

REPORT 4, THREE PARTS COMBINED TOGETHER

Bahador Amjadi

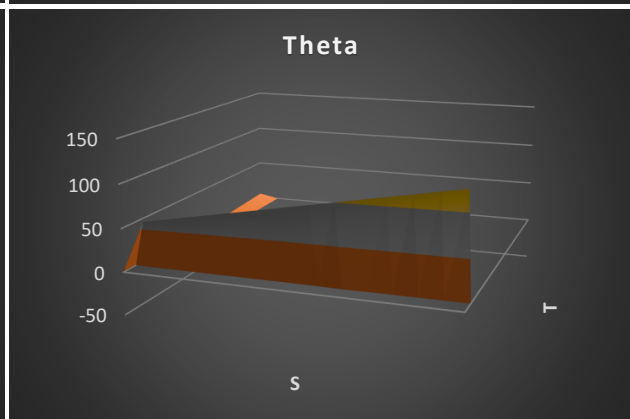
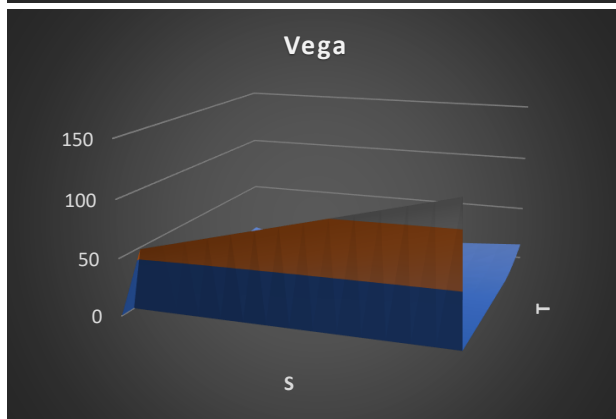
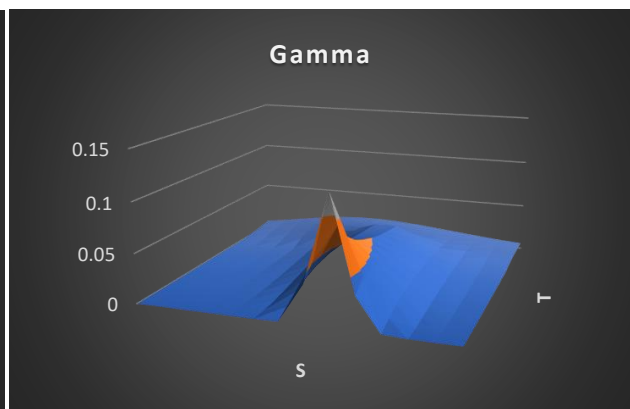
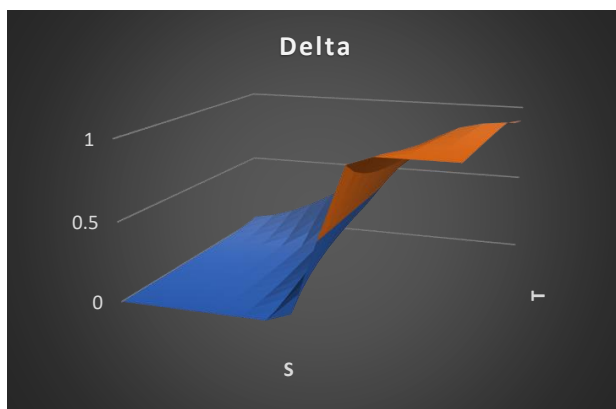
2040470

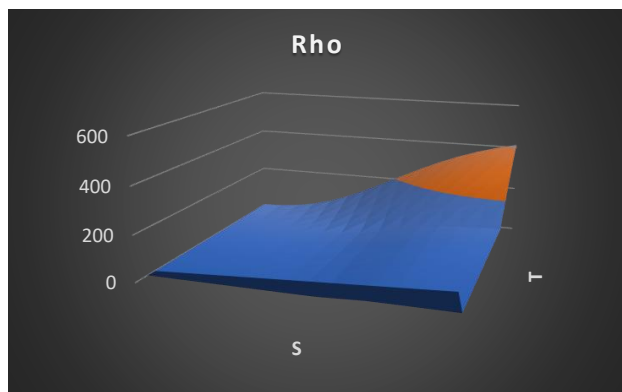
PART 1

In this part, we have to find the Greeks surface for a B-S model as a function of S and T , the maturity time. Then we repeat the former procedure when having a 50% shock in volatility. The essential parameters to calculate Greeks are provided as the following:

