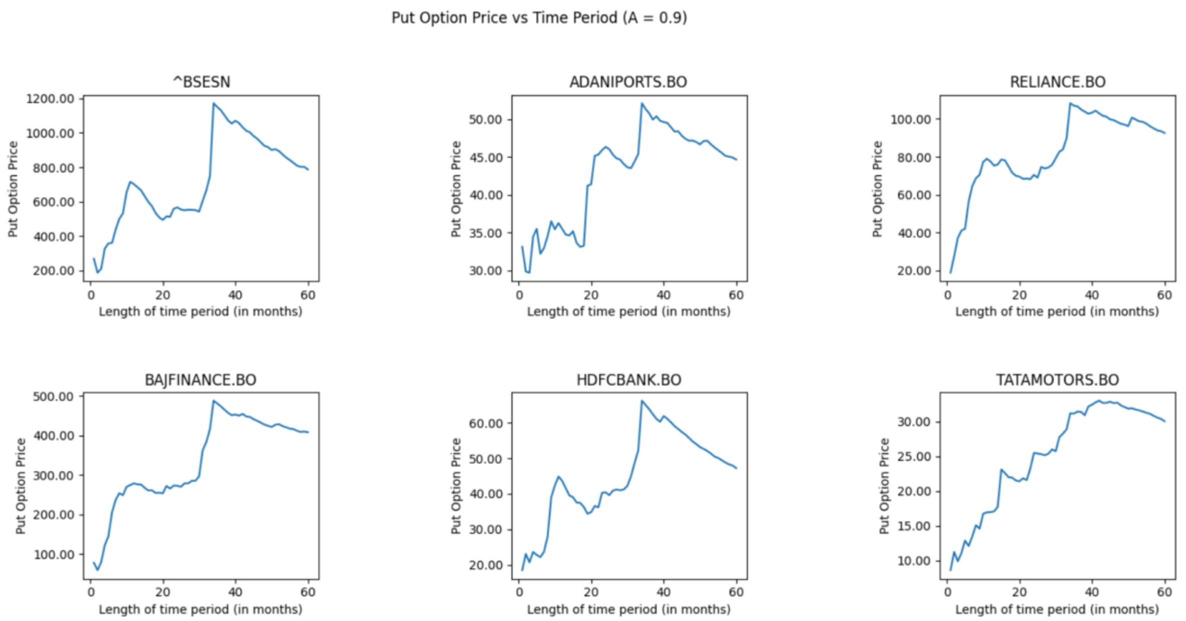


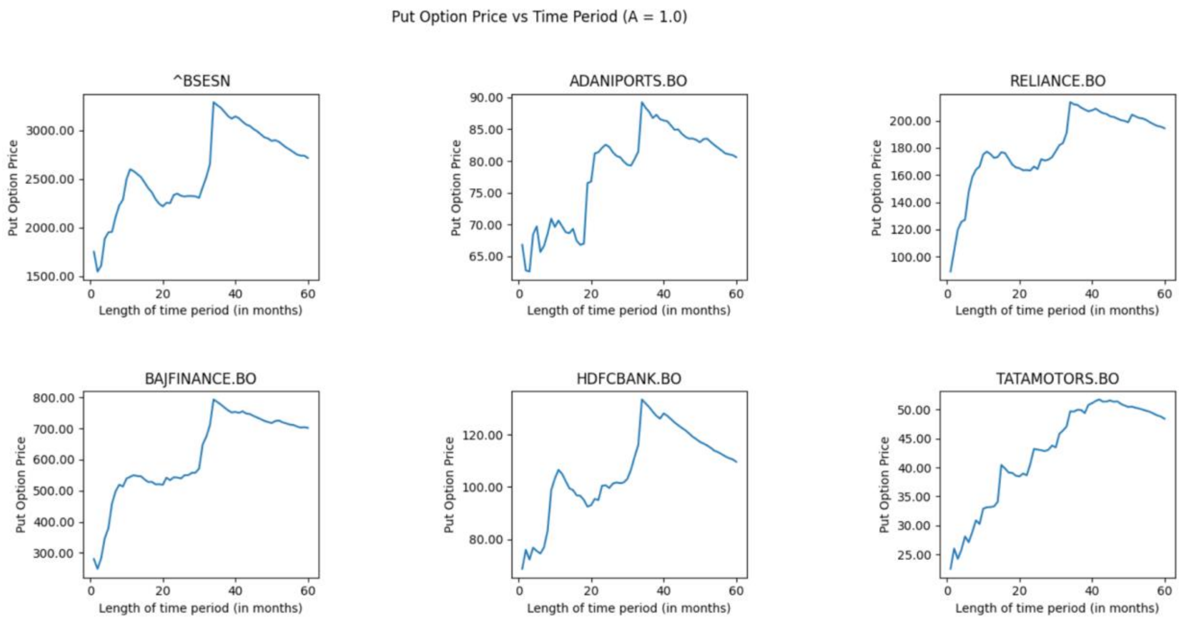
Put Option Price vs Time Period (A = 0.7)



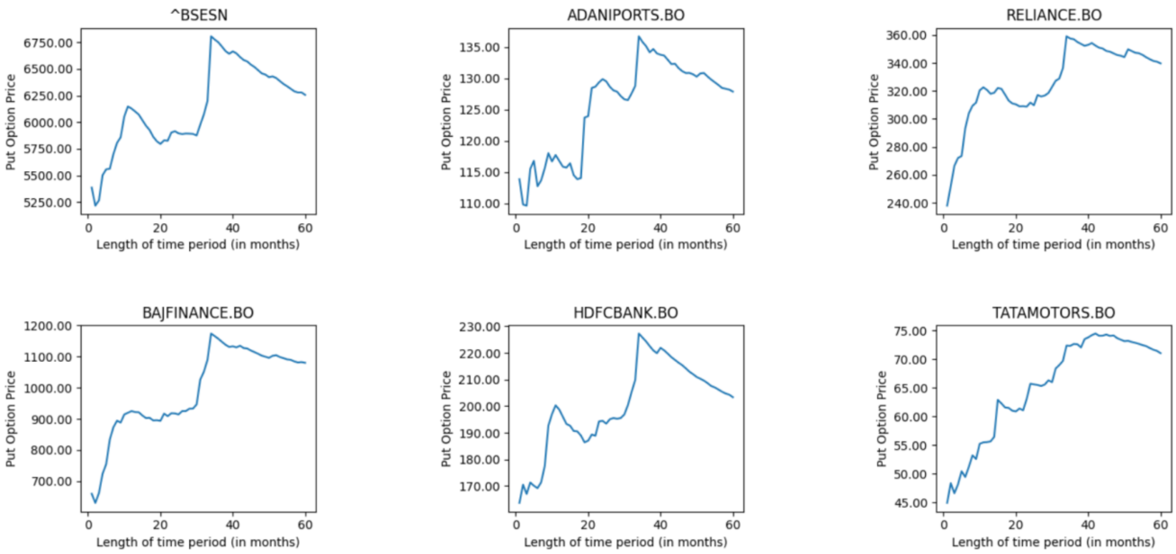
Put Option Price vs Time Period (A = 0.8)



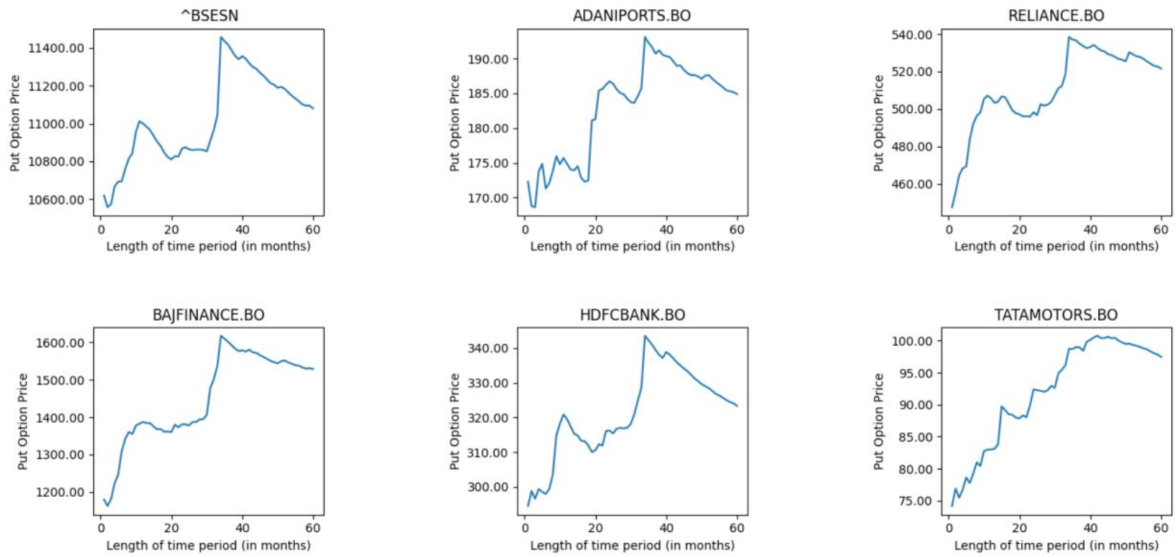

Put Option Price vs Time Period (A = 0.9)
^BSESN
ADANIPORTS.BO
RELIANCE.BO
BAJFINANCE.BO
HDFCBANK.BO
TATAMOTORS.BO
Put Option Price
Length of time period (in months)

