Lab - 09

Dipanshu Goyal 210123083

Ques - 1

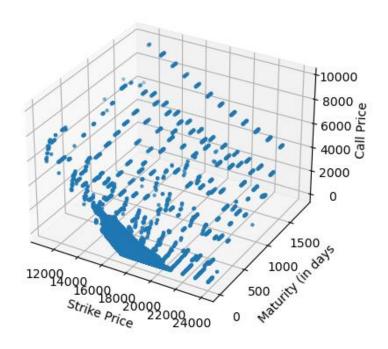
Data for the following companies are taken for analysis: -

- 1. Ambuja Cements
- 2. Apollo Hospitals
- 3. InterGlobe Aviation
- 4. Maruti Suzuki
- 5. TCS
- 6. NSE Index

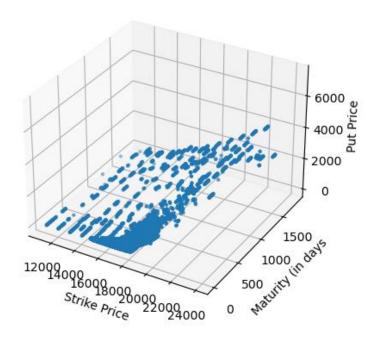
Ques - 2(a)

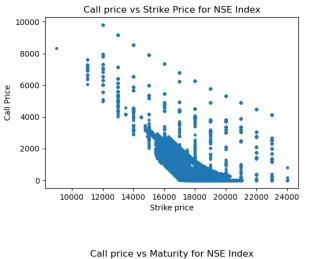
i. Nifty50

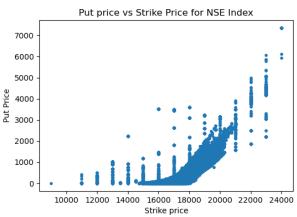
3D plot for Call Option - NSE Index

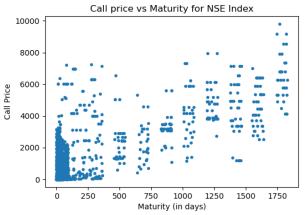


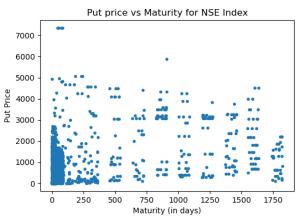
3D plot for Put Option - NSE Index





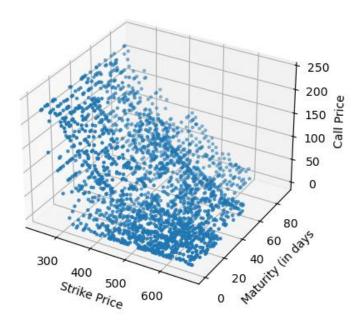




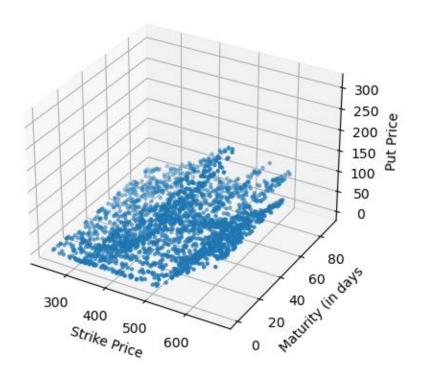


