Financial Engineering Lab   MA – 374   Lab – 9

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Roll Number – 210123072

Branch – Mathematics and Computing

Question 1:

1. Similar to Question 2 in the previous lab, collect the data of option prices on some of the stocks that are included in NIFTY index. Choose the stocks such that they are from different industries and are already included in your database "nsedata1". The data should comprise of closing prices of calls and puts of various maturities and strike prices. Put all these data in an Excel file and name it as "stockoptiondata".

Data for following companies (from nsedata1) are taken for the analysis:
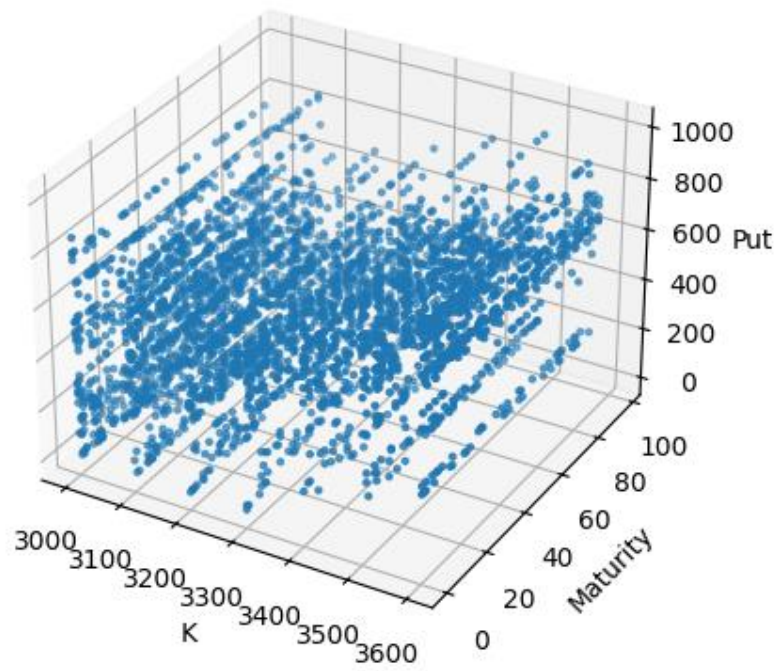
1. Bajaj-Auto
2. Reliance
3. HDFC Bank
4. Hero Motor Corp.
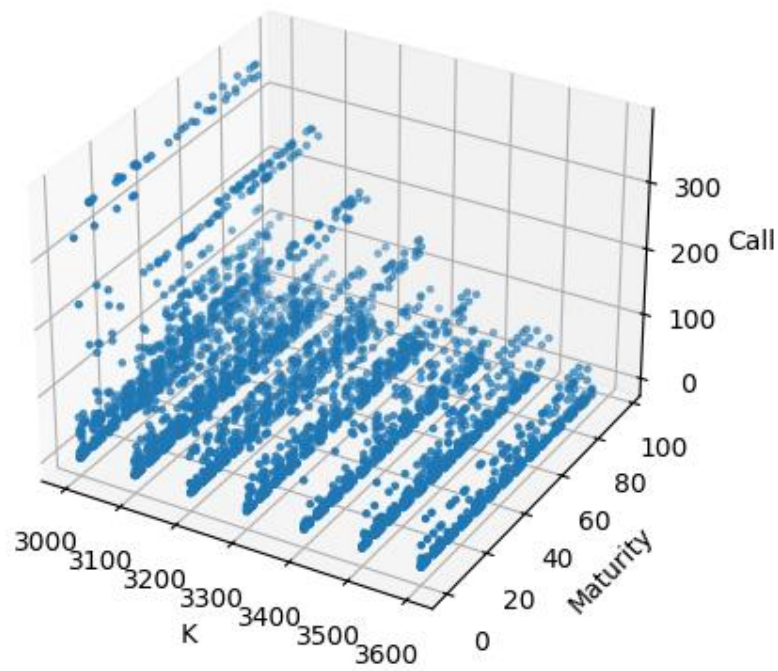5. Tata Motors
6. NSE Index (NIFTY 50)

Question 2:

2. Consider the data of option prices on **NIFTY** and on stocks stored in the Excel files "NIFTYoptiondata" and "stockoptiondata". Take the current time to be $t = 0$ and S_0 to be the current index level or the current stock price. Assume $r = 5\%$.

   (a) Plot the option prices (for both call and put) for a range of maturities and strike prices in three dimension. (Your plot axes are option price, maturity and strike price). If you visualize the above plot in two dimensions (option price vs. strike and option price vs. maturity) what do you observe ?

   (b) For each maturity and each strike, compute the implied volatility from the BSM formula using the appropriate root-finding method (*eg. Newton-Raphson method*).
   Plot the implied volatilities against strike price and maturity in three dimensions. What are your observations if you examine the plot in two dimensions (implied volatility vs. strike and implied volatility vs. maturity) ?

   (c) Estimate the historical volatility for the same period for which you have estimated the implied volatility. How do the two volatilities compare ? Present your results in tabular and graphical forms.
   Note that when you are computing the historical volatilities, you have to take data starting from $t = 0$ and going back in time for a period equal to the maturity of the option.
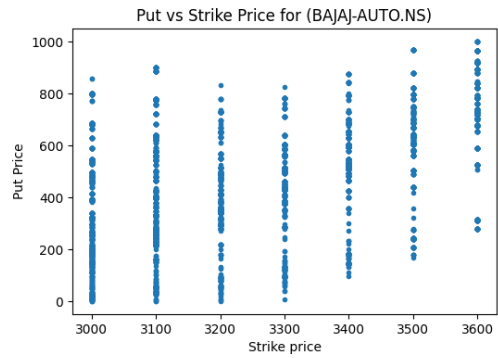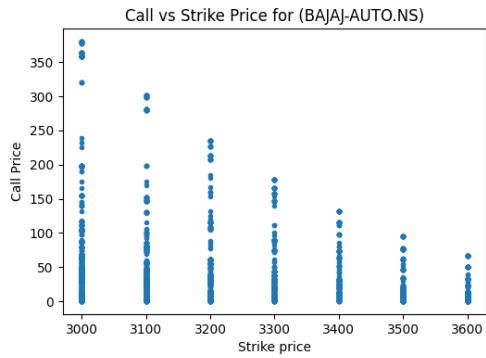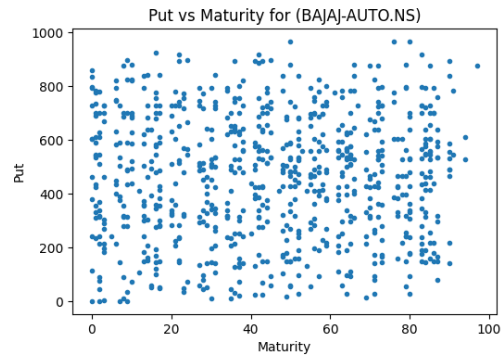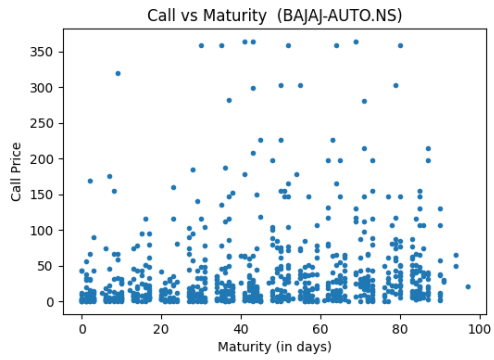
a)

3D PUT for BAJAJ-AUTO.NS

3D call- BAJAJ-AUTO.NS

Call vs Maturity (BAJAJ-AUTO.NS)

Put vs Maturity for (BAJAJ-AUTO.NS)

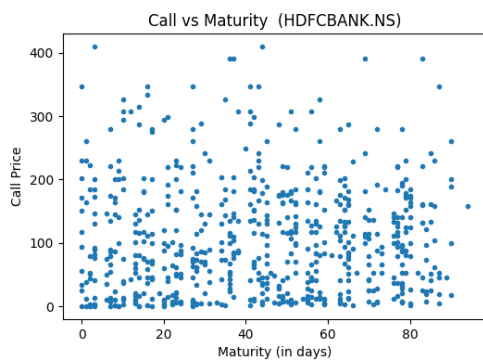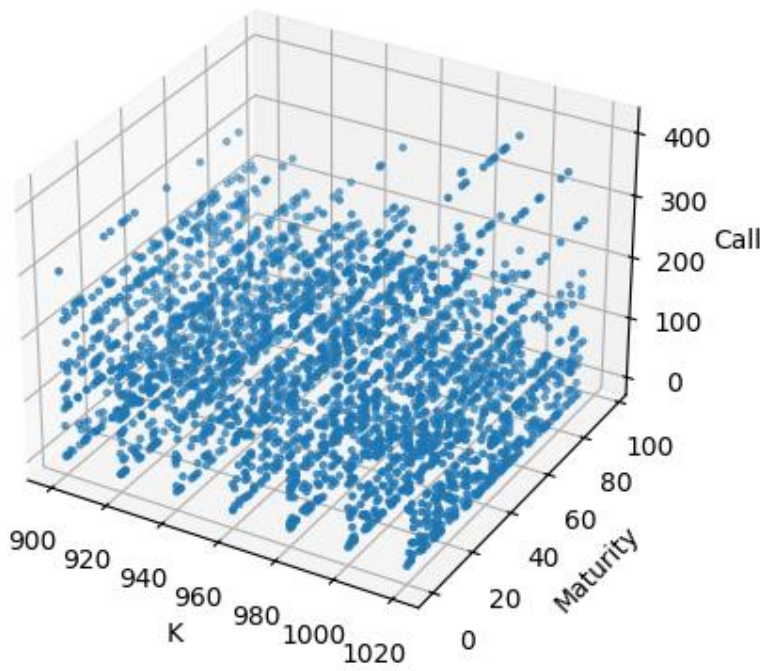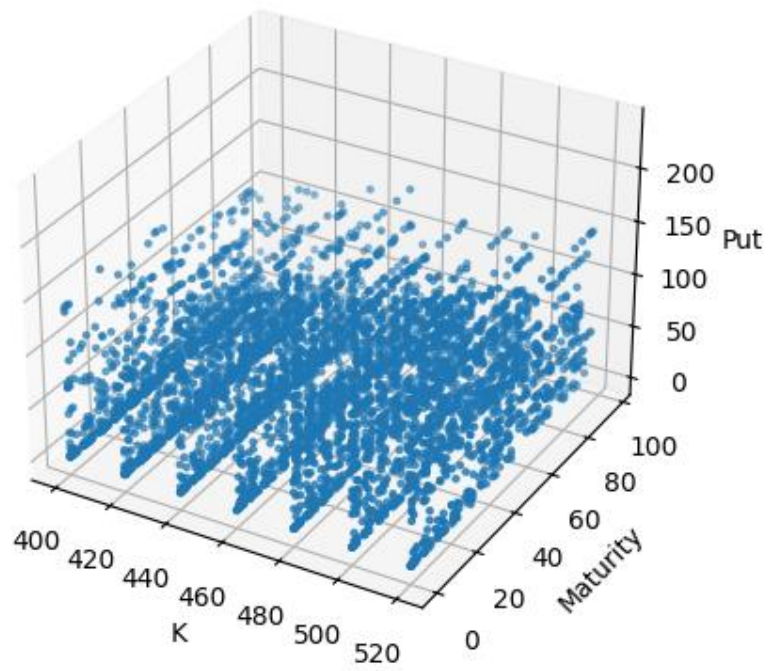Call vs Strike Price for (BAJAJ-AUTO.NS)