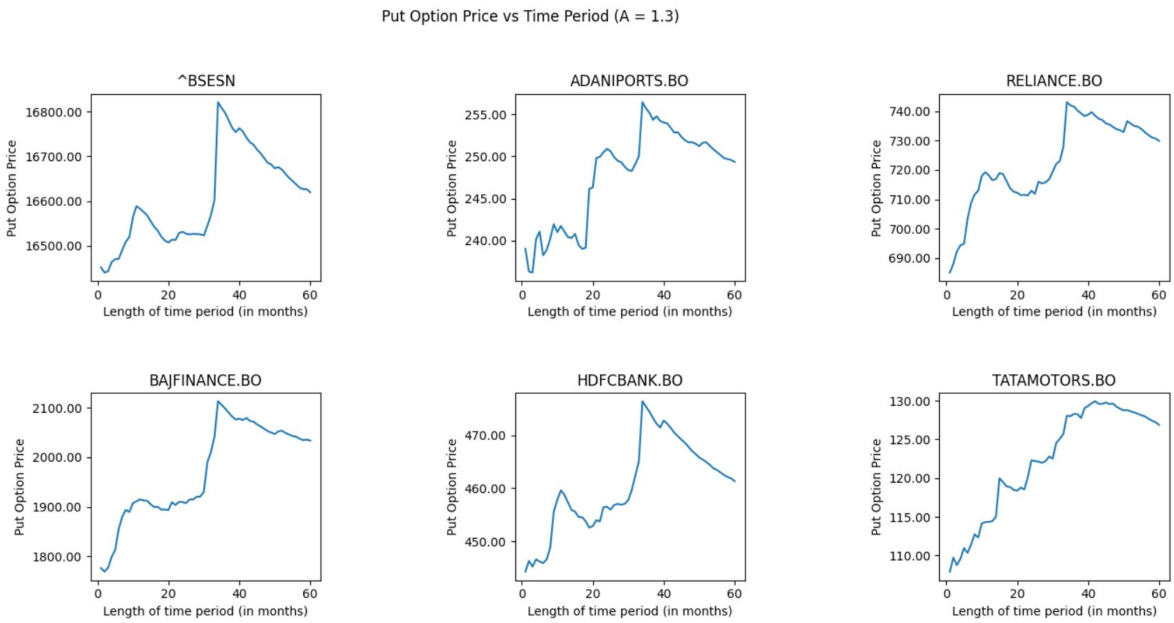

Put Option Price vs Time Period (A = 1.0)
^BSESN
ADANIPORTS.BO
RELIANCE.BO
BAJFINANCE.BO
HDFCBANK.BO
TATAMOTORS.BO
Put Option Price
Length of time period (in months)

Put Option Price vs Time Period (A = 1.1)



Put Option Price vs Time Period (A = 1.2)




Put Option Price vs Time Period (A = 1.3)
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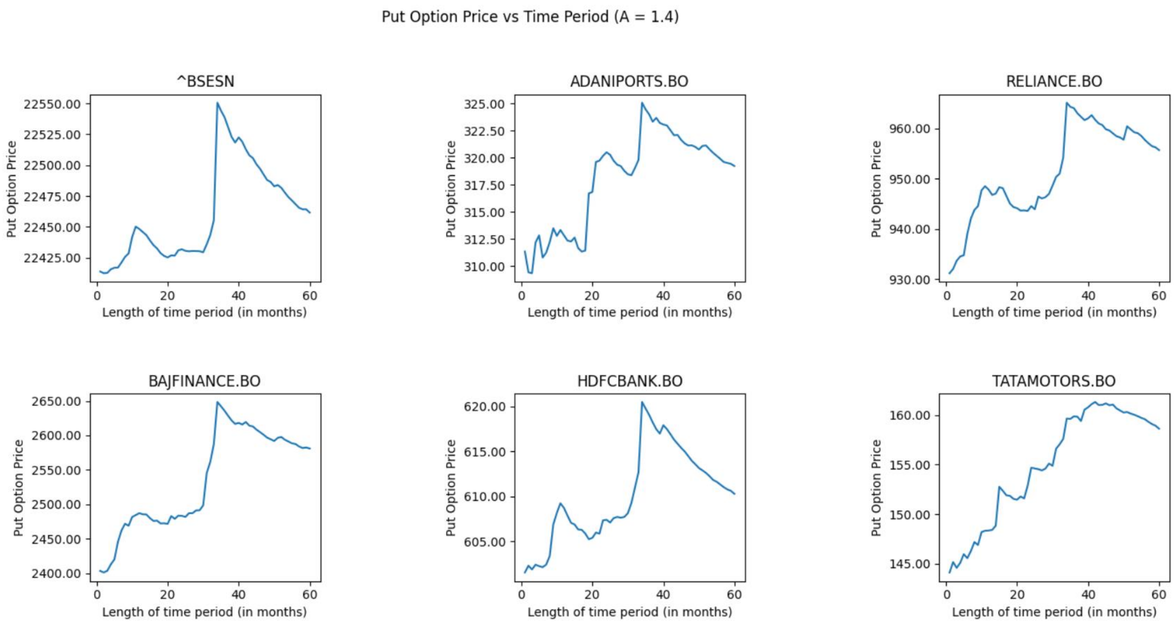
RELIANCE.BO
BAJFINANCE.BO
HDFCBANK.BO
TATAMOTORS.BO
Put Option Price
Length of time period (in months)