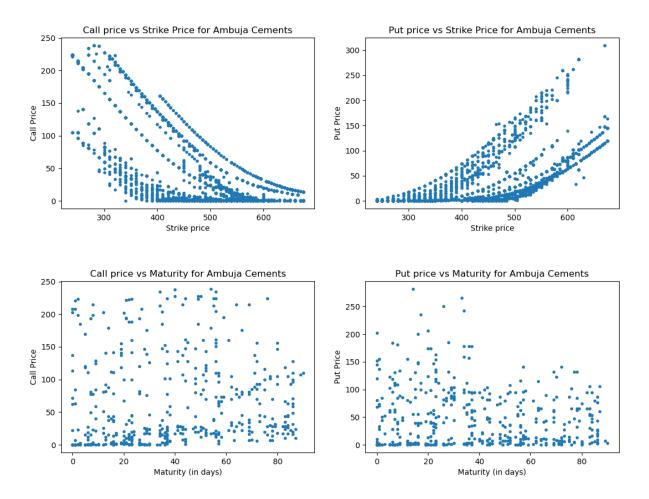
ii. Ambuja Cements

3D plot for Call Option - Ambuja Cements



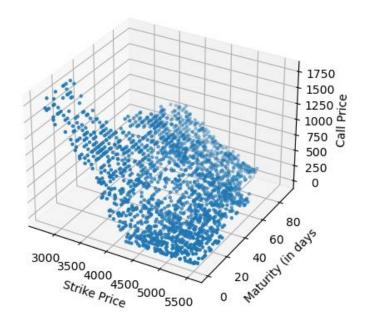
3D plot for Put Option - Ambuja Cements



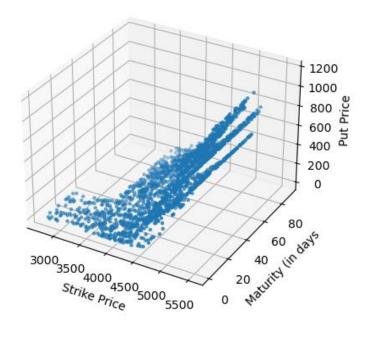


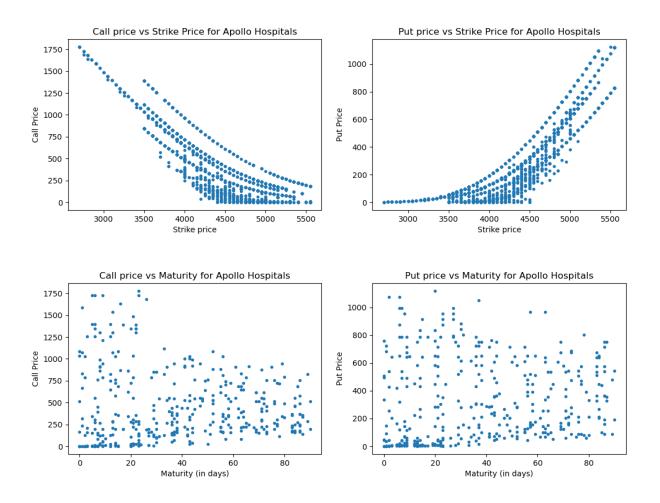
iii. Apollo Hospitals

3D plot for Call Option - Apollo Hospitals



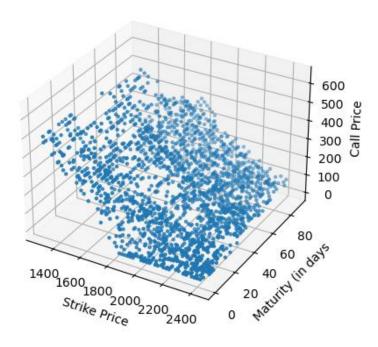
3D plot for Put Option - Apollo Hospitals



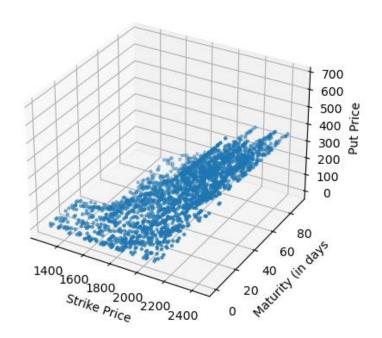


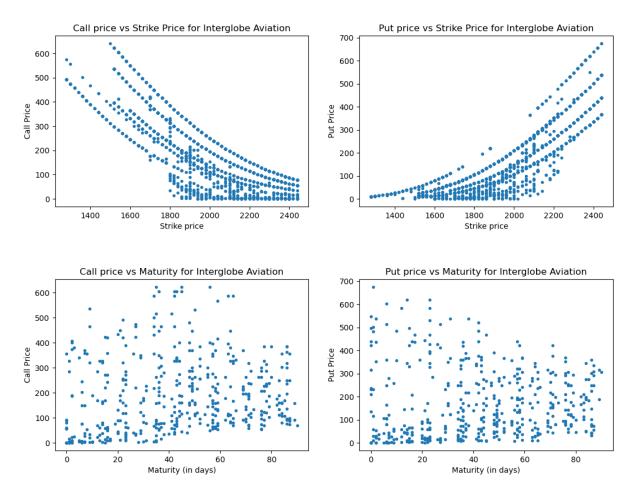
iv. InterGlobe Aviation

3D plot for Call Option - Interglobe Aviation



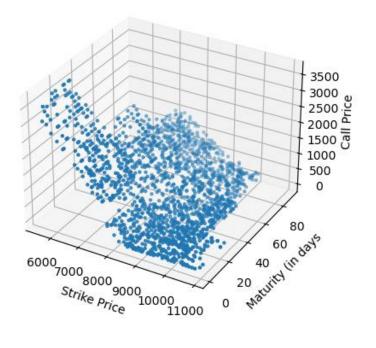
3D plot for Put Option - Interglobe Aviation