Put vs Strike Price for (BAJAJ-AUTO.NS)

3D PUT for HDFCBANK.NS

3D call- HDFCBANK.NS

Call vs Maturity (HDFCBANK.NS)

Put vs Maturity for (HDFCBANK.NS)

Call vs Strike Price for (HDFCBANK.NS)
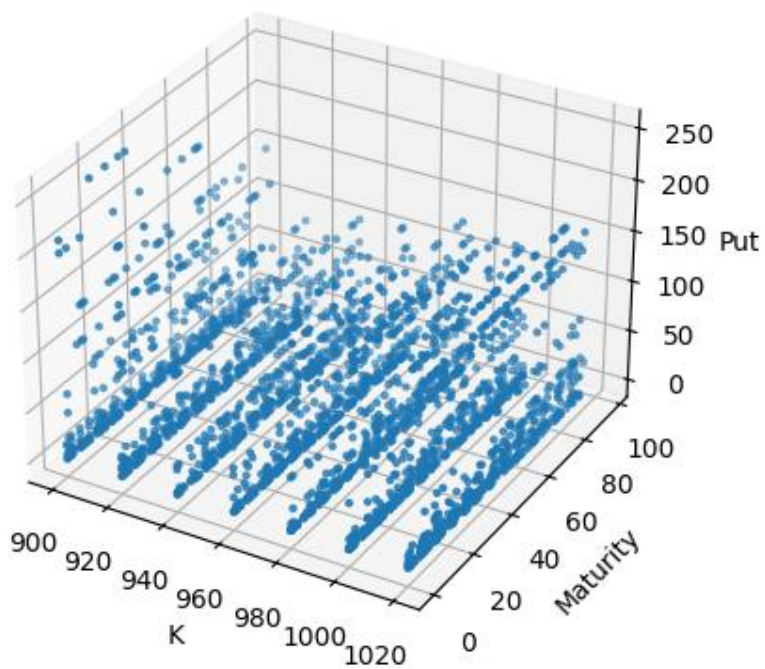
Put vs Strike Price for (HDFCBANK.NS)
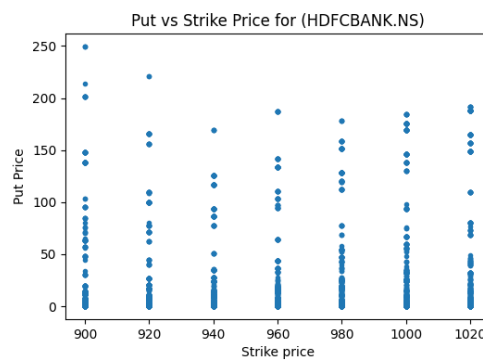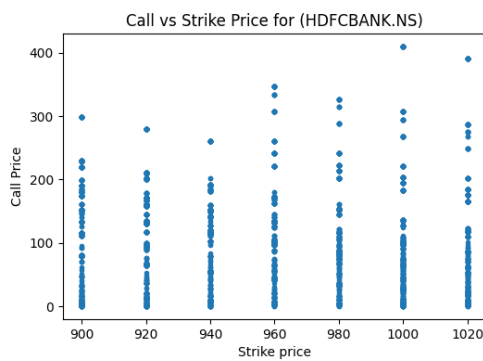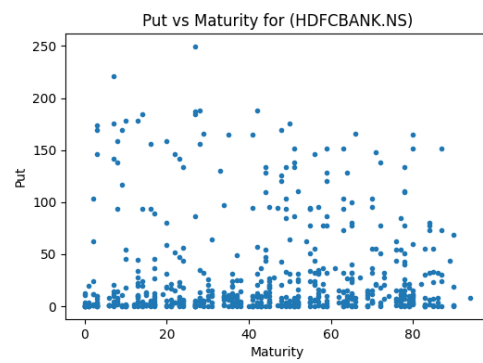
3D PUT for TATAMOTORS.NS

3D call- TATAMOTORS.NS

Call vs Maturity (TATAMOTORS.NS)

Put vs Maturity for (TATAMOTORS.NS)

Call vs Strike Price for (TATAMOTORS.NS)

Put vs Strike Price for (TATAMOTORS.NS)
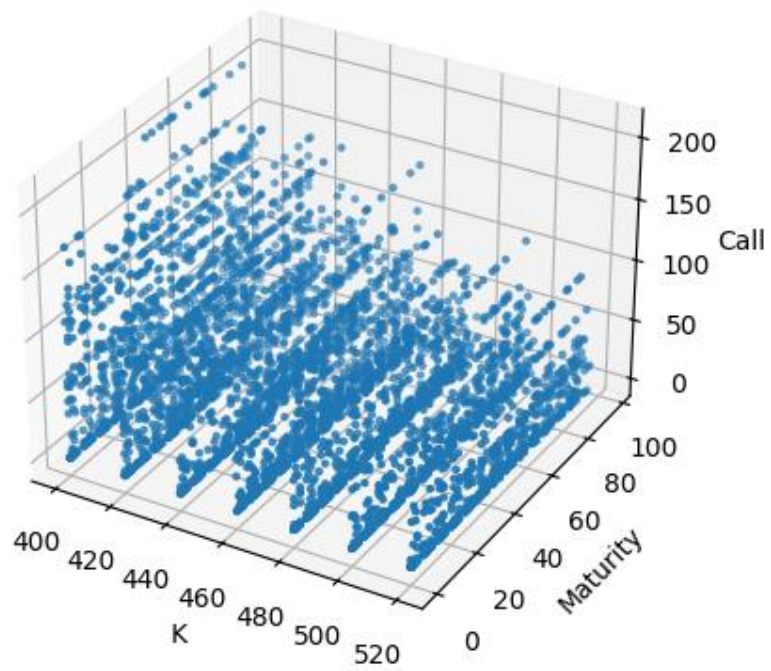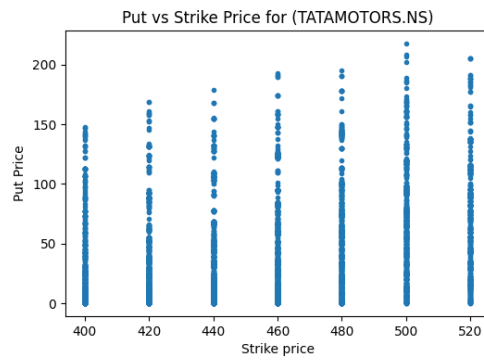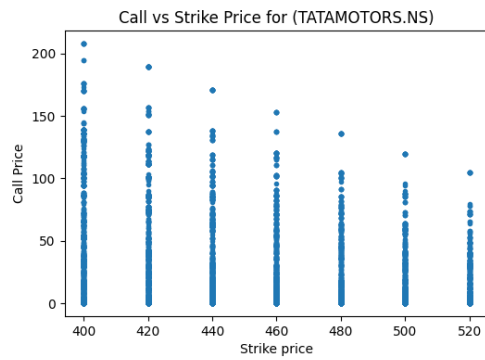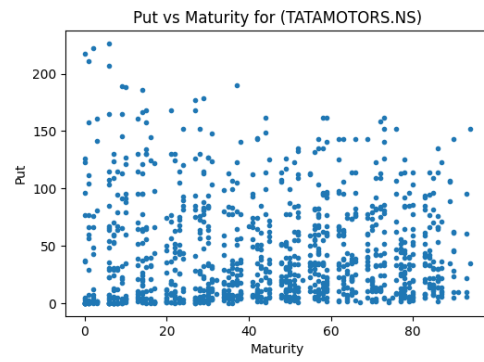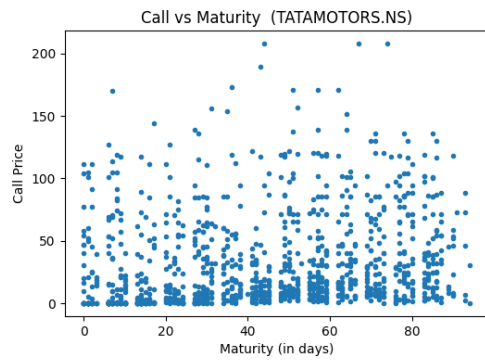
3D PUT for RELIANCE.NS

3D call- RELIANCE.NS

Call vs Maturity (RELIANCE.NS)

Put vs Maturity for (RELIANCE.NS)