Put Option Price vs Time Period (A = 1.4)
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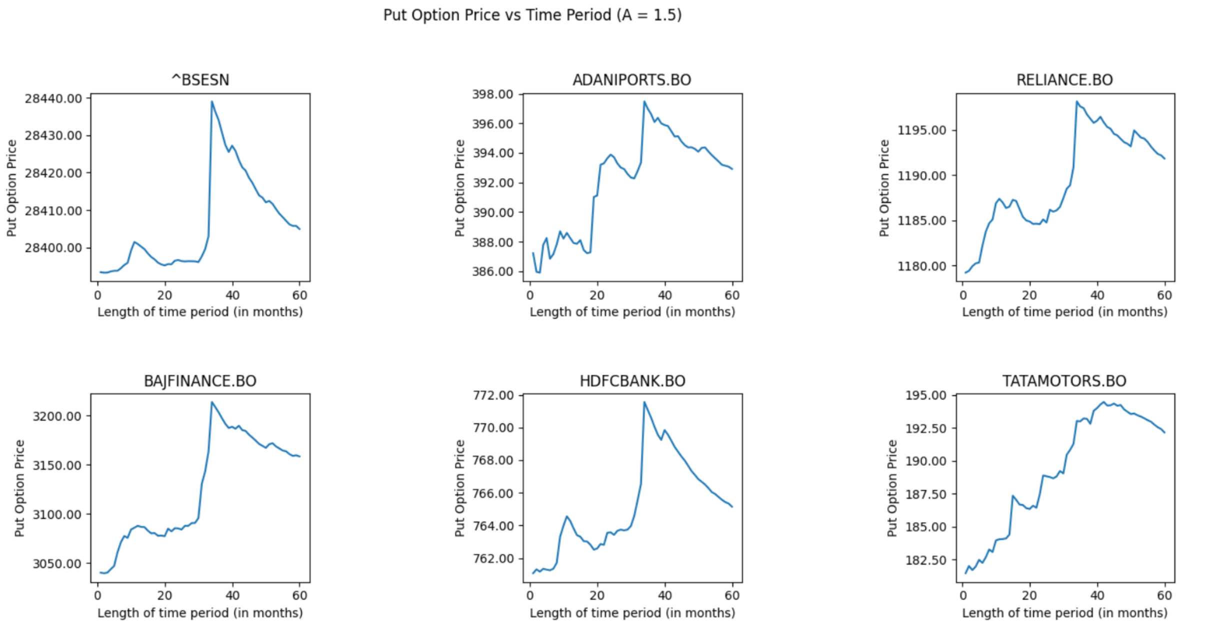
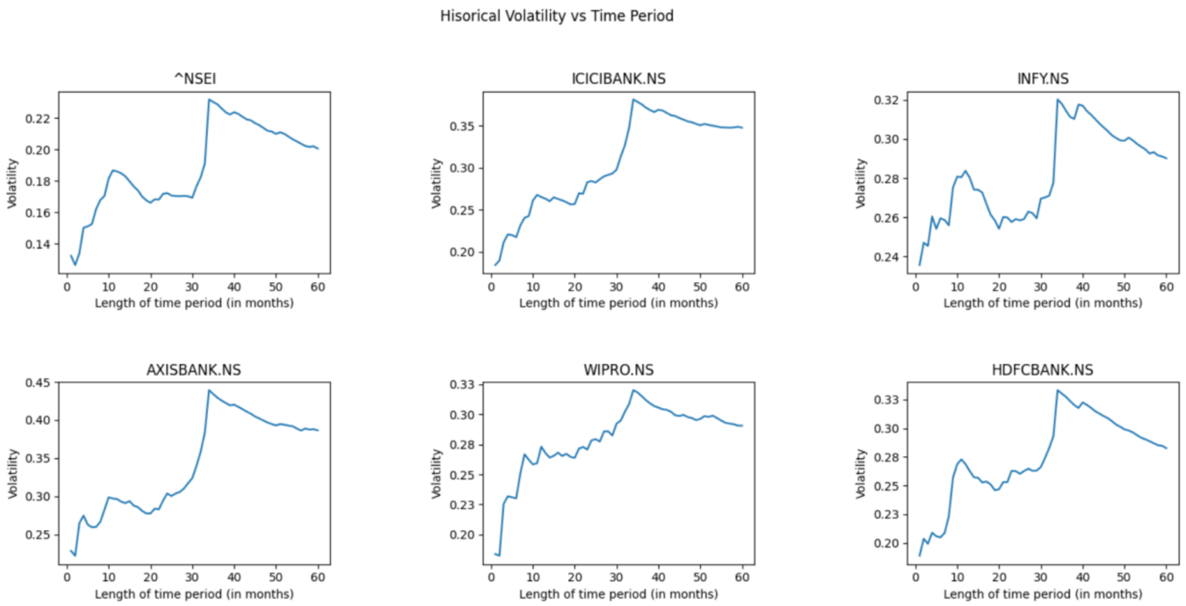
ADANIPORTS.BO
RELIANCE.BO
BAJFINANCE.BO
HDFCBANK.BO
TATAMOTORS.BO
Put Option Price
Length of time period (in months)



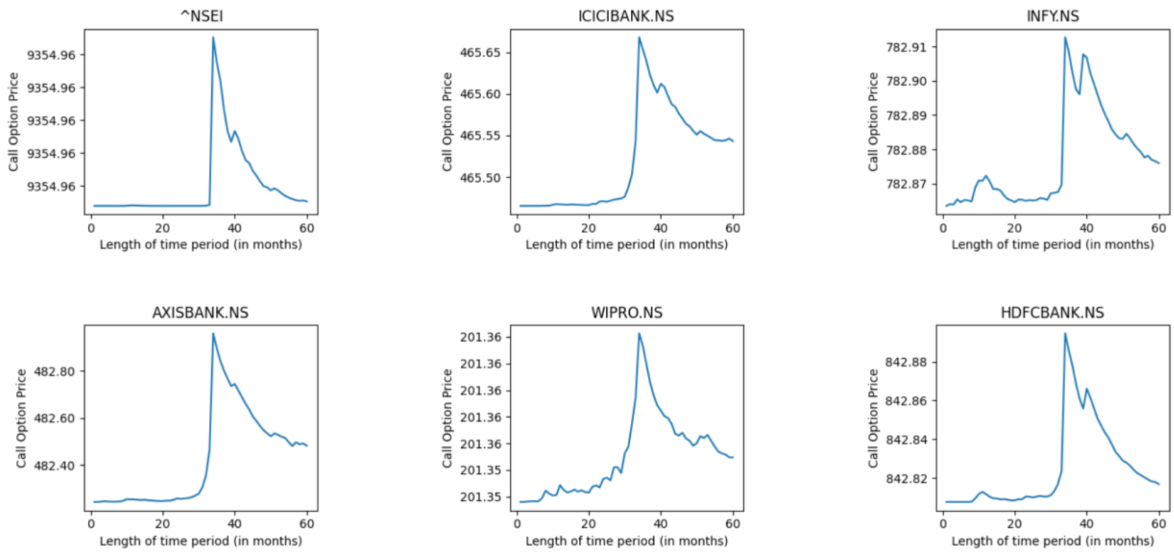
nsedata1:

Volatility Plots

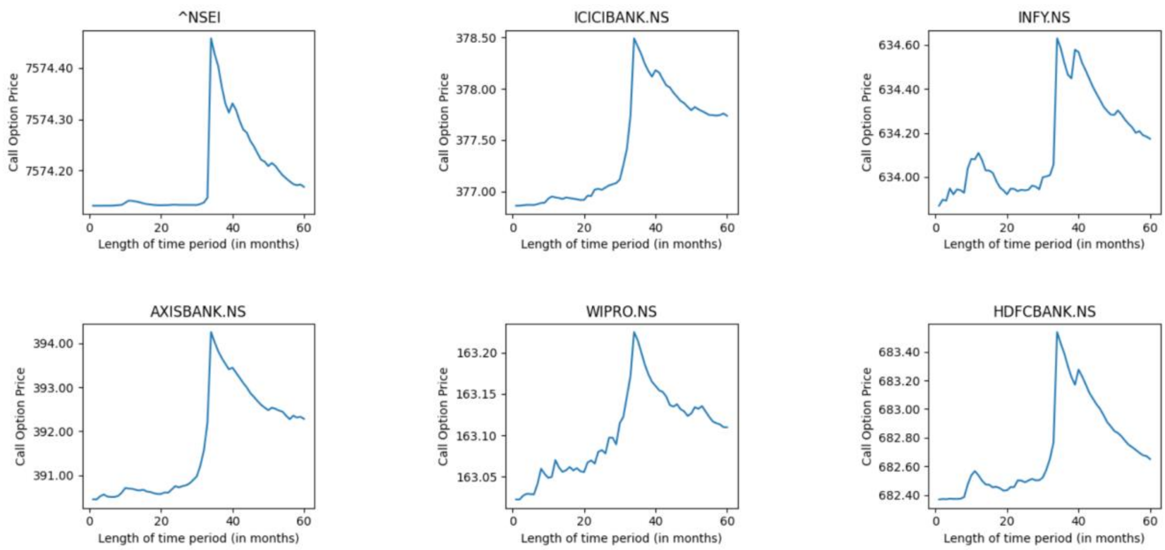


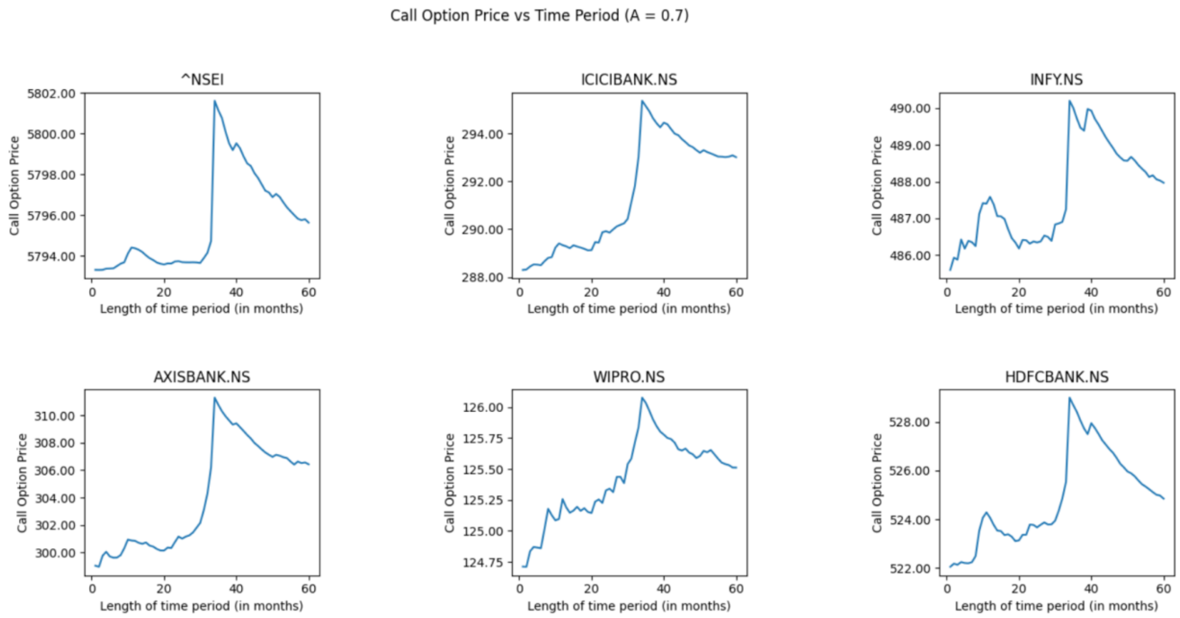
Call Option Price Plots

Call Option Price vs Time Period (A = 0.5)