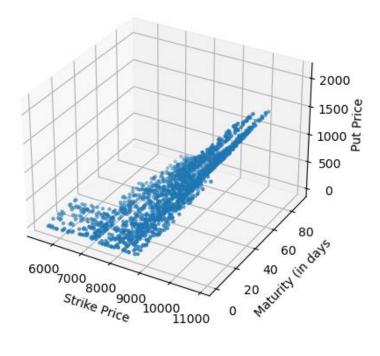


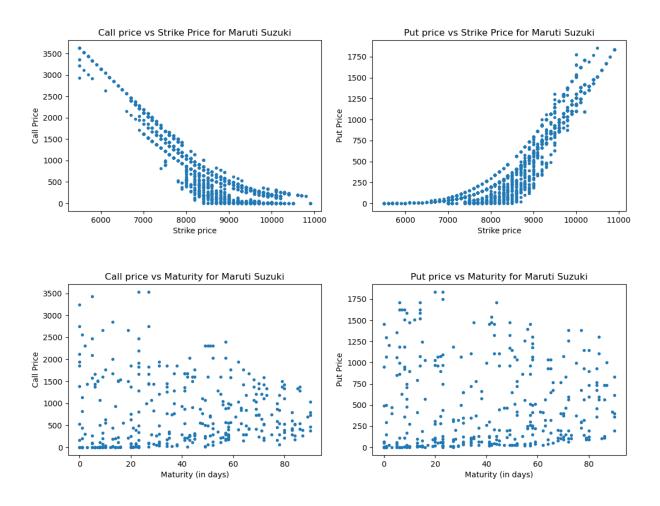
v. Maruti Suzuki

3D plot for Call Option - Maruti Suzuki



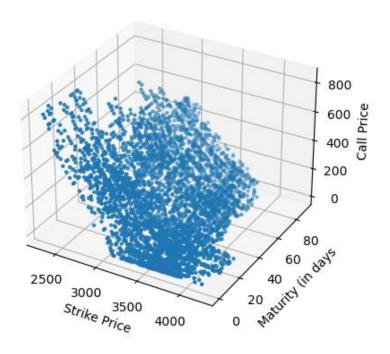
3D plot for Put Option - Maruti Suzuki



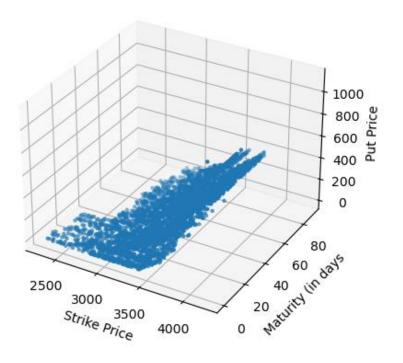


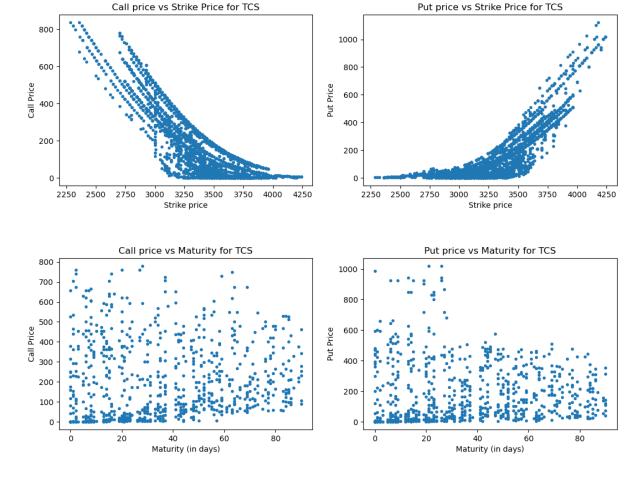
vi. TCS

3D plot for Call Option - TCS



3D plot for Put Option - TCS





Observations: -

- 1. We can observe that the price of call option decreases and that of put option increases with an increase in strike price.
- 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.

Ques
$$-2(b)$$

Newton-Raphson method is used to find out the implied volatility from the BSM formula.

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

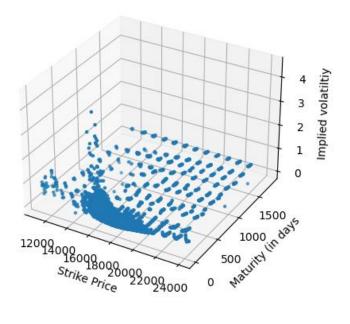
$$C(x,t)=xN(d_1)-Ke^{-r(T-t)}N(d_2)$$
 where,
$$d_1=\frac{\log\left(\frac{x}{K}\right)+(r+\frac{1}{2}\sigma^2)(T-t)}{\sigma\sqrt{T-t}}$$