Call vs Strike Price for (RELIANCE.NS)
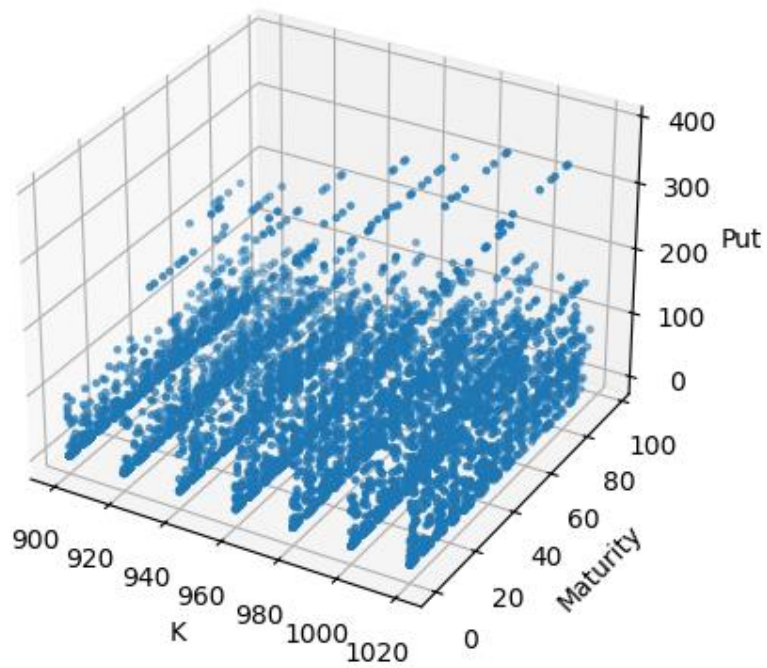
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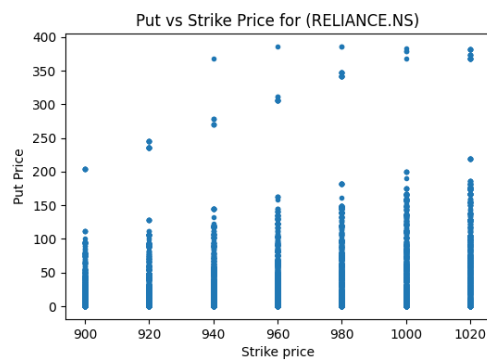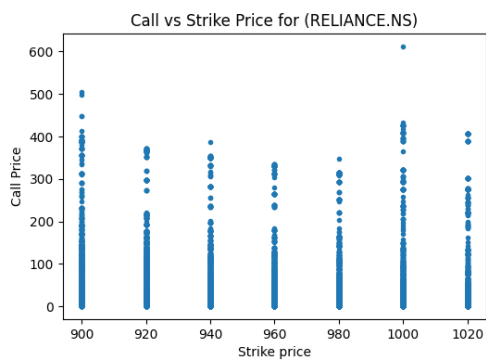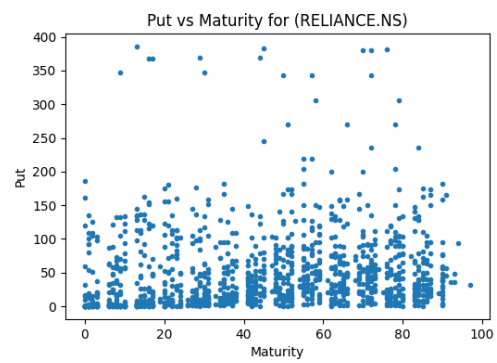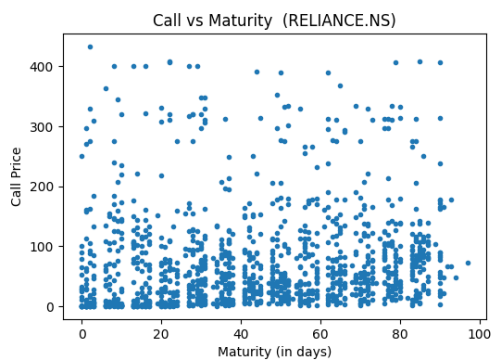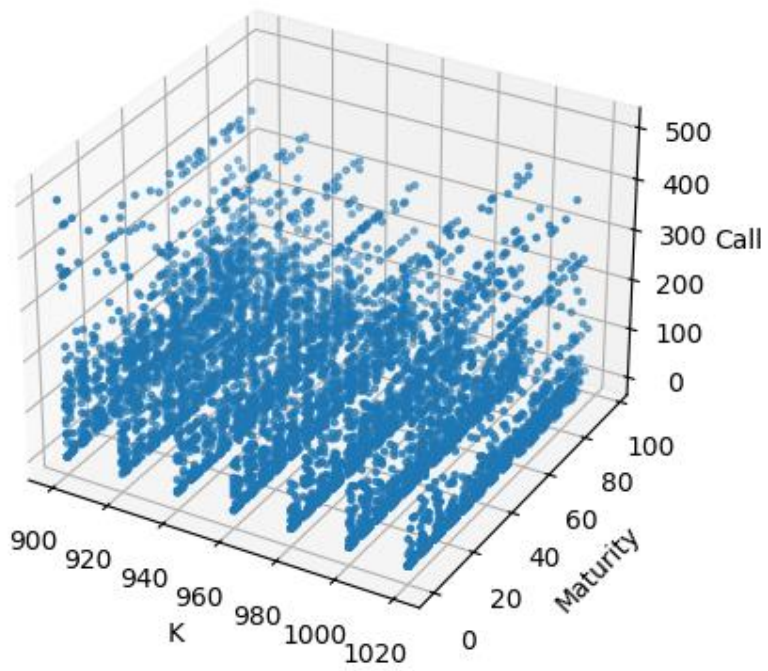
3D PUT for HEROMOTOCO.NS

3D call- HEROMOTOCO.NS

Call vs Maturity (HEROMOTOCO.NS)

Put vs Maturity for (HEROMOTOCO.NS)

Call vs Strike Price for (HEROMOTOCO.NS)
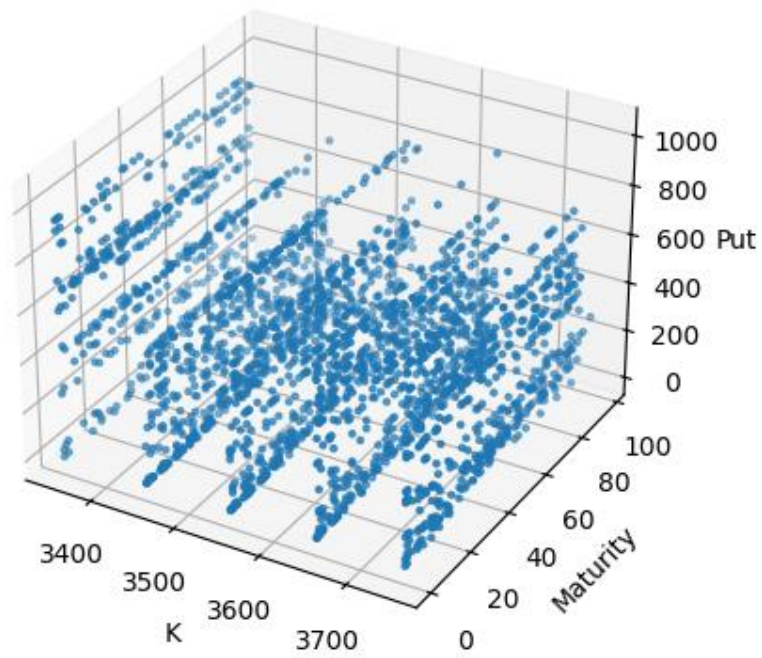
Put vs Strike Price for (HEROMOTOCO.NS)
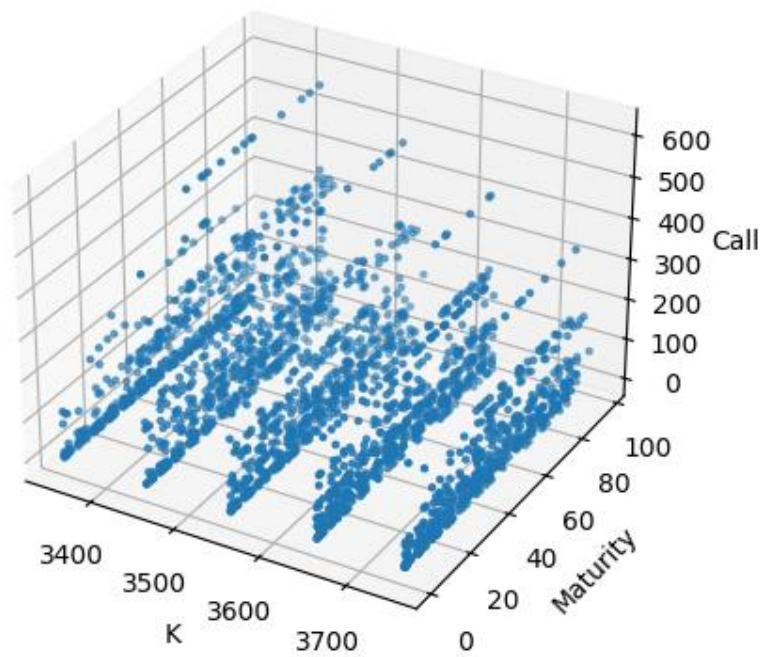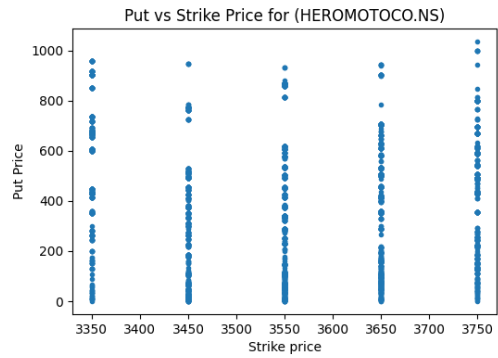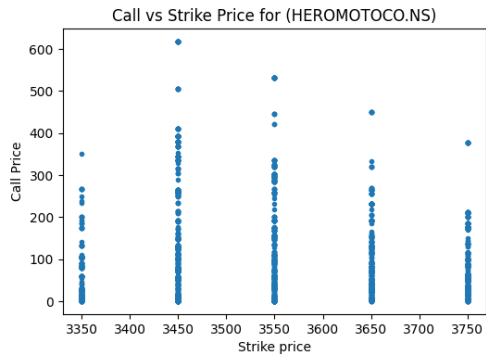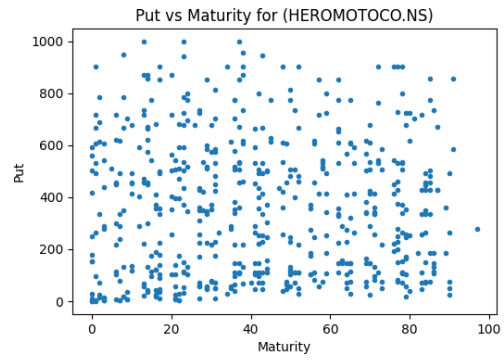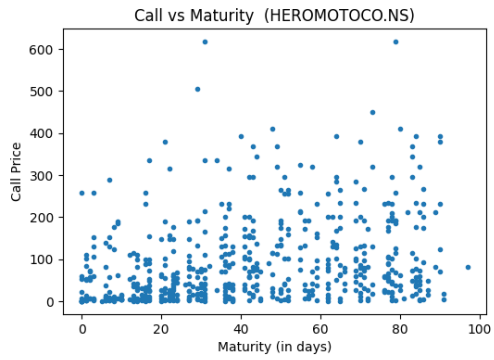
3D PUT for NSE Index

3D call- NSE Index

Call vs Maturity (NSE Index)

Put vs Maturity for (NSE Index)