Call Option Price vs Time Period (A = 0.6)




Call Option Price vs Time Period (A = 0.7)
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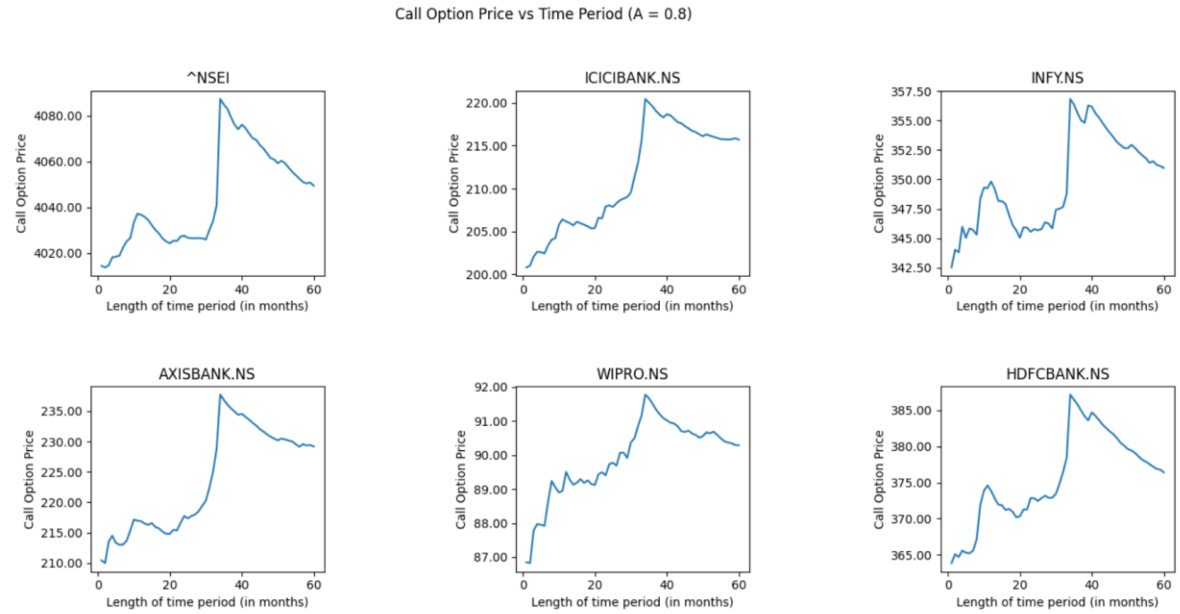
INFY.NS
AXISBANK.NS
WIPRO.NS
HDFCBANK.NS
Call Option Price
Length of time period (in months)


Call Option Price vs Time Period (A = 0.8)
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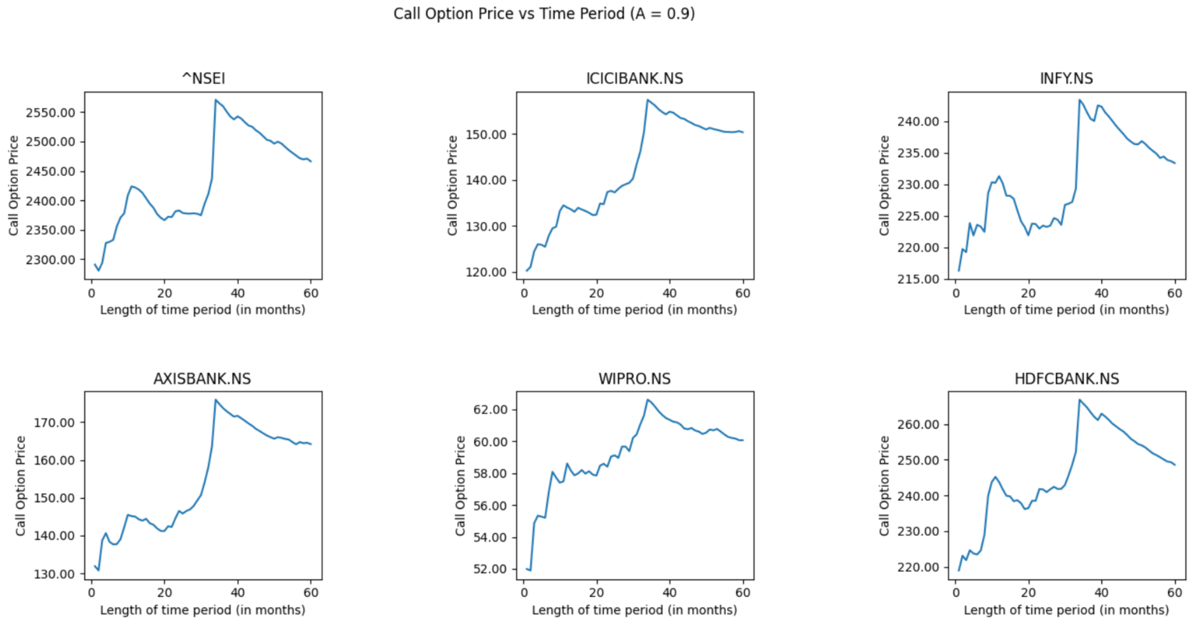
INFY.NS
AXISBANK.NS
WIPRO.NS
HDFCBANK.NS
Call Option Price
Length of time period (in months)