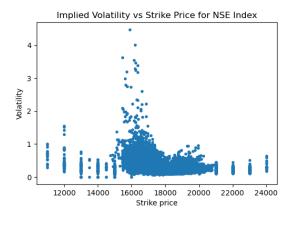
$$d_2=\frac{\log\left(\frac{x}{K}\right)+(r-\frac{1}{2}\sigma^2)(T-t)}{\sigma\sqrt{T-t}}$$

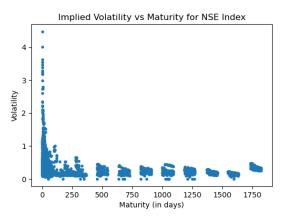
$$N(x)=\frac{1}{\sqrt{2\pi}}\int_{-\infty}^x e^{-\frac{1}{2}y^2}dy$$

i. Nifty50

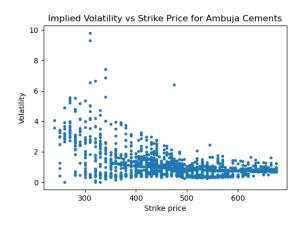
3D plot for Implied volatility - NSE Index

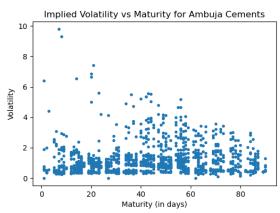




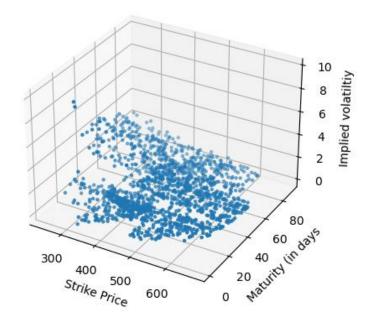


ii. Ambuja Cements



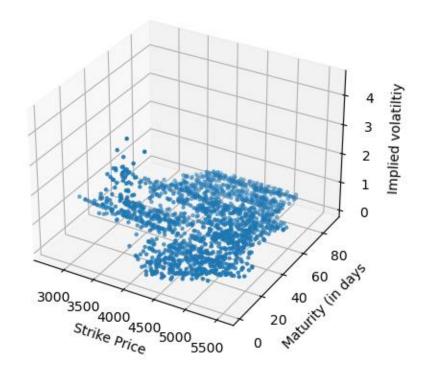


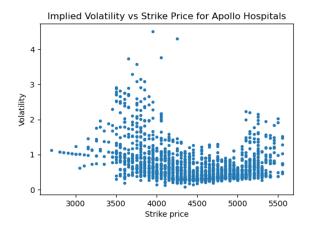
3D plot for Implied volatility - Ambuja Cements

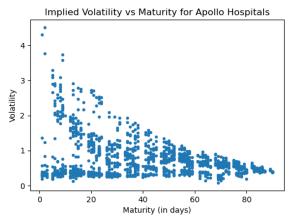


iii. Apollo Hospitals

3D plot for Implied volatility - Apollo Hospitals

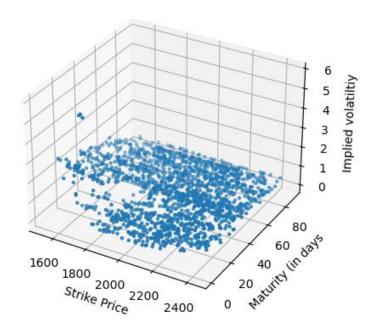


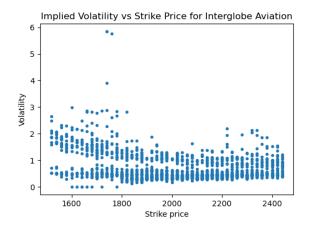


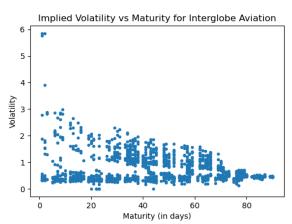


iv. InterGlobe Aviation

3D plot for Implied volatility - Interglobe Aviation

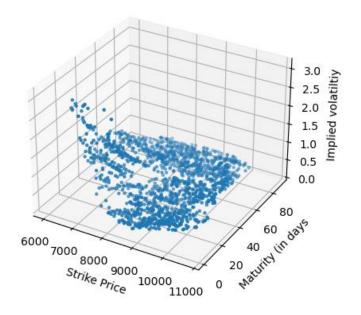


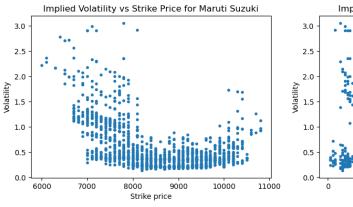


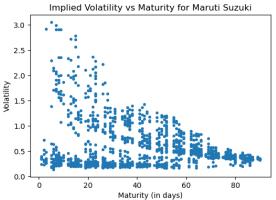


v. Maruti Suzuki

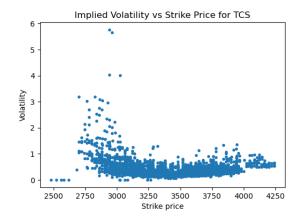
3D plot for Implied volatility - Maruti Suzuki