Call vs Strike Price for (NSE Index)
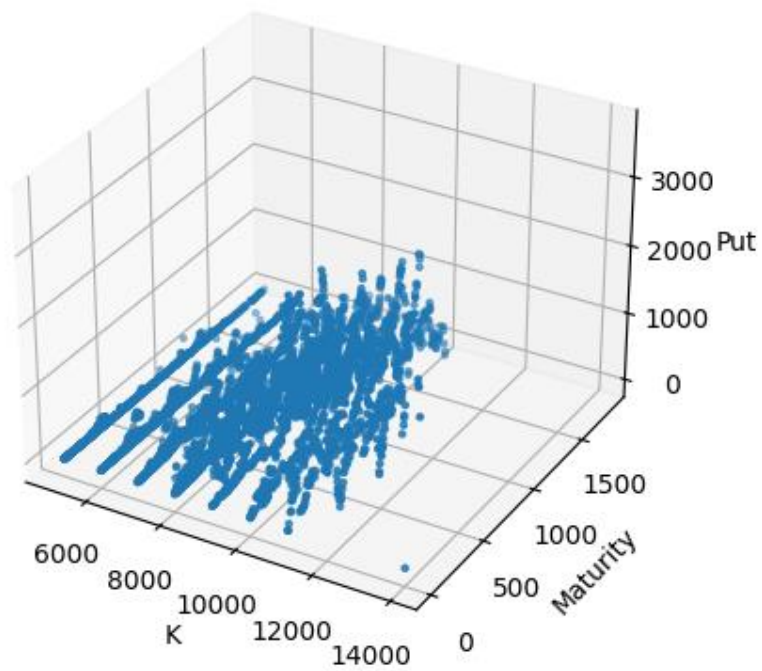
Put vs Strike Price for (NSE Index)
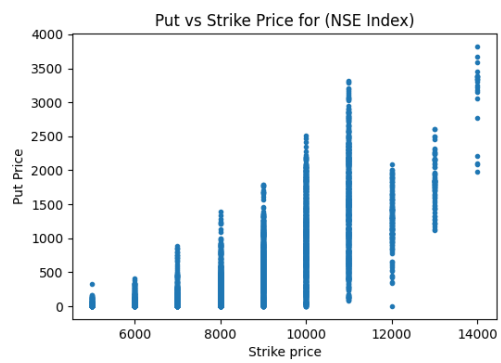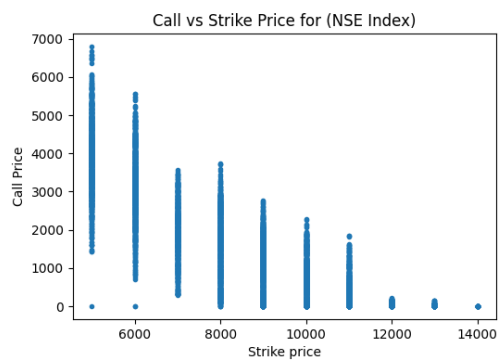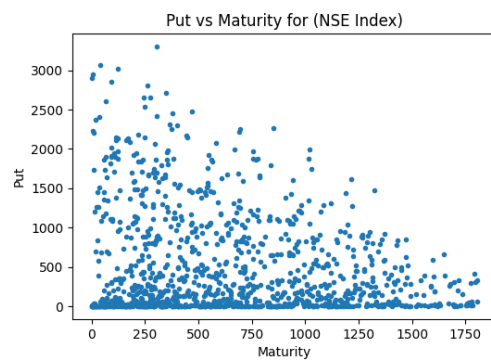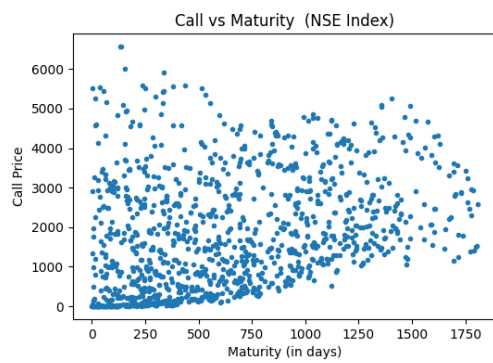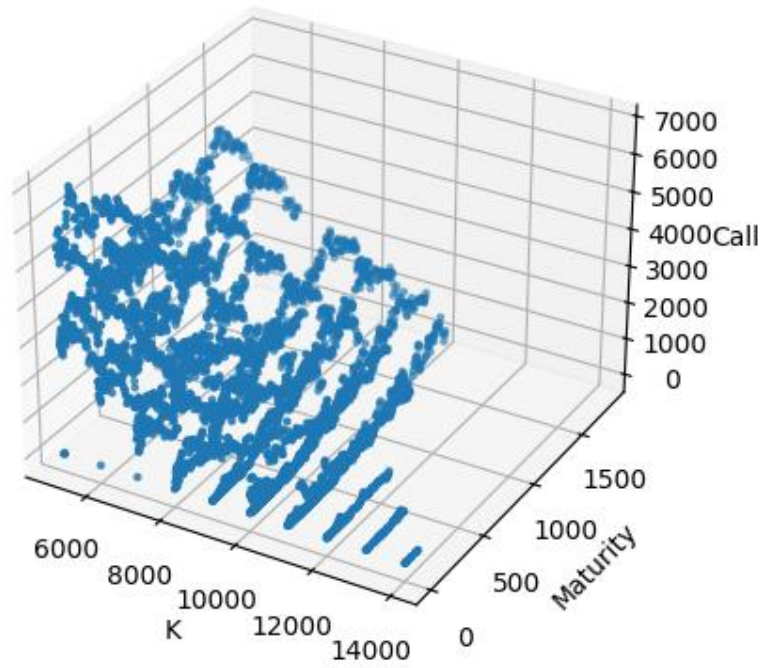
b)

3D plot for Implied volatility - NSE Index

Implied Volatility vs Strike Price for NSE Index

Implied Volatility vs Maturity for NSE Index
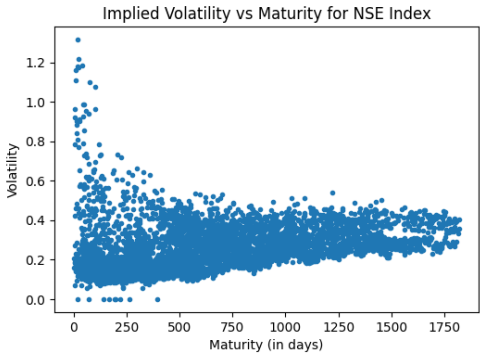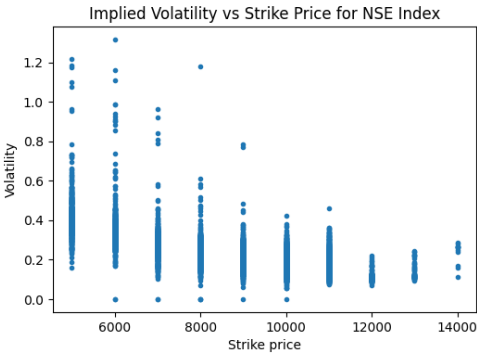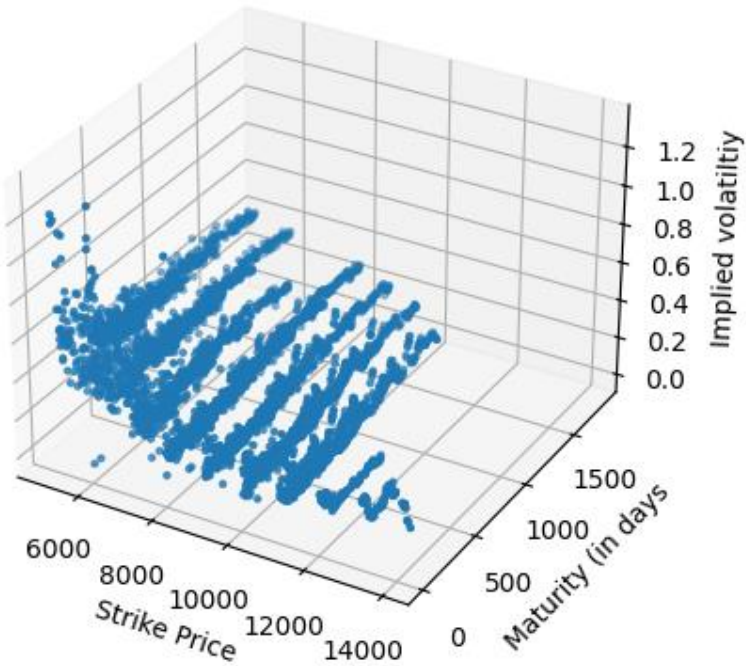
3D plot for Implied volatility - BAJAJ-AUTO.NS

Implied Volatility vs Strike Price for BAJAJ-AUTO.NS

Implied Volatility vs Maturity for BAJAJ-AUTO.NS

3D plot for Implied volatility - HDFCBANK.NS

Implied Volatility vs Strike Price for HDFCBANK.NS
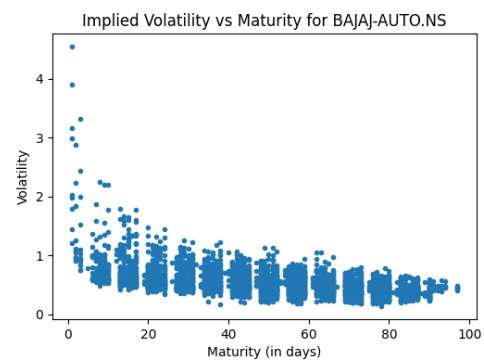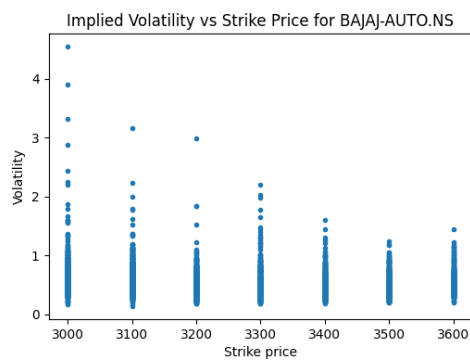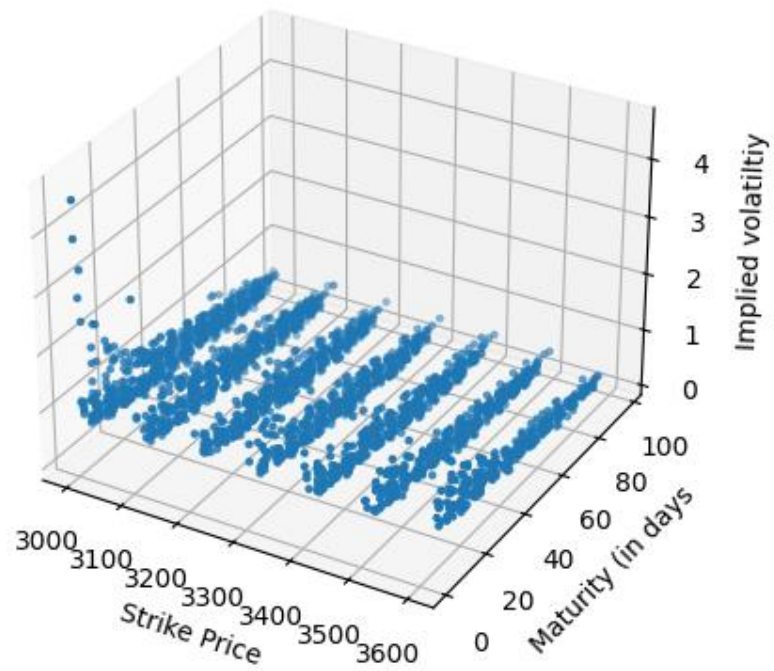
Implied Volatility vs Maturity for HDFCBANK.NS