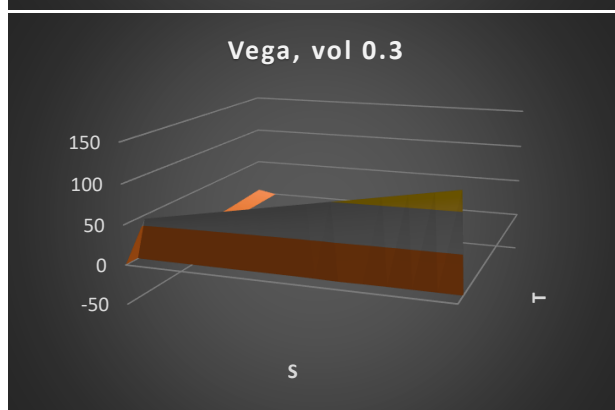
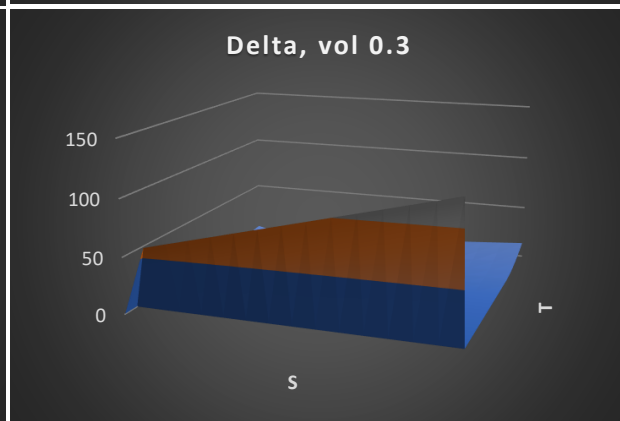
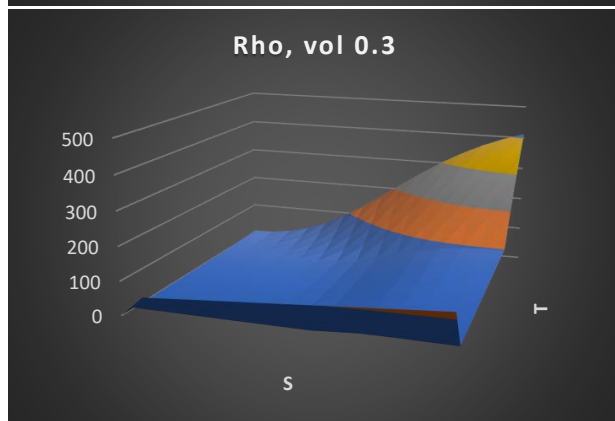
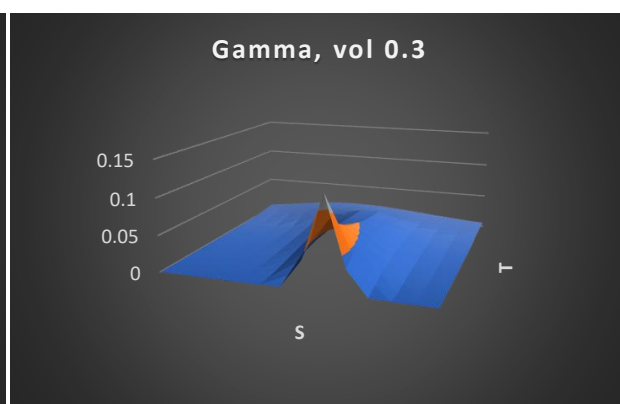
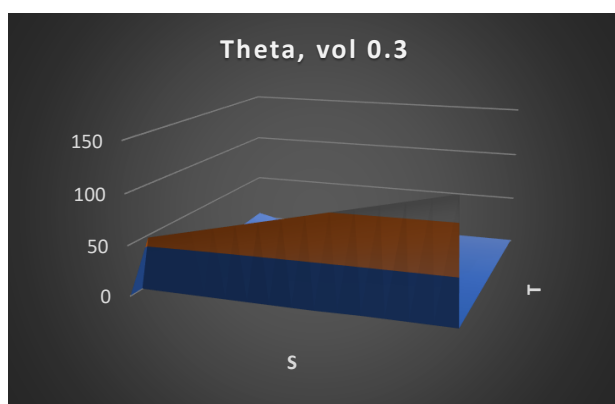
K	r	Vol	S	T
100	0.01	0.2	60	0.1
			65	0.2
			70	0.3
			75	0.4
			80	0.5
			85	0.6
			90	0.7
			95	0.8
			100	0.9
			105	1
			110	2
			115	3
			120	4
			125	5