Call Option Price vs Time Period (A = 0.9)
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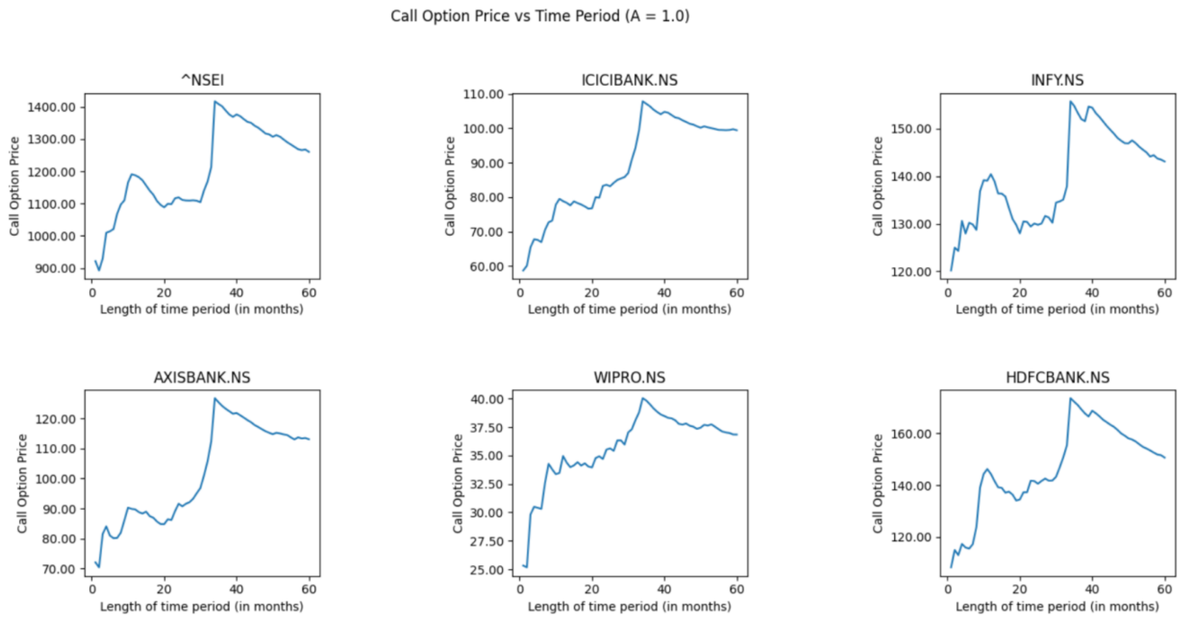
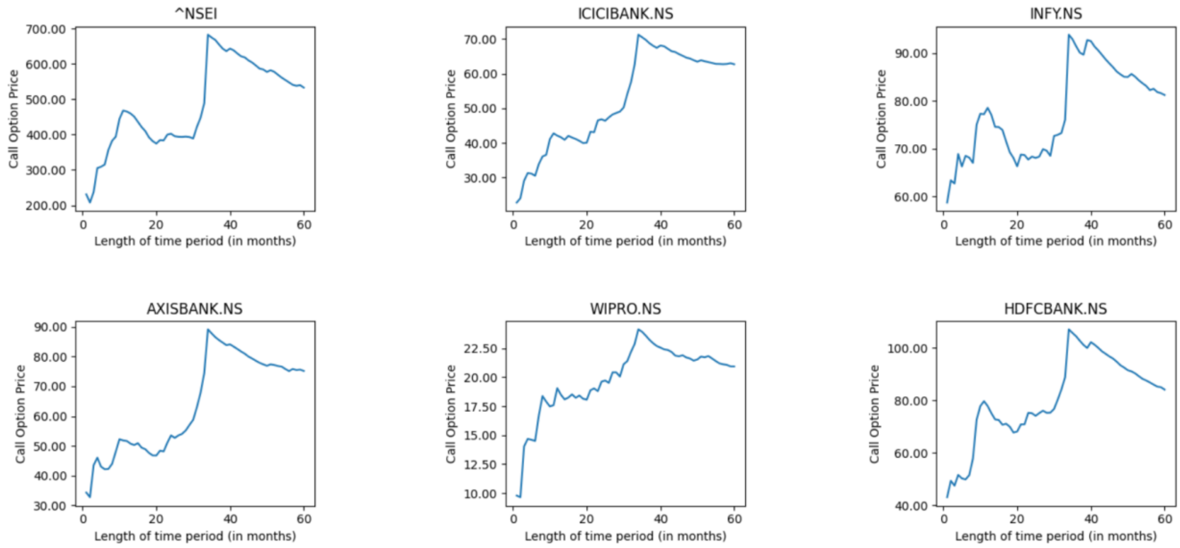
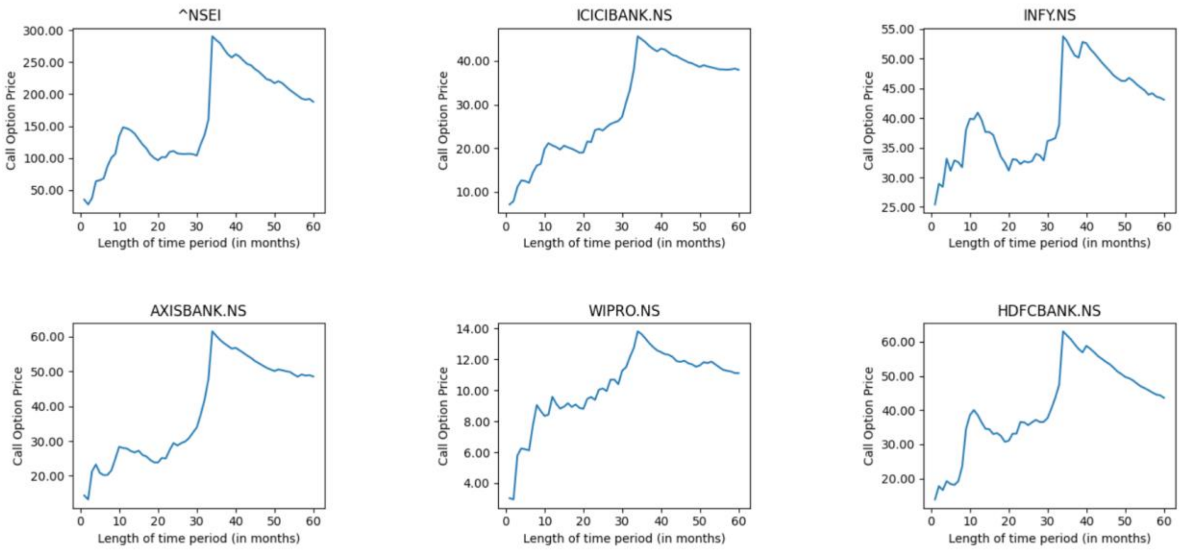
INFY.NS
AXISBANK.NS
WIPRO.NS
HDFCBANK.NS
Call Option Price
Length of time period (in months)


Call Option Price vs Time Period (A = 1.0)
^NSEI
ICICIBANK.NS
INFY.NS
AXISBANK.NS
WIPRO.NS
HDFCBANK.NS
Call Option Price
Length of time period (in months)

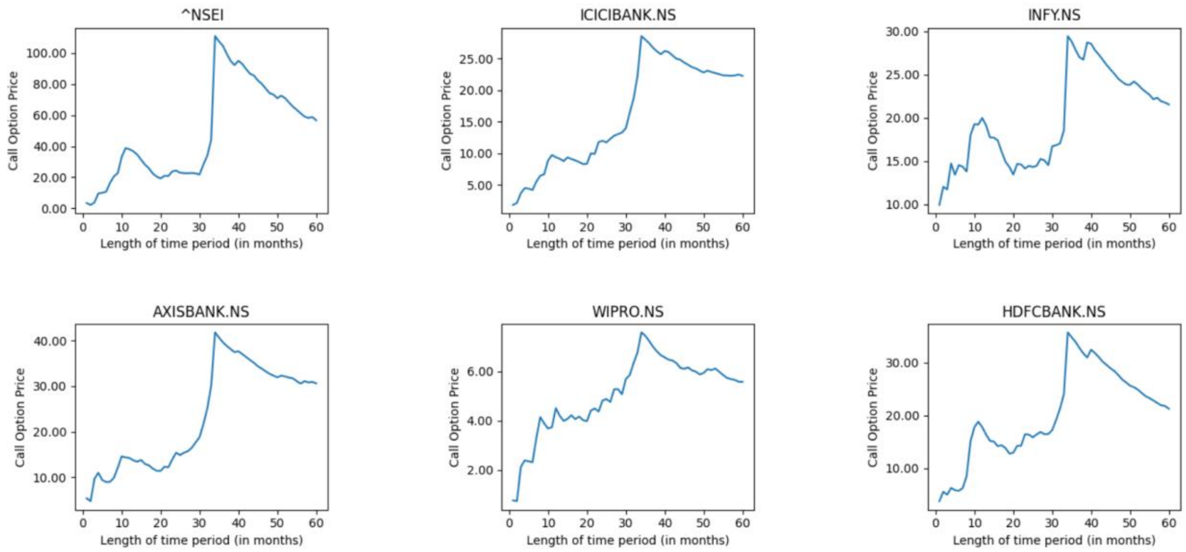
Call Option Price vs Time Period (A = 1.1)



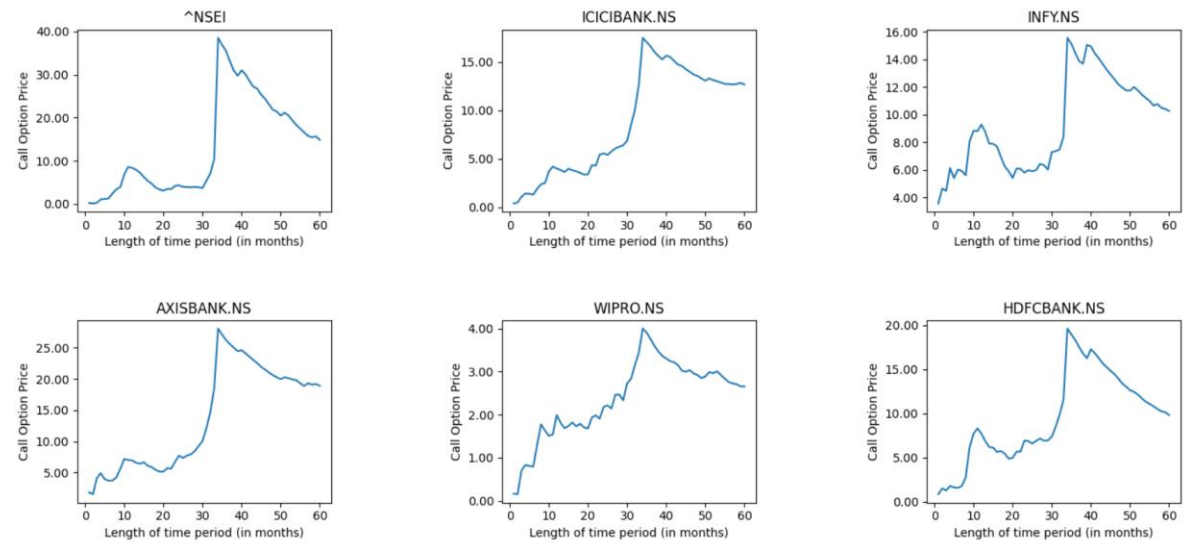
Call Option Price vs Time Period (A = 1.2)