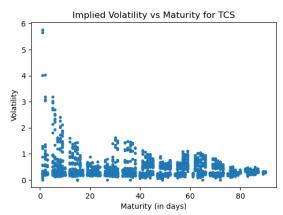


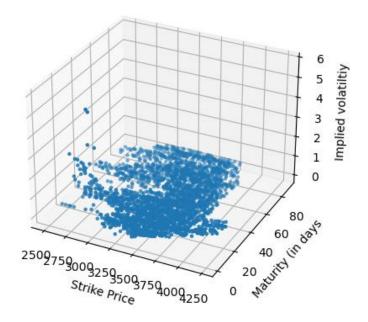




vi. TCS





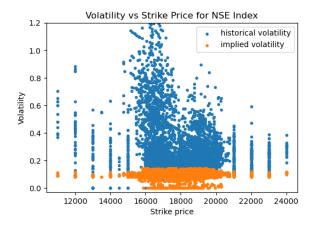


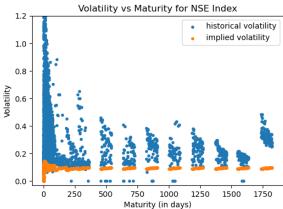
Observations: -

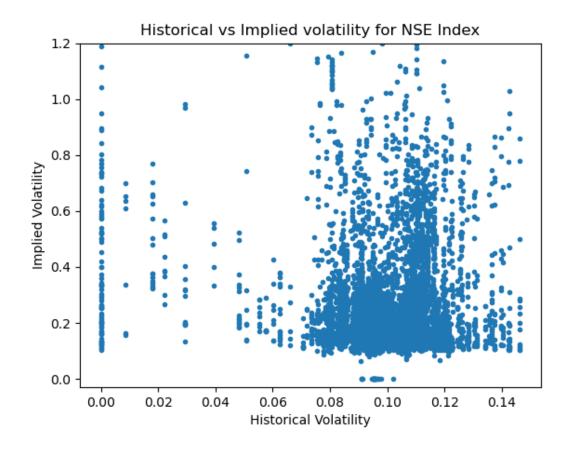
- 1. Theoretically, the implied volatility is generally a convex function of strike price, and the curve so formed is known as the **Volatility Smile**. But this feature is not prominently observed in some of the plotted curves. In some curves, we can observe bit of a smile like shape.
- 2. The volatility generally tends to decrease for larger maturity values, but for some of the above plots this nature is not very much observed.

Ques
$$-2(c)$$

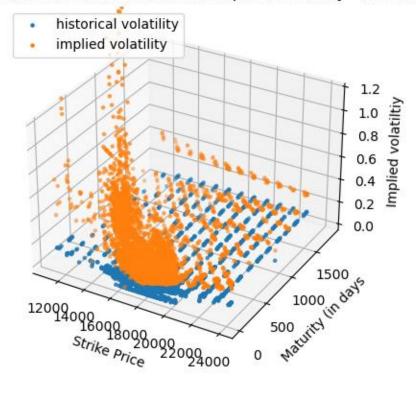
i. Nifty50



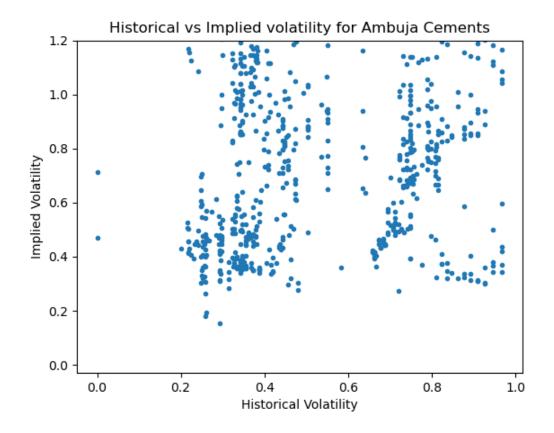




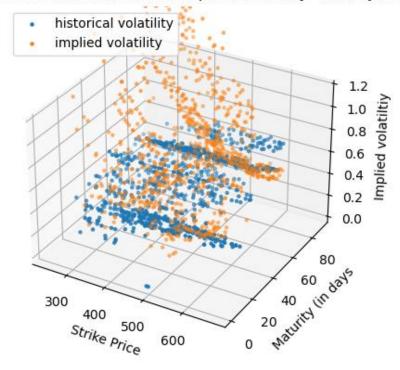
Comparison between historical and implied volatility - NSE Index