3D plot for Implied volatility - TATAMOTORS.NS

Implied Volatility vs Strike Price for TATAMOTORS.NS
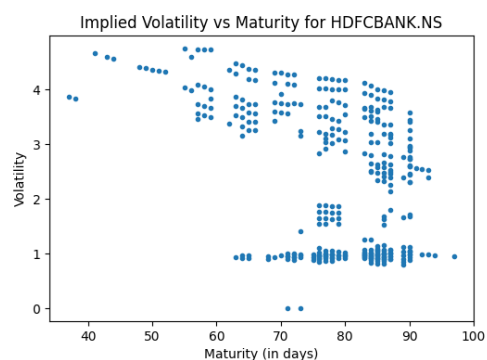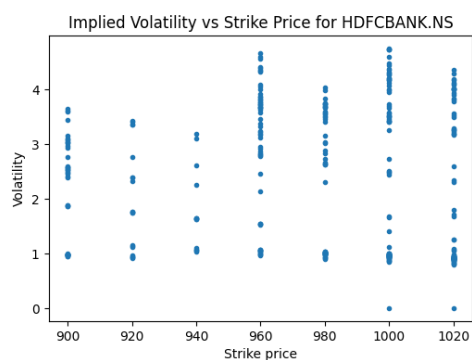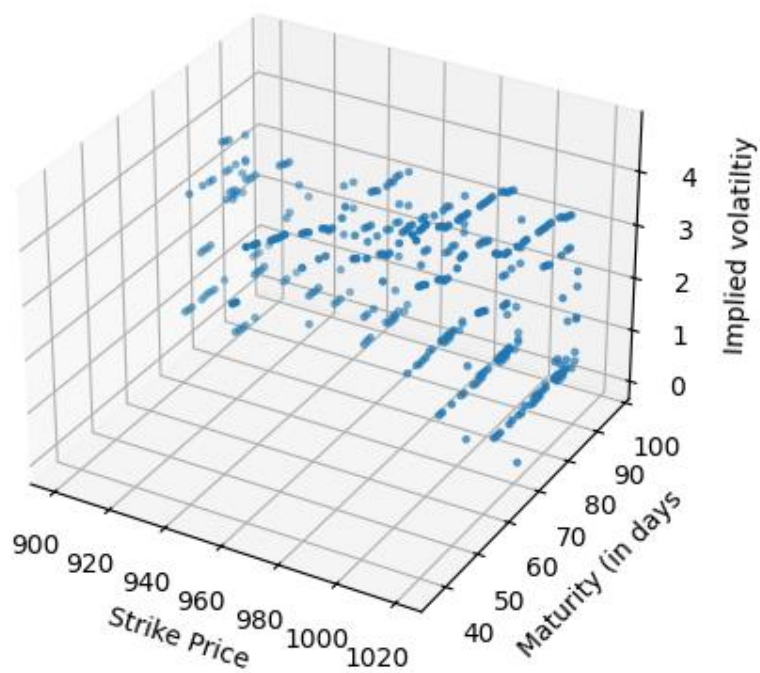
Implied Volatility vs Maturity for TATAMOTORS.NS
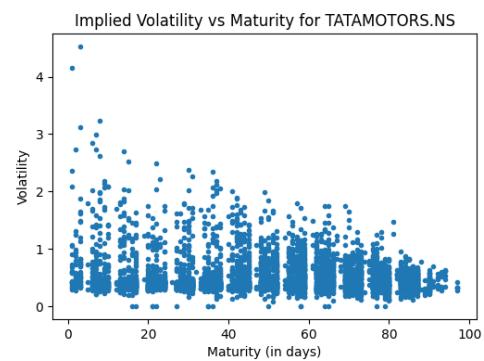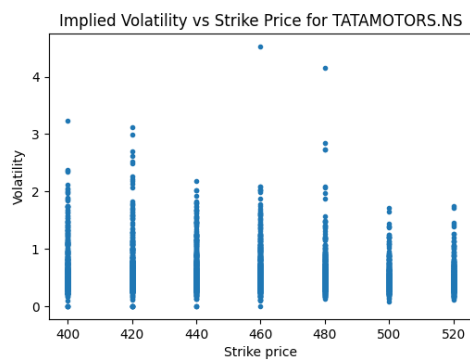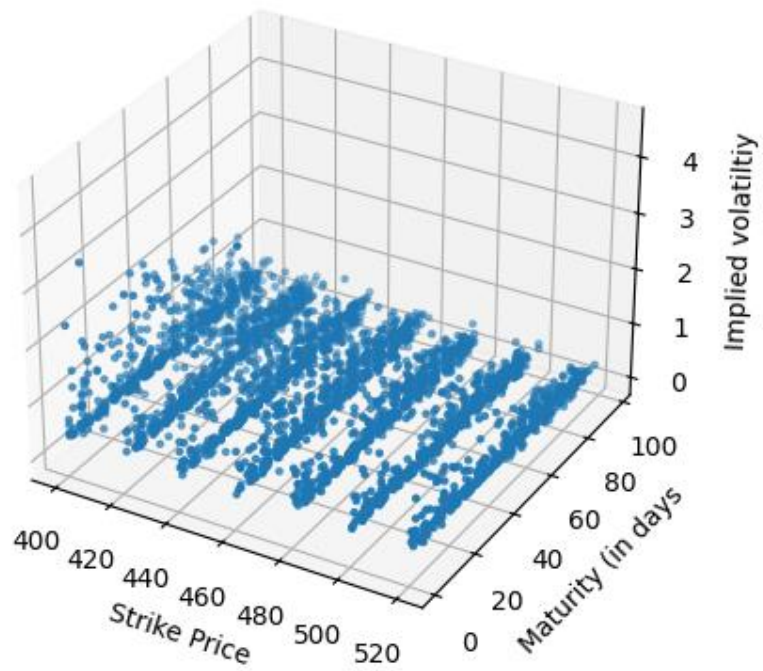
3D plot for Implied volatility - RELIANCE.NS

Implied Volatility vs Strike Price for RELIANCE.NS

Implied Volatility vs Maturity for RELIANCE.NS
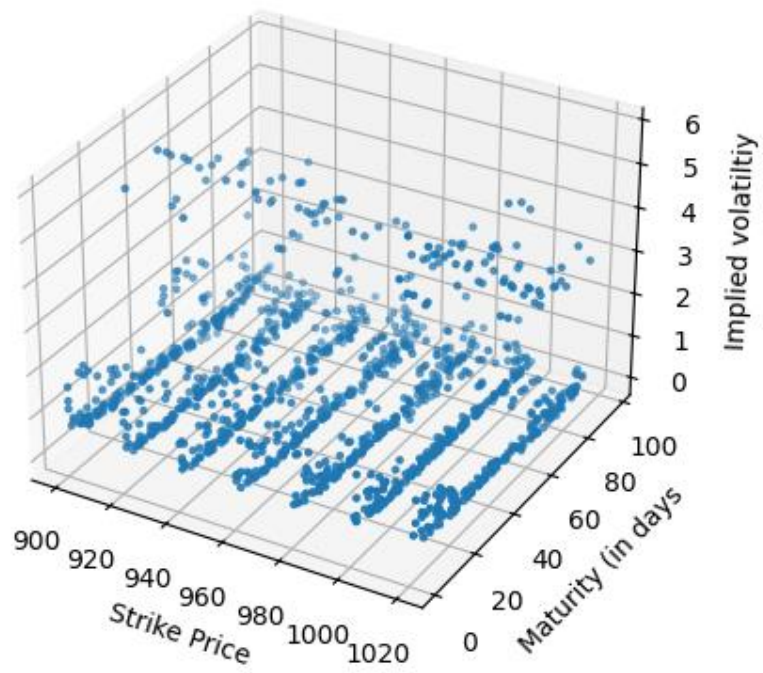
3D plot for Implied volatility - HEROMOTOCO.NS

Implied Volatility vs Strike Price for HEROMOTOCO.NS

Implied Volatility vs Maturity for HEROMOTOCO.NS

c)

Comparison between historical and implied volatility - Nifty

Volatility vs Strike Price for Nifty
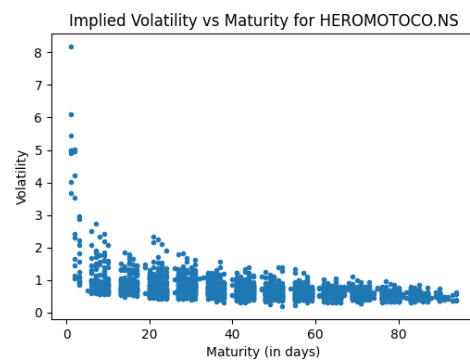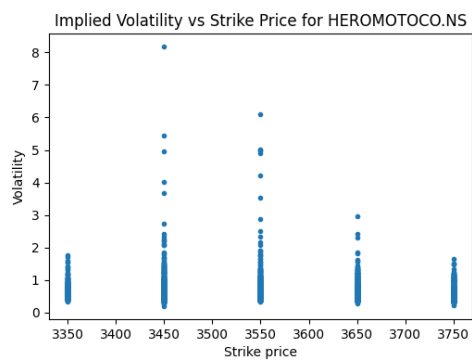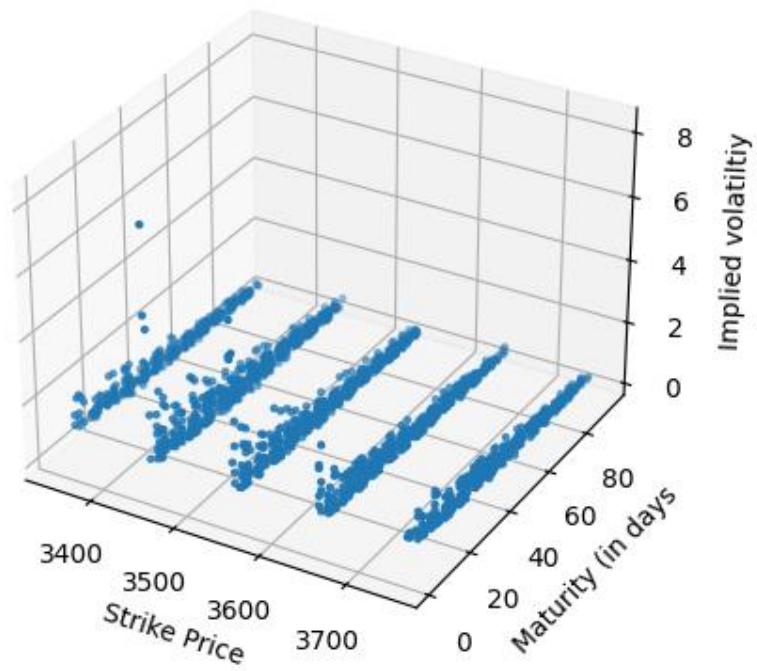
Volatility vs Maturity for Nifty