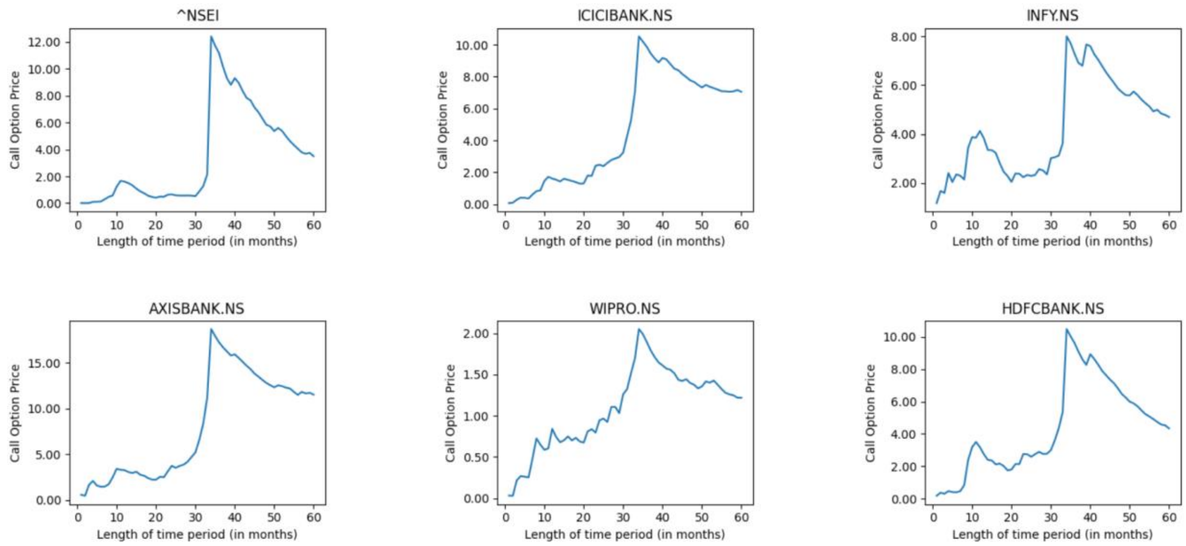
Call Option Price vs Time Period (A = 1.3)



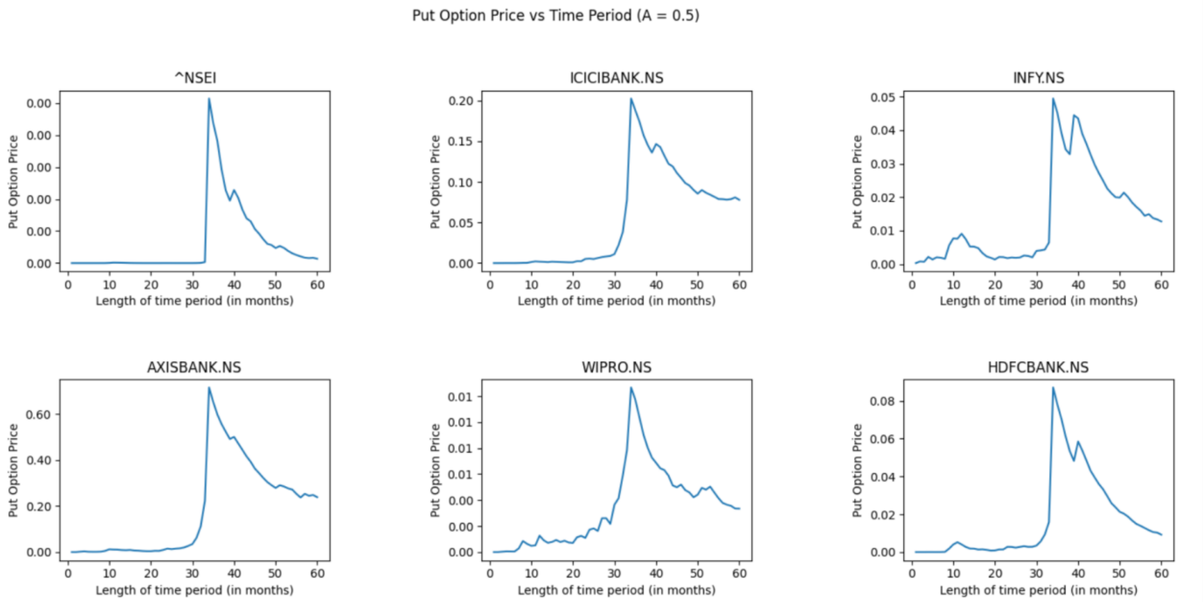
Call Option Price vs Time Period (A = 1.4)