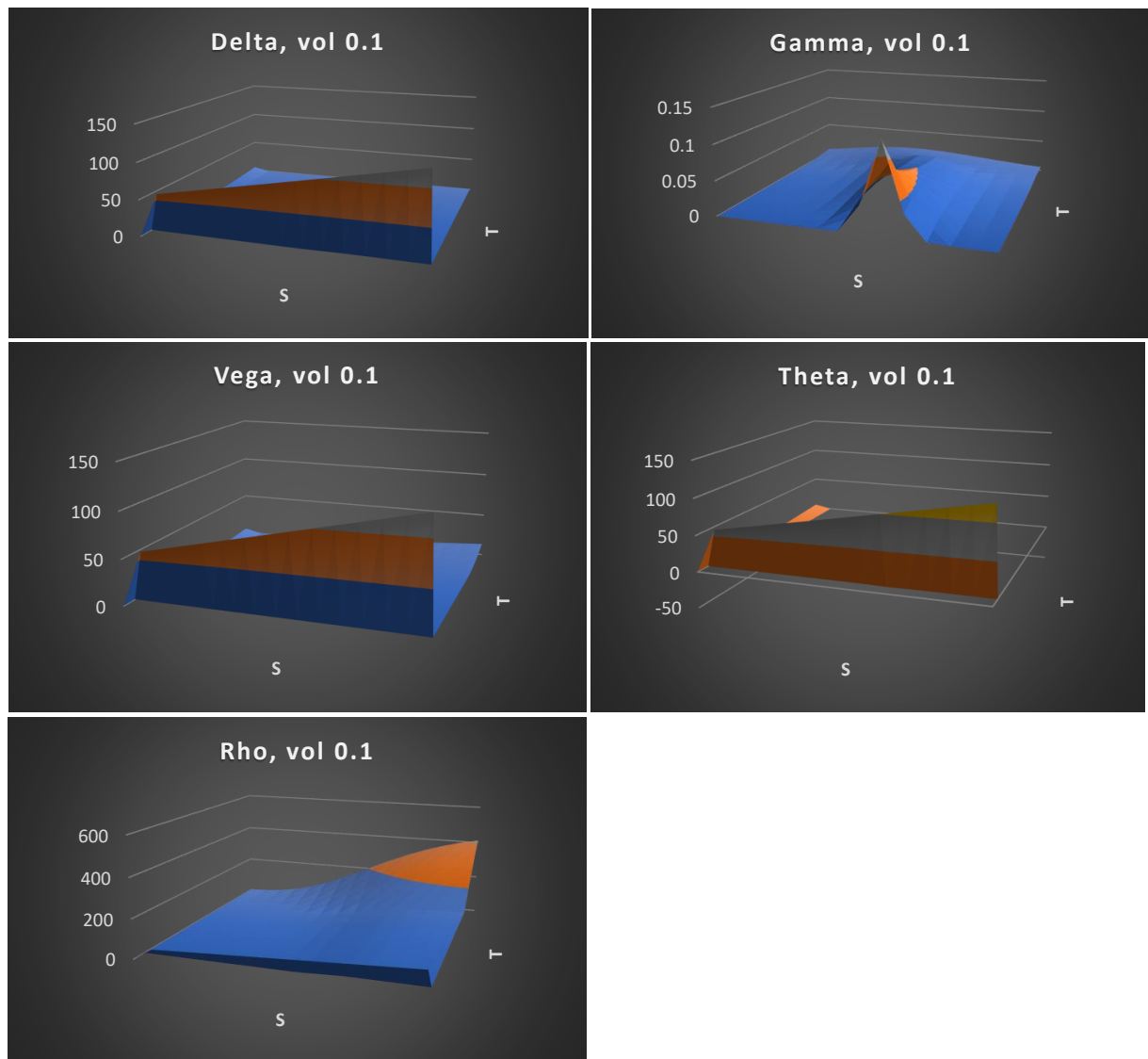
For each Greek, we set up a 2-D table storing the output values of the VBA function given S and T . Then we plot the 3-D surface as a function of S and T for each Greek.





Now we repeat the same procedure considering a 50% positive or negative shock in volatility:





PART 2

In this section, unlike the previous part, we are supposed to work on emirical data taken from Yahoo Finance. We choose a non-paying dividend stock. The stock we choose is The Walt Disney Company (DIS). Then we plot volatility surface as function of T and K and check the volatility smile effect. Additionally the smoothness of Greeks at large values of T is evaluated.