Historical vs Implied volatility for Nifty
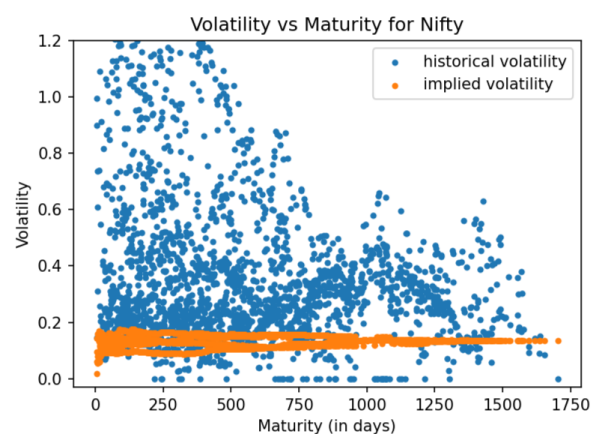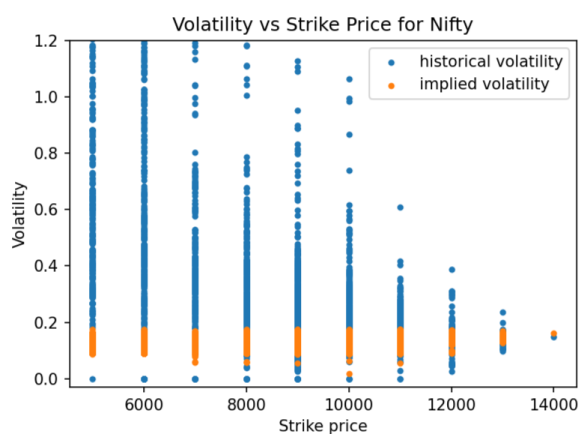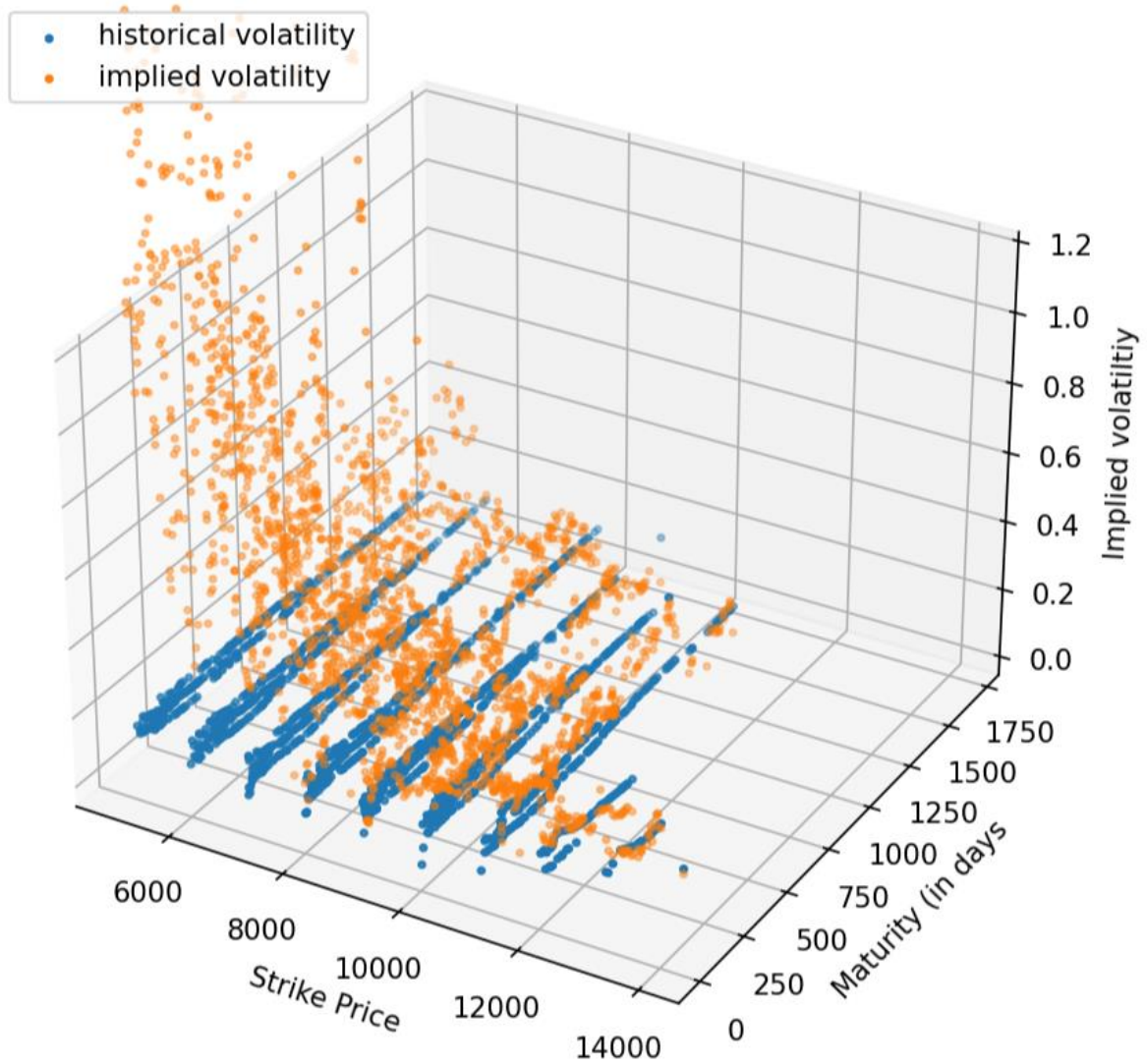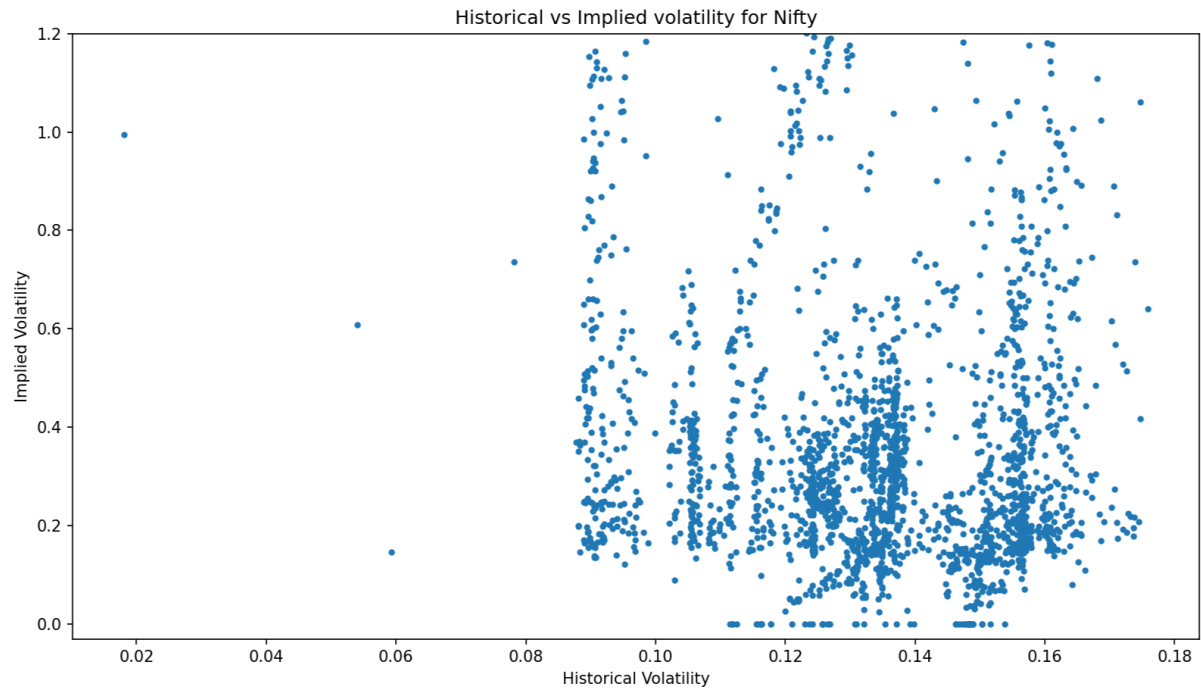
The tabular data is as follows:

For Nifty SI No.	Call Price	Stock Price (S0)	Maturity (in days)	Historical Volatility	Implied Volatility
1	1595.15	6221.15	344	0.127343	0.291944
2	1500	6211.15	330	0.126471	0.231073
3	1451.4	6211.15	320	0.127165	0.182725
4	1555.4	6191.45	301	0.127889	0.317942
5	1555.2	6191.45	299	0.127692	0.319618
6	1600.5	6191.45	294	0.127491	0.357405
7	1772.35	6191.45	286	0.127489	0.479672
8	1976	6162.25	265	0.1308	0.647277
9	1955	6162.25	264	0.131168	0.635699
10	1911	6174.6	239	0.132118	0.639415
11	1834.55	6174.6	231	0.133514	0.601297
12	2545	6168.35	204	0.126361	1.14421
13	2649.55	6171.45	187	0.125765	1.27329
14	2690.2	6171.45	182	0.125341	1.32193
15	2758.9	6171.45	176	0.124888	1.39771
16	2869.8	6171.45	173	0.126199	1.49608
17	2805	6272.75	156	0.122313	1.46347
18	2950	6272.75	153	0.123569	1.59669
19	2666.7	6272.75	138	0.120611	1.44309
20	2975	6241.85	126	0.12176	1.81025

Comparison between historical and implied volatility - TATAMOTORS.NS

Volatility vs Strike Price for TATAMOTORS.NS

Volatility vs Maturity for TATAMOTORS.NS

Historical vs Implied volatility for TATAMOTORS.NS
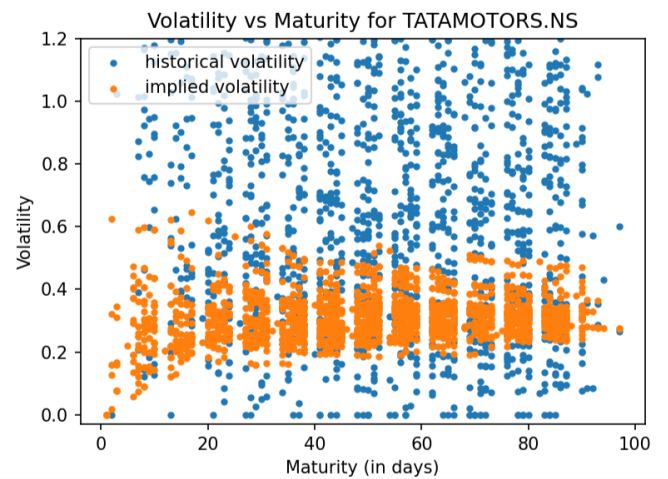
The tabular data is as follows:

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For TATAMOTORS.NS
 SI No.    Call Price    Stock Price (S0)    Maturity (in days)    Historical Volatility    Implied Volatility
--------  ------------  ------------------  --------------------  -----------------------  --------------------
      1        2.65            369.243                     24               0.351857                  0.307437
      2        9               366.682                     48               0.333519                  0.377781
      3        8.4             357.179                     44               0.337675                  0.44519
      4        1.85            357.179                     16               0.404144                  0.434775
      5        6.4             361.365                     37               0.354743                  0.404347
      6       16.65            361.365                     66               0.326994                  0.484695
      7       16.65            361.365                     65               0.325199                  0.488684
      8       16.65            359.543                     63               0.331983                  0.508693
      9       16.65            364.614                     56               0.28737                   0.506869
     10        1.9             364.614                     26               0.249555                  0.293369
     11       16.65            362.349                     49               0.252152                  0.560707
     12        2.95            361.414                     16               0.183515                  0.464144
     13       12.25            370.425                     37               0.251598                  0.482272
     14       20               366.141                     59               0.288048                  0.542142
     15       20               366.141                     58               0.29171                   0.547102
     16       24.85            371.557                     27               0.249346                  0.882607
     17       19.1             371.557                     24               0.251634                  0.782945
     18       45               364.122                     84               0.274898                  0.822218
     19       45               364.122                     83               0.277381                  0.827424
     20        6.1             364.073                     14               0.267757                  0.625852
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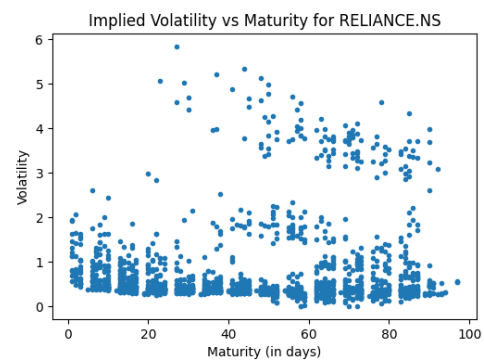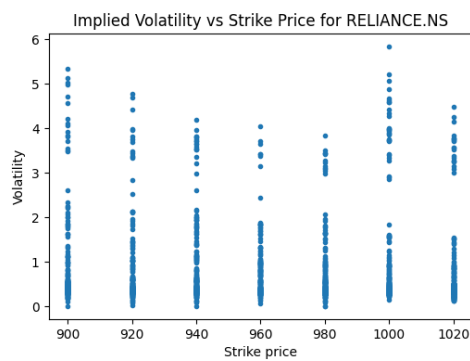
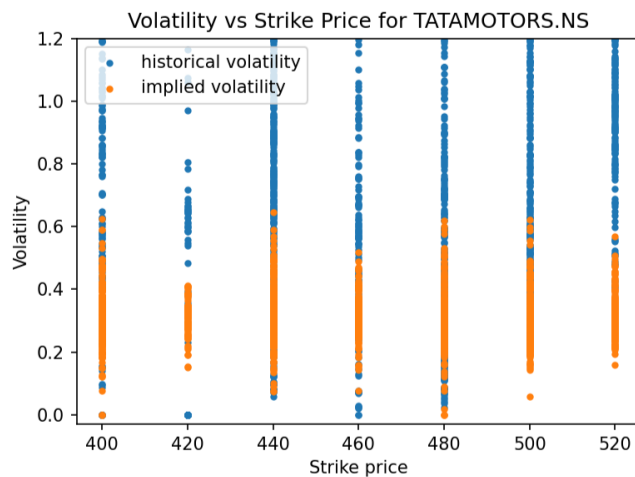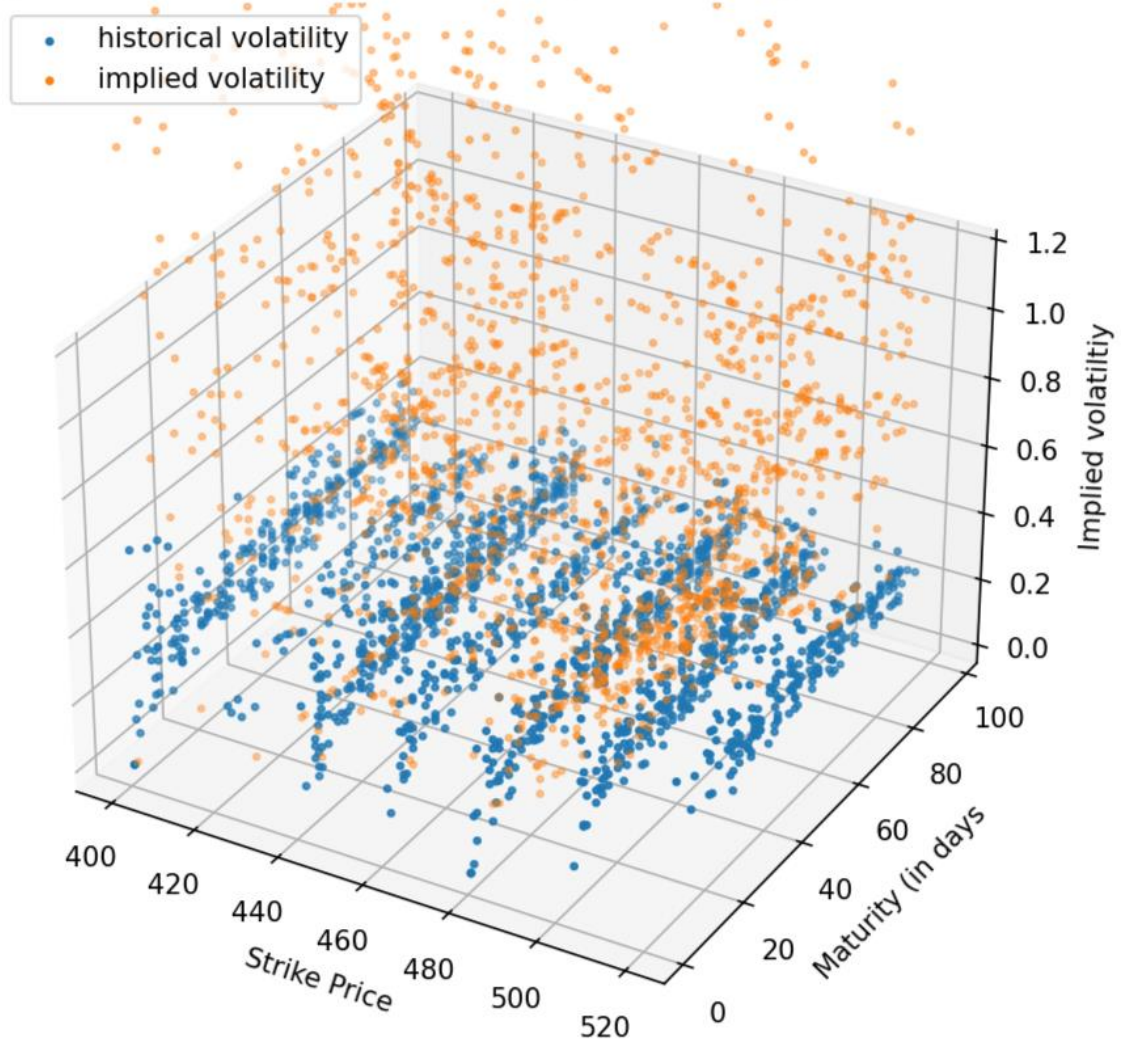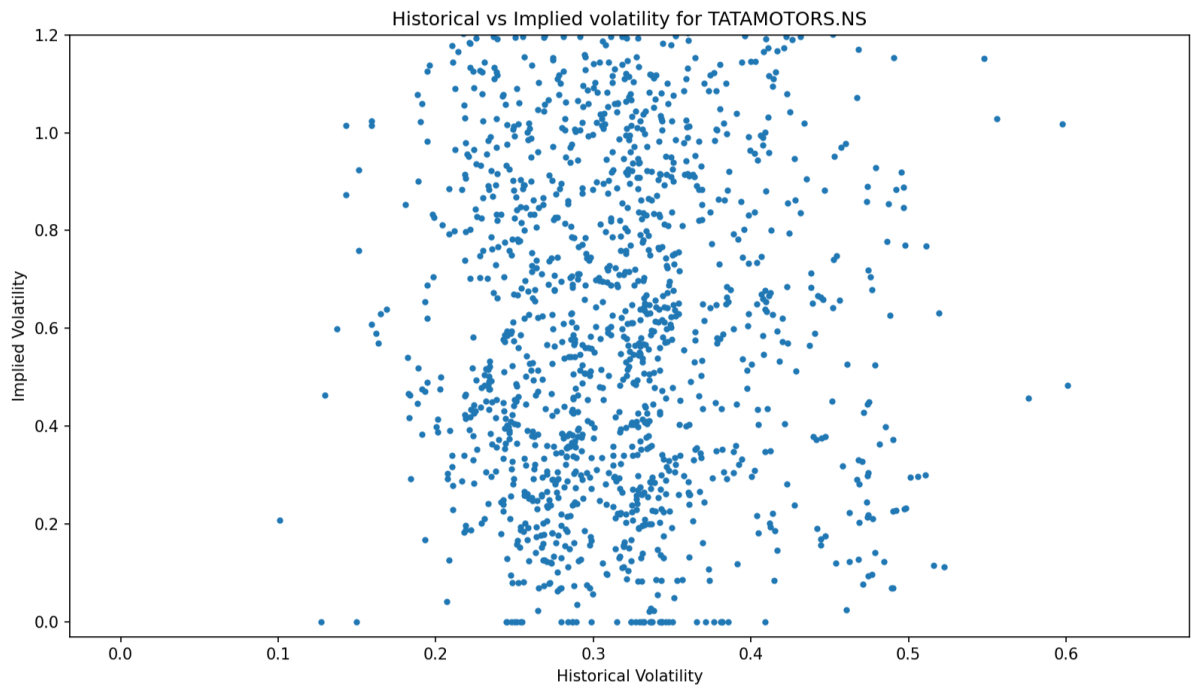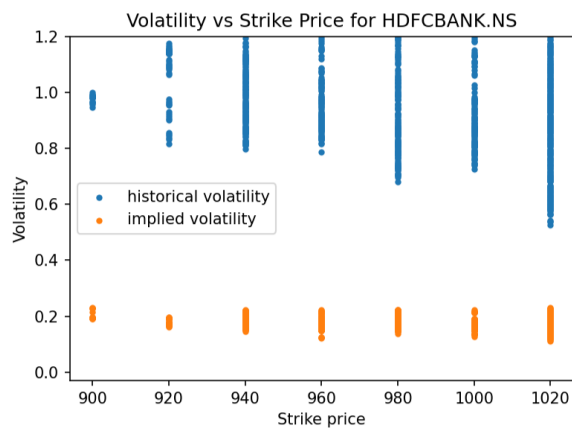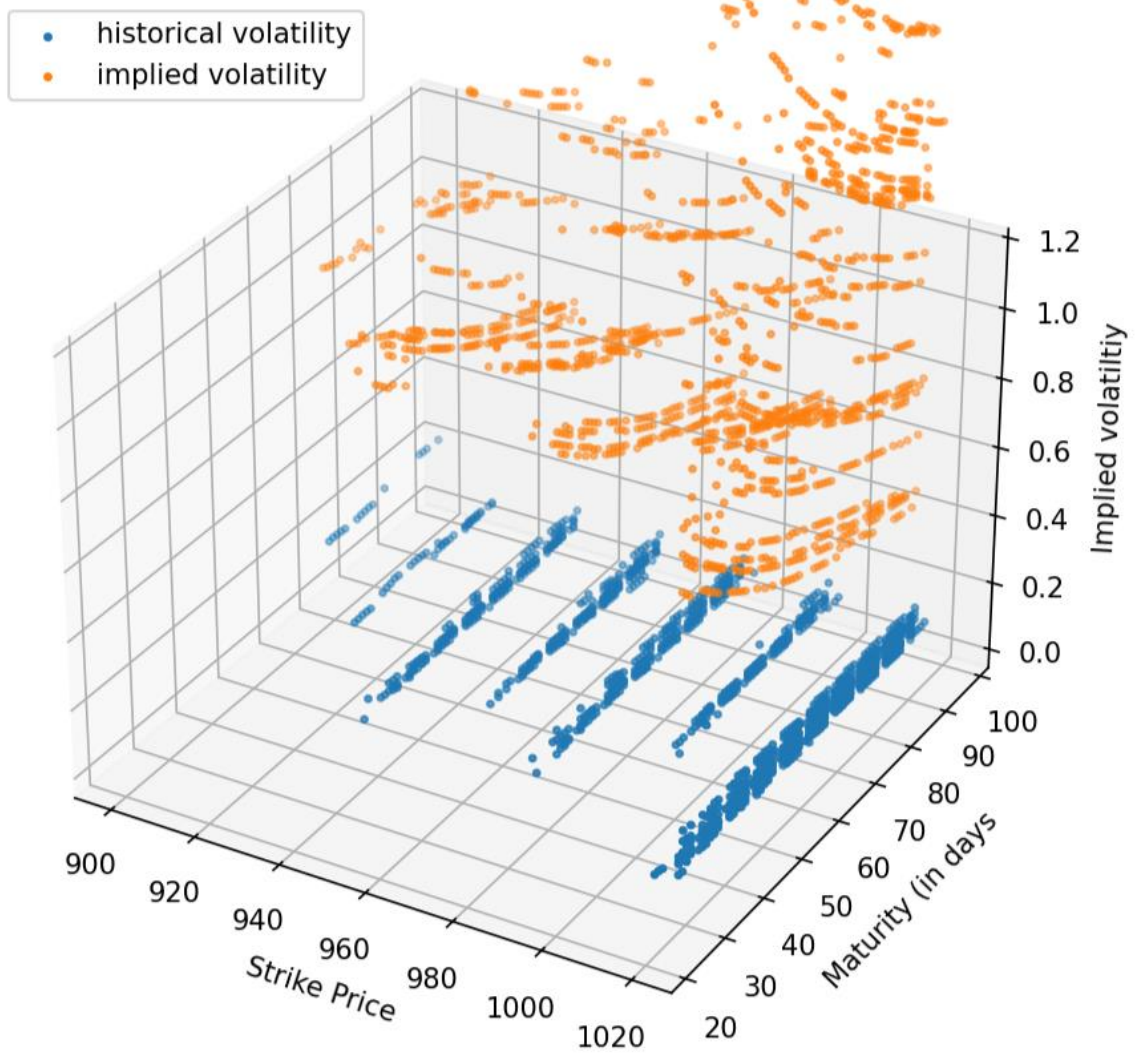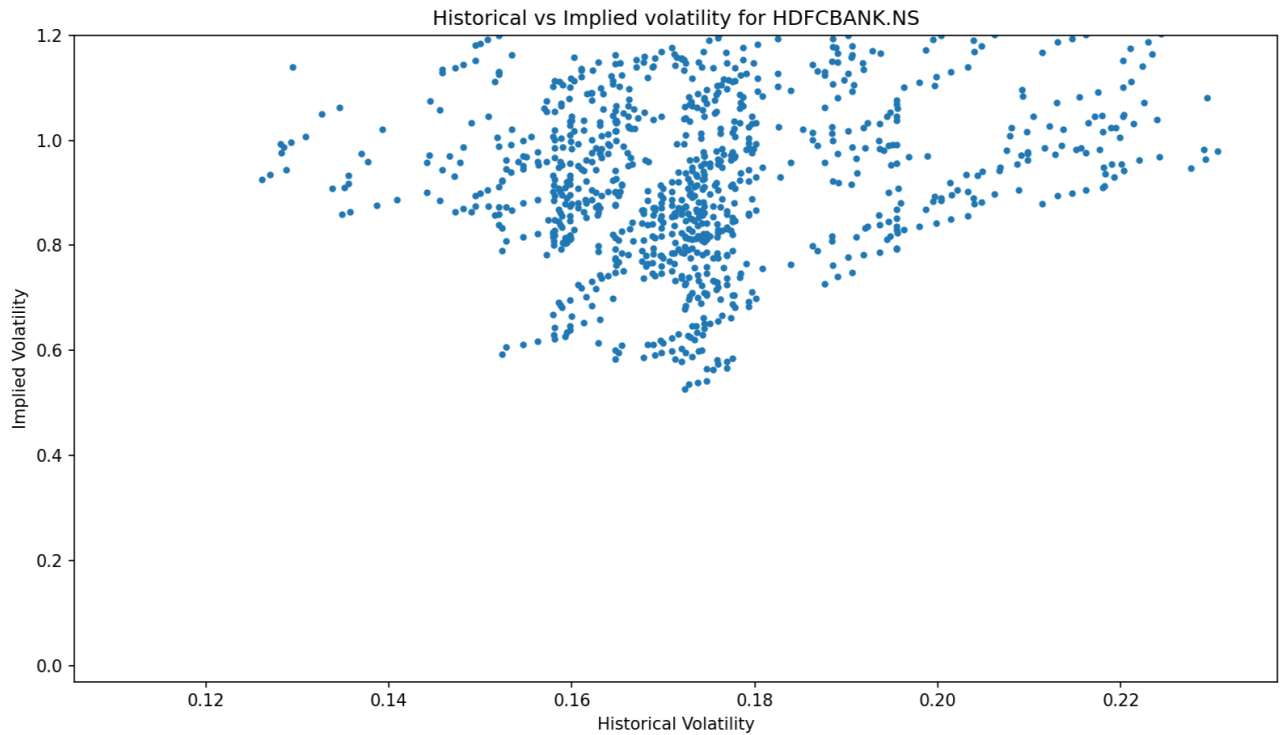Comparison between historical and implied volatility - HDFCBANK.NS
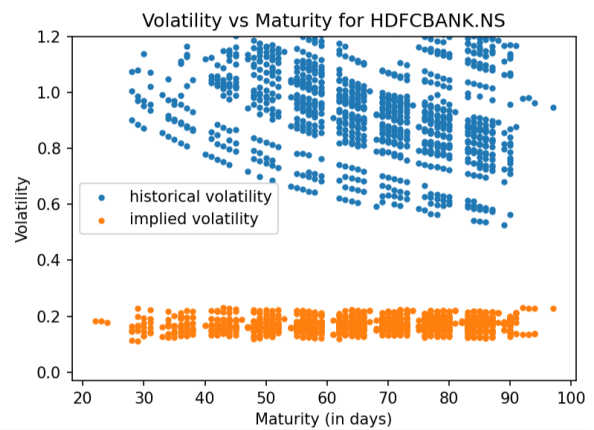
The tabular data is as follows:

For HDFCBANK.NS

SI No.	Call Price	Stock Price (S0)	Maturity (in days)	Historical Volatility	Implied Volatility
1	2.75	347.047	97	0.227676	0.947319
2	2.75	346.474	94	0.229271	0.964195
3	2.75	341.983	93	0.229055	0.981824
4	2.75	344.61	92	0.230601	0.979967
5	2.75	361.571	83	0.215605	0.984651
6	2.75	378.46	80	0.195486	0.956791
7	2.75	376.549	79	0.196801	0.968133
8	2.75	370.481	78	0.195076	0.991193
9	2.75	376.644	77	0.194052	0.980602
10	2.75	384.456	76	0.191053	0.965712
11	2.75	384.456	73	0.192019	0.985725
12	2.75	387.896	72	0.193626	0.983114
13	2.75	387.896	71	0.194595	0.990138
14	2.75	389.878	70	0.195439	0.991765
15	2.75	389.878	69	0.193505	0.999053
16	1.8	427.649	76	0.191053	0.81616
17	1.8	427.649	73	0.192019	0.83312
18	1.8	427.649	72	0.193626	0.839006
19	1.8	427.649	71	0.194595	0.845015
20	1.8	427.649	70	0.195439	0.851151

Observations:

1) We can observe that the price of call option decreases and that of put option increases with an increase in strike price. This trend is within our expectations.

2) But the plot for call option and put option doesn't exactly match with our expectations. The general trend is that the price of call

option tends to increase while that of put option tends to decrease with an increase in maturity period.

3) The lack of sufficient data adds difficulty in making proper analysis, but general trends can be figured out by considering the plots for NIFTY50 since it has larger data-points. The other plots also show similar trends.

4) Theoretically, the implied volatility is generally a convex function of strike price, and the curve so formed is known as the Volatility Smile. But this feature is not prominently observed in the plotted curves.

5) The volatility generally tends to decrease for larger maturity values, but for some of the above plots this nature is not very much observed.

6) Historical volatility is an estimate of the volatility over the past period, while the implied volatility is the estimation of the volatility for the upcoming months.

7) For data of some of the stocks like NIFTY50 and RELIANCE, implied volatility is generally higher while for stocks like BAJAJ-AUTO and TATAMOTORS, historical volatility is generally higher than the implied volatility. The significant difference between these 2 values arises due to several factors present in real market.

8) The plot for historical vs implied volatility very well captures this relation. Other plots show the dependence of different types of volatility with varying strike price and maturity.

9) Apart from the strike price and maturity period, the implied volatility and the option value also seems to also depend on when the price was collected. This means that even if the period values are same, the prices may differ if they are collected at different point of time. This is because the real market has several other random components, which affect the prices. Owing to this reason, the scatter plots are constructed to capture all these factors.