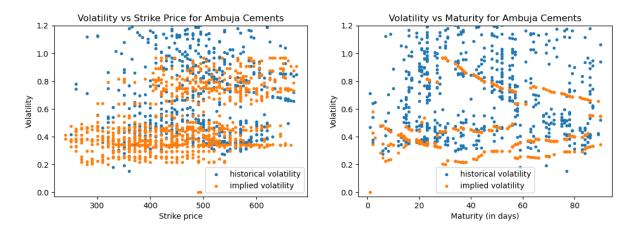


ii. Ambuja Cements

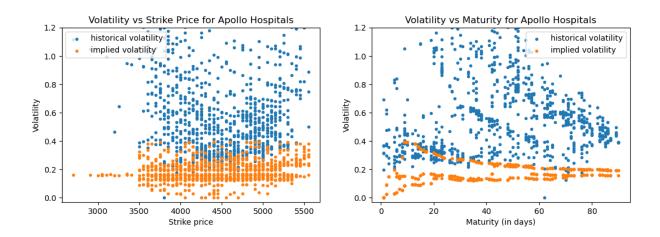


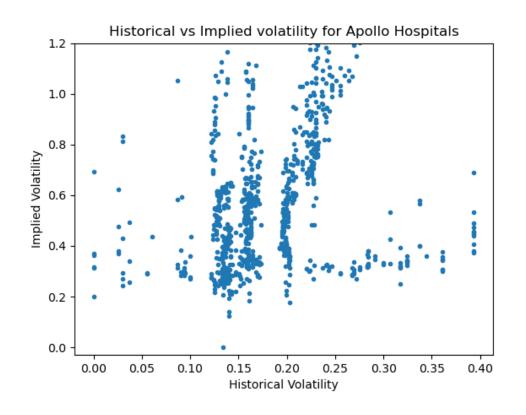
Comparison between historical and implied volatility - Ambuja Cements