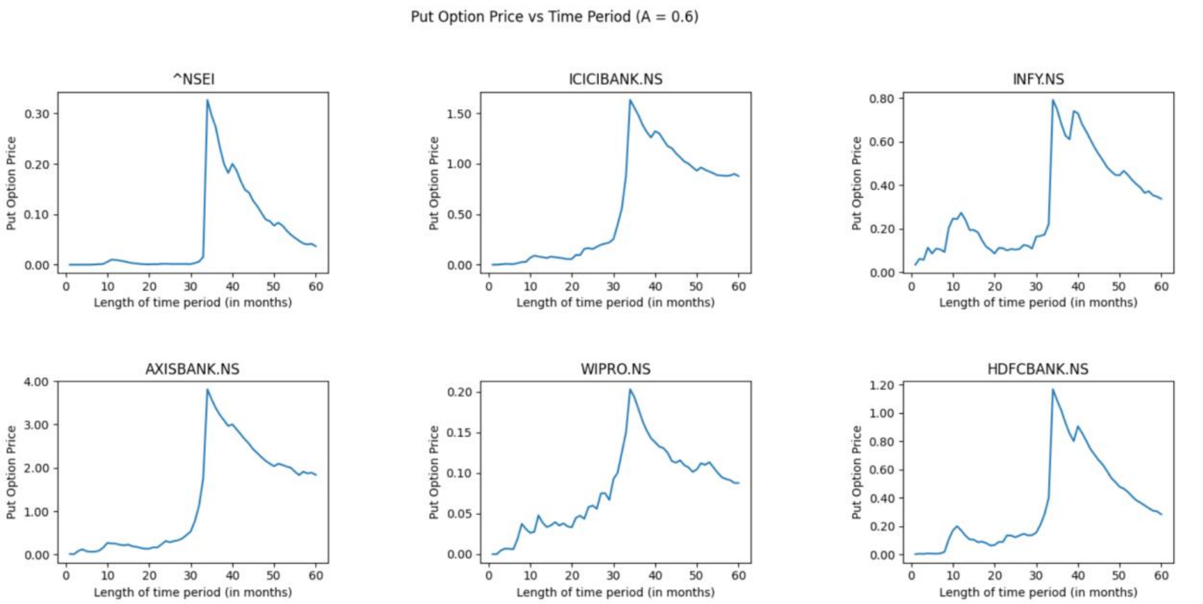


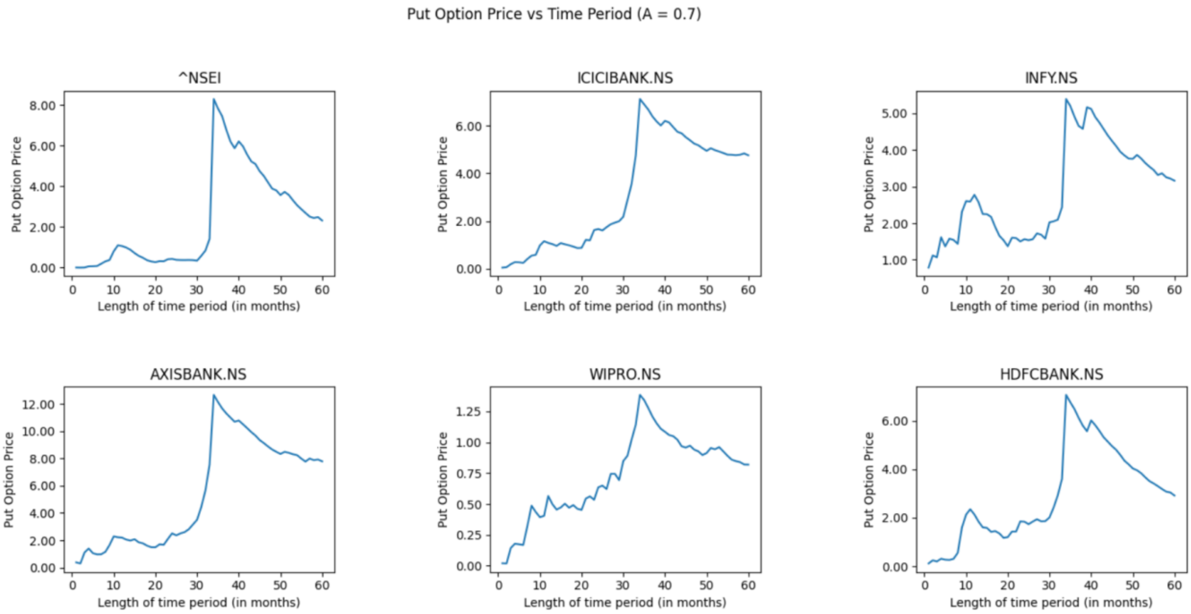
Call Option Price vs Time Period (A = 1.5)



<u>Put Option Price Plots</u>

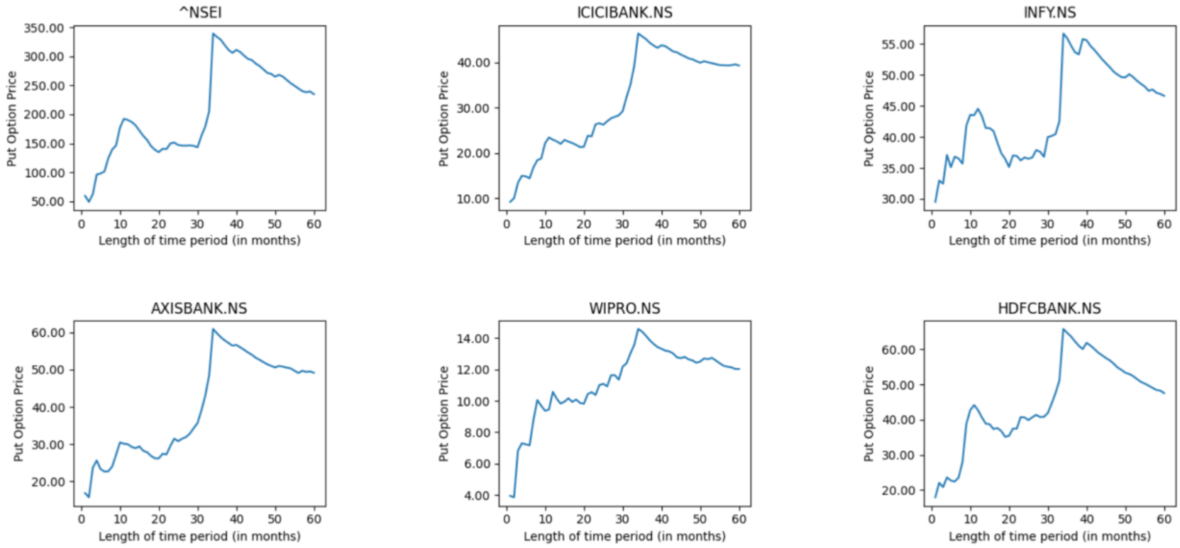




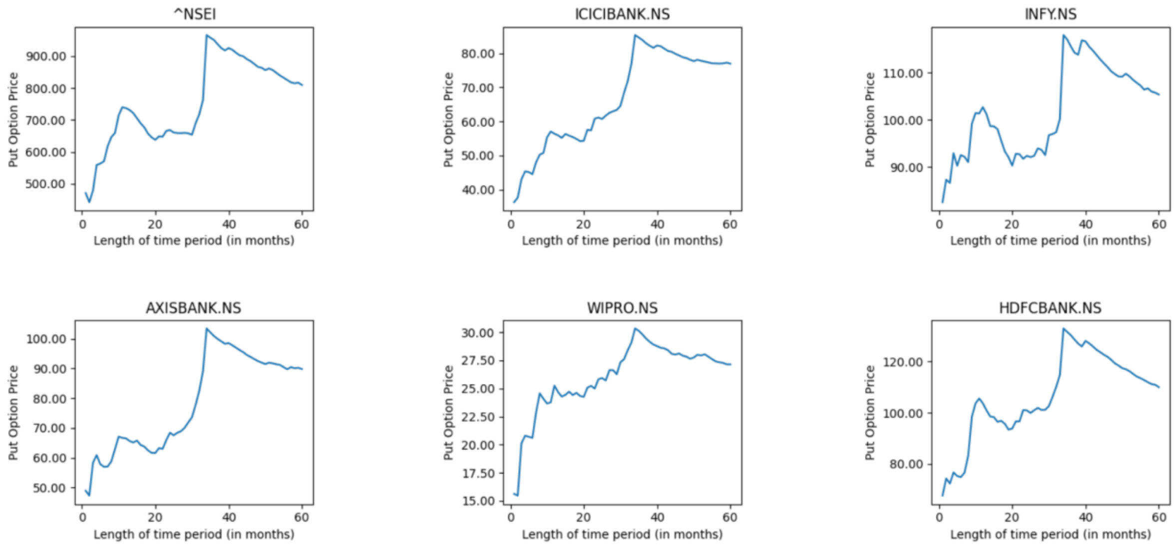

Put Option Price vs Time Period (A = 0.7)
^NSEI
ICICIBANK.NS
INFY.NS
AXISBANK.NS
WIPRO.NS
HDFCBANK.NS
Put Option Price
Length of time period (in months)

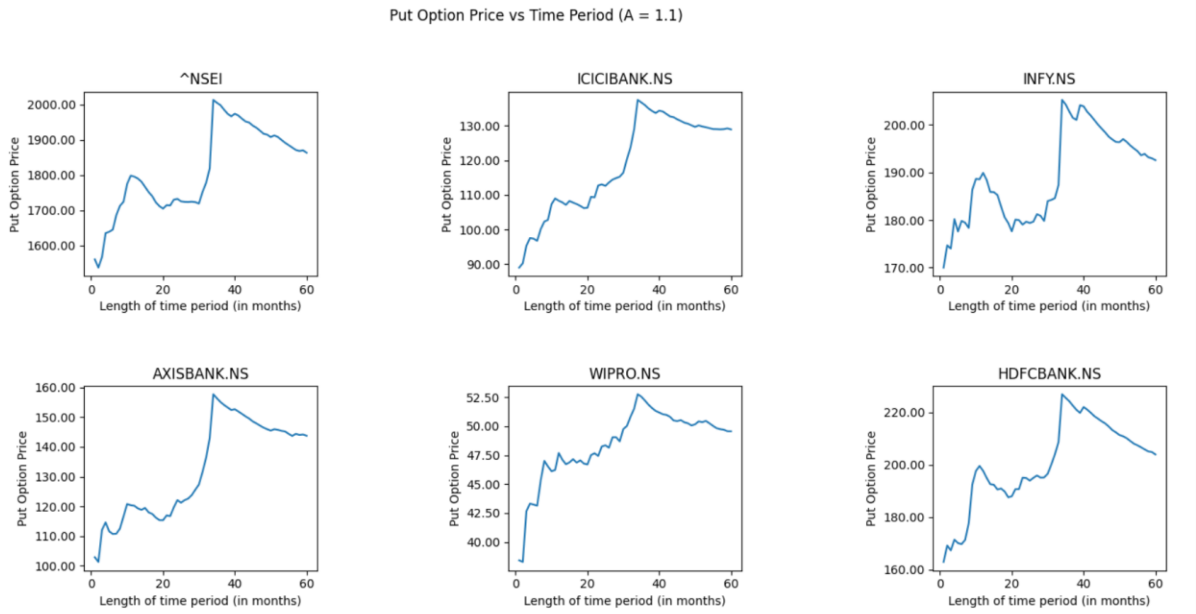

Put Option Price vs Time Period (A = 0.8)
^NSEI
ICICIBANK.NS
INFY.NS
AXISBANK.NS
WIPRO.NS
HDFCBANK.NS
Put Option Price
Length of time period (in months)