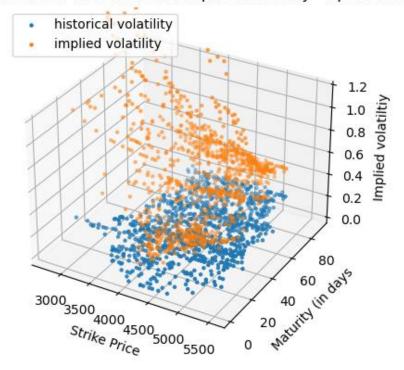


iii. Apollo Hospitals

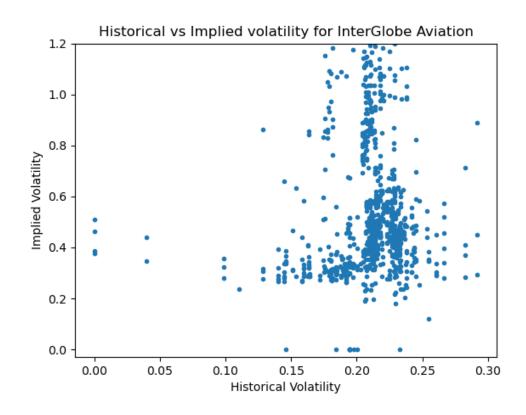


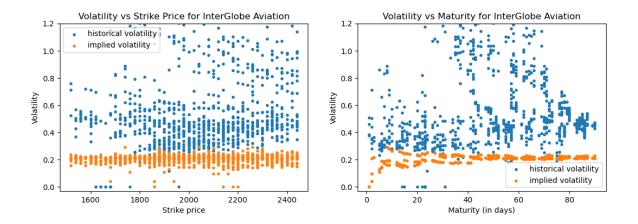


Comparison between historical and implied volatility - Apollo Hospitals

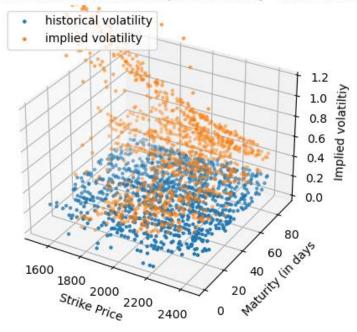


iv. InterGlobe Aviation

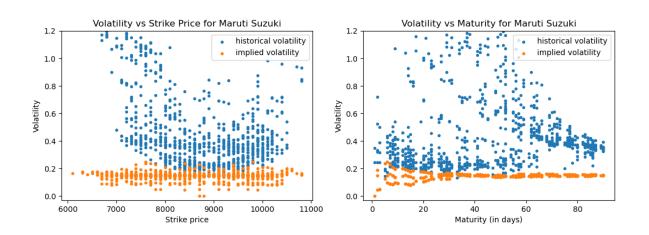




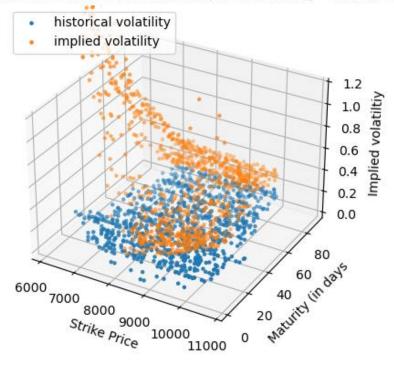
Comparison between historical and implied volatility - InterGlobe Aviation

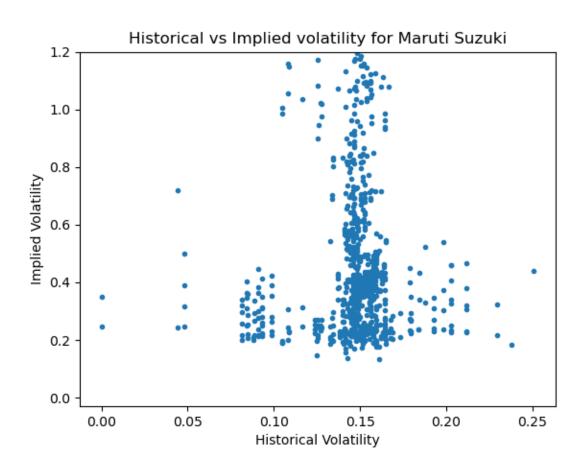


v. Maruti Suzuki



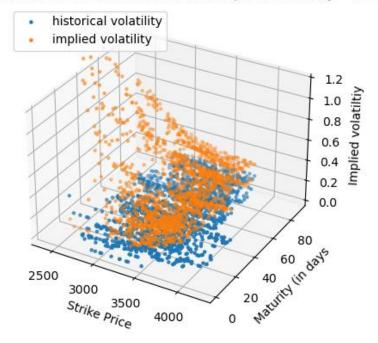
Comparison between historical and implied volatility - Maruti Suzuki

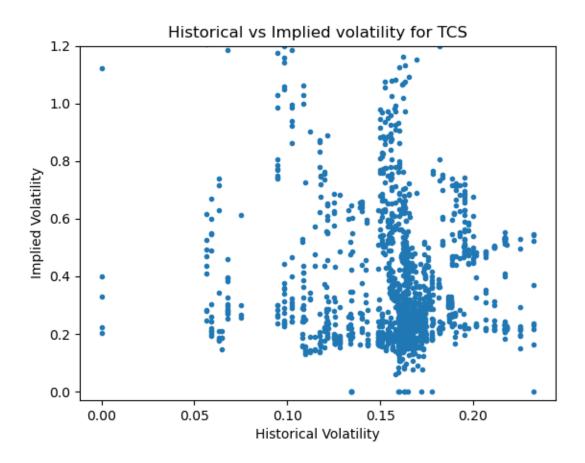


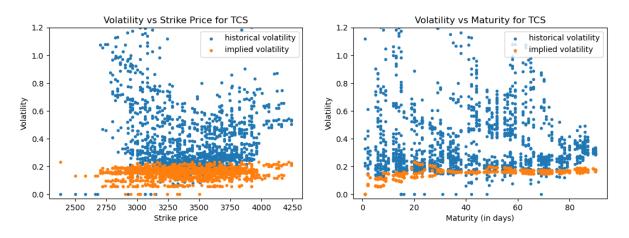


vi. TCS

Comparison between historical and implied volatility - TCS







<u>Tabular Data</u> (for few points): -

**************************************	****** For N Call Price	SE Index ********* Stock Price (S0)	******* Maturity (in days)	Historical Volatility	Implied Volatility
1	2934.9	18191	7	0.085219	0.730068
2	1.1	18191	7	0.085219	0.199349
3	122.6	18191	7	0.085219	0.117769
4	1.05	18191	7	0.085219	0.261815
5	475.55	18191	7	0.085219	0.14509
6	613.55	18191	7	0.085219	0.140538
7	568.95	18191	7	0.085219	0.150372
8	2743.2	18191	7	0.085219	0.719412
9	2367.2	18191	7	0.085219	0.701084
10	2321.1	18191	7	0.085219	0.699139
11	2695.6	18191	7	0.085219	0.716863
12	520	18191	7	0.085219	0.142585
13	1.05	18191	7	0.085219	0.351335
14	2506.85	18191	7	0.085219	0.707515
15	1	18191	7	0.085219	0.338042
16	1543.05	18191	7	0.085219	0.674112
17	2	18191	14	0.110508	0.197546
18	1327.3	18191	14	0.110508	0.440969
19	4.9	18191	14	0.110508	0.136632
20	1938	18191	14	0.110508	0.426916

*****	****** For	Ambuja Cements ****	*****		
SI No.	Call Price	Stock Price (S0)	Maturity (in days)	Historical Volatility	Implied Volatility
1	29	518.4	1	0	0.712496
2	132.75	518.4	28	0.323464	1.15054
3	74.75	518.4	28	0.323464	0.485992
4	128.35	518.4	28	0.323464	1.1301
5	17.35	518.4	28	0.323464	0.824233
6	19.6	518.4	28	0.323464	0.827632
7	14.65	518.4	28	0.323464	0.396325
8	146.2	518.4	28	0.323464	1.21646
9	107.3	518.4	28	0.323464	1.04359
10	19.2	518.4	57	0.723714	0.682521
11	48.35	518.4	57	0.723714	0.774482
12	46	518.4	57	0.723714	0.766731
13	20.35	518.4	57	0.723714	0.686054
14	105.4	518.4	57	0.723714	0.993735
15	43.75	518.4	57	0.723714	0.759507
16	109.35	518.4	57	0.723714	1.01166
17	103.3	522.75	27	0.327651	0.968792
18	3.95	522.75	27	0.327651	0.388983
19	48.15	522.75	27	0.327651	0.501684
20	6.55	522.75	27	0.327651	0.375401

1 320	**************************************	******* For Call Price	Apollo Hospitals ** Stock Price (S0)	************** Maturity (in days)	Historical Volatility	Implied Volatility
2 199.2 4588.65 1 1 0 0.654932 3 4.75 4588.65 1 1 0 0.153934 0.70373 4 104.6 4588.65 2 0 0.153934 0.73437 5 104.7 4588.65 2 0 0.153934 0.734432 7 7 375.75 4588.65 3 7 0.225654 0.69158 9 423.5 4588.65 5 77 0.225654 0.80158 9 423.5 4588.65 5 77 0.225654 0.71473 110 740.65 4588.65 5 77 0.225654 0.71473 111 720.55 4588.65 5 77 0.225654 0.71473 112 720.55 4588.65 5 77 0.225654 0.71473 113 720.55 4588.65 5 77 0.225654 0.71473 114 740.65 4588.65 5 77 0.225654 0.71473 115 720.55 4588.65 5 77 0.225654 0.71473 116 740.65 4588.65 5 77 0.225654 0.71473 117 740.65 4588.65 5 77 0.225654 0.71473 118 720.55 4588.65 5 77 0.225654 0.71473 119 720.55 4588.65 5 77 0.225654 0.668335 110 10 10 10 10 10 10 10 10 10 10 10 10						
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SI No.	Call Price	Stock Price (S0)	Maturity (in days)	Historical Volatility	Implied Volatility
1	24.4	3257.1	1	0	0.204964
2	123.25	3257.1	28	0.201686	0.236141
3	9.85	3257.1	28	0.201686	0. 482468
4	10.7	3257.1	28	0.201686	0.482209
5	3.65	3257.1	28	0.201686	0.327089
6	30.85	3257.1	28	0.201686	0.472315
7	214	3257.1	28	0.201686	0.397333
8	109.55	3257.1	28	0.201686	0.231006
9	12.6	3257.1	28	0.201686	0.227129
10	87.45	3257.1	28	0.201686	0.22981
11	640	3257.1	57	0.188535	0.739073
12	58.15	3257.1	57	0.188535	0.440342
13	131.4	3257.1	57	0.188535	0.470309
14	604.3	3257.1	57	0.188535	0.714888
15	7	3257.1	57	0.188535	0.228527
16	74.5	3257.1	57	0.188535	0.447701
17	407.05	3257.1	57	0.188535	0.595797
18	105.45	3257.1	57	0.188535	0.459991
19	309.6	3257.1	57	0.188535	0.546546
20	9.85	3268.75	27	0.206897	0.48504

Observations: -

- 1. Historical volatility is an estimate of the volatility over the past period of time, while the implied volatility is the estimation of the volatility for the upcoming months.
- 2. For data of some of the stocks, implied volatility is generally higher while for other stocks, historical volatility is generally higher than the implied volatility. The significant difference between these 2 values arises due to a number of factors present in real market.
- 3. 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.