Put Option Price vs Time Period (A = 0.9)



Put Option Price vs Time Period (A = 1.0)




Put Option Price vs Time Period (A = 1.1)
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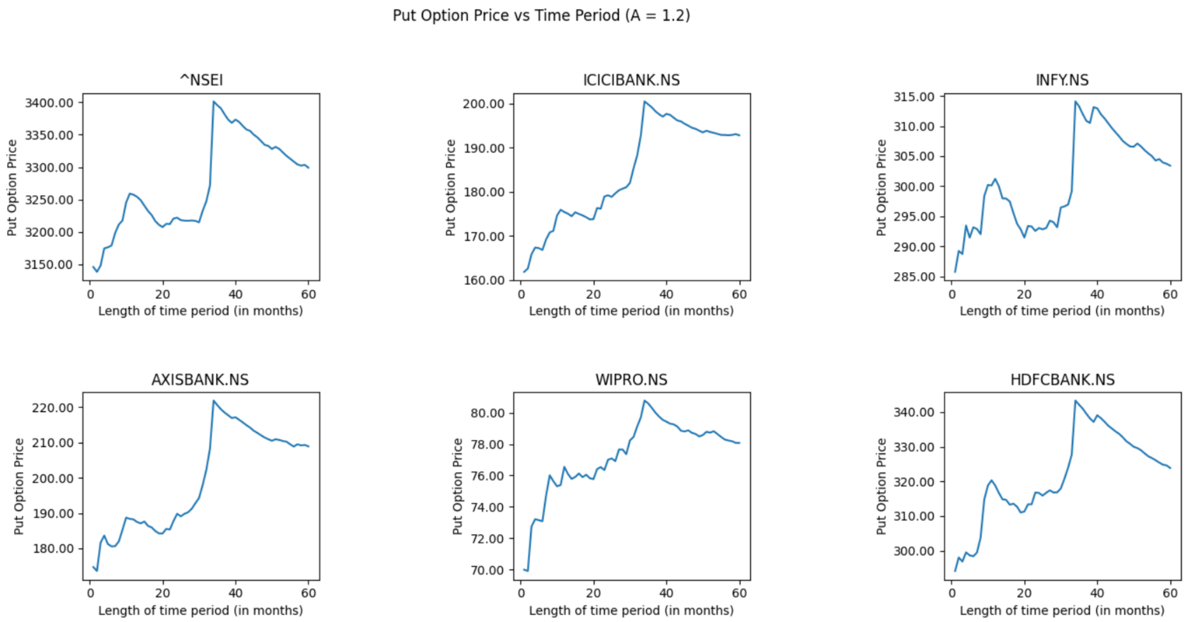
ICICIBANK.NS
INFY.NS
AXISBANK.NS
WIPRO.NS
HDFCBANK.NS
Put Option Price
Length of time period (in months)


Put Option Price vs Time Period (A = 1.2)
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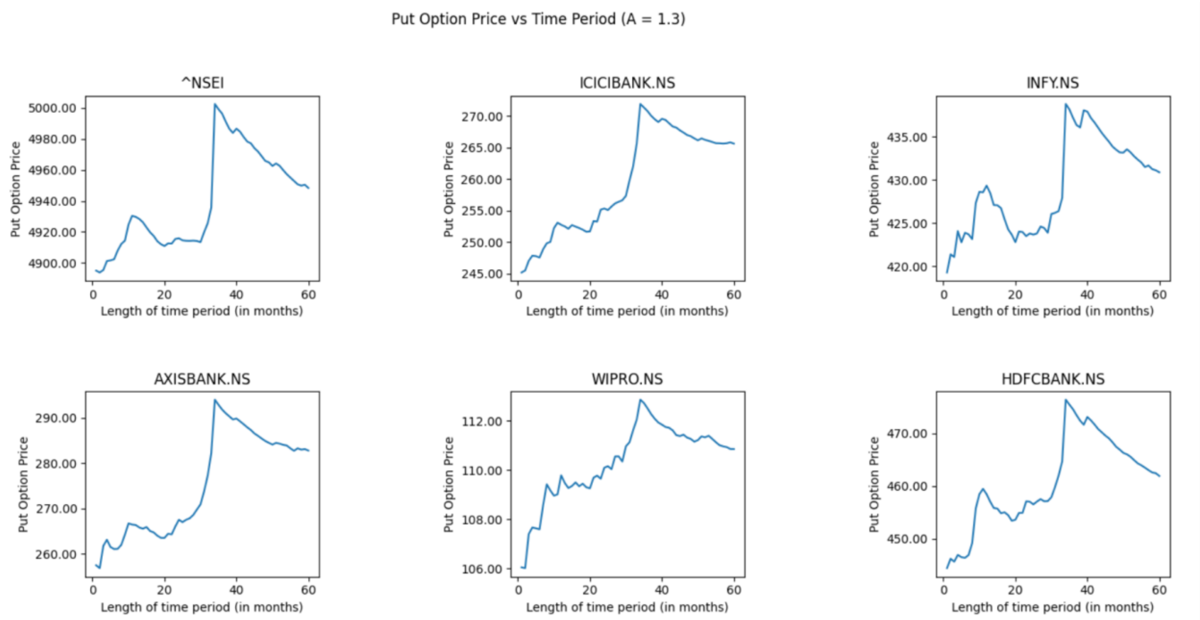
Put Option Price
Length of time period (in months)


Put Option Price vs Time Period (A = 1.3)
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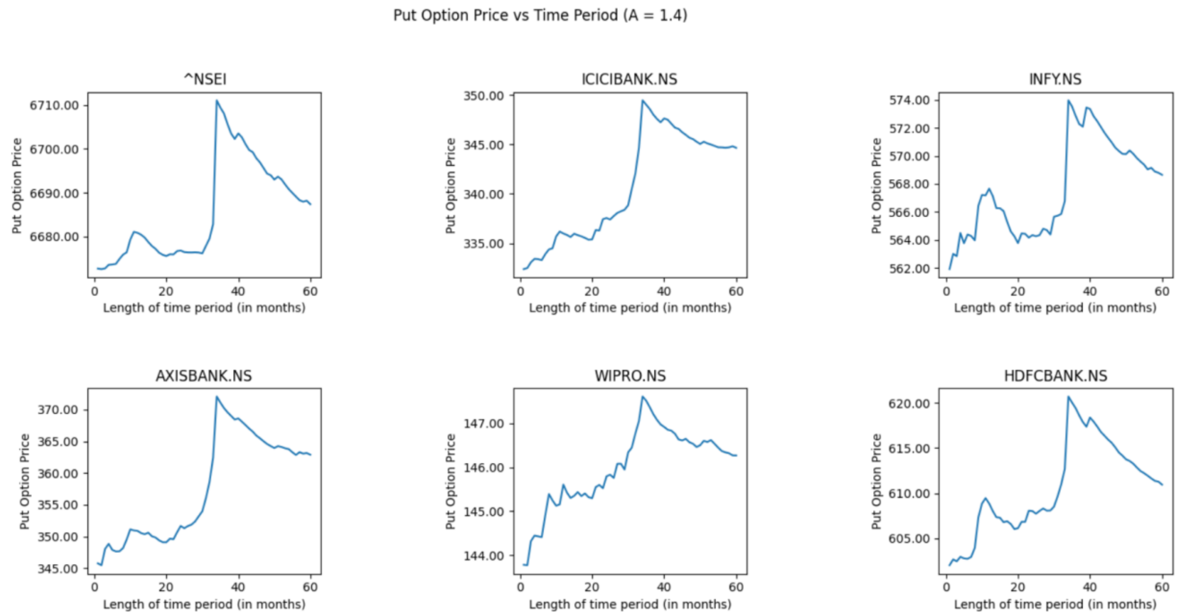
HDFCBANK.NS
Put Option Price
Length of time period (in months)


Put Option Price vs Time Period (A = 1.4)
^NSEI
ICICIBANK.NS
INFY.NS
AXISBANK.NS
WIPRO.NS
HDFCBANK.NS
Put Option Price
Length of time period (in months)

Put Option Price vs Time Period (A = 1.5)