The Walt Disney Company (DIS)

NYSE - Nasdaq Real Time Price. Currency in USD

[Add to watchlist](#)

132.96 **+1.10 (+0.83%)**

As of 12:55PM EDT. Market open.

[Start Trading >>](#)

Plus500 73% of retail CFD accounts lose money

[Summary](#) [Chart](#) [Conversations](#) [Statistics](#) [Historical Data](#) [Profile](#) [Financials](#) [Analysis](#) [Options](#) [Holders](#) [Sustainability](#)

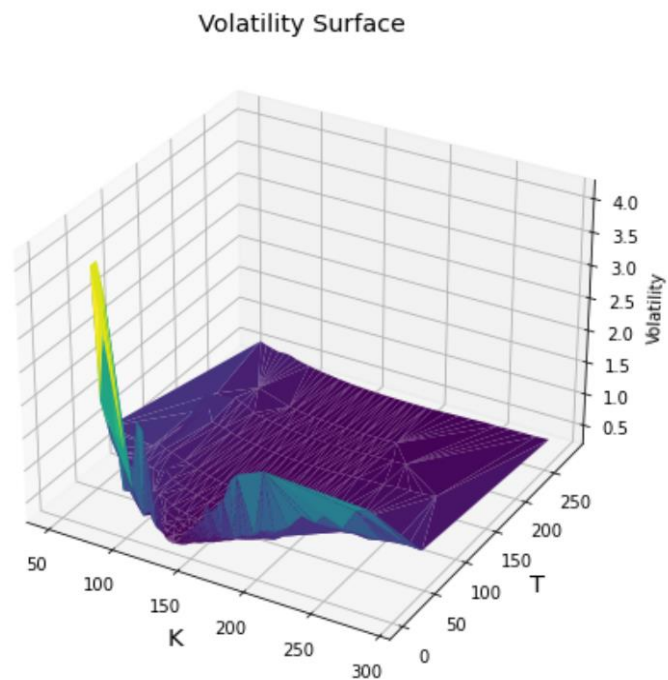
Previous Close	131.87	Market Cap	242.074B
Open	132.00	Beta (5Y Monthly)	1.16
Bid	132.85 x 800	PE Ratio (TTM)	79.00
Ask	132.87 x 1100	EPS (TTM)	1.68
Day's Range	130.63 - 133.11	Earnings Date	May 11, 2022
52 Week Range	128.38 - 190.40	Forward Dividend & Yield	N/A (N/A)
Volume	3,247,925	Ex-Dividend Date	Dec 13, 2019
Avg. Volume	11,871,709	1y Target Est	N/A



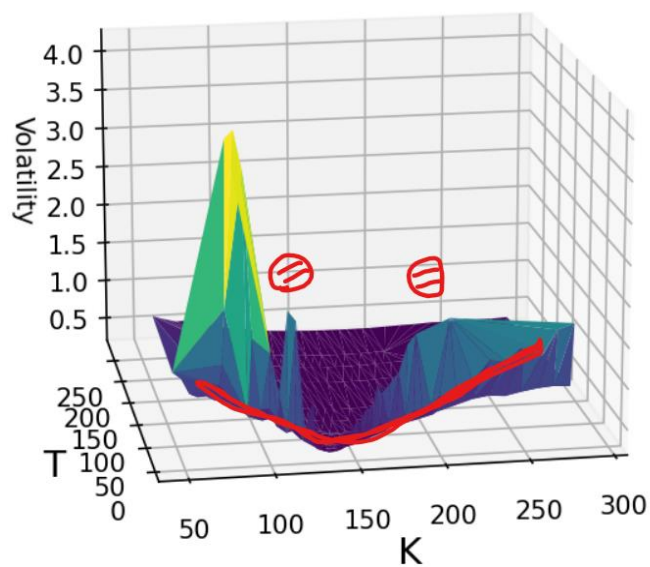
For this part, although calculations are done in excel, the output of calculations is stored using Python Pandas library and plotted in 3-D using Python Matplotlib library:

	T	K	V
0	1	100.0	1.5469
1	1	105.0	1.0625
2	1	110.0	2.0586
3	1	115.0	1.9297
4	1	120.0	0.6172
...
364	281	250.0	0.3232
365	281	260.0	0.3318
366	281	270.0	0.3355
367	281	280.0	0.3379
368	281	290.0	0.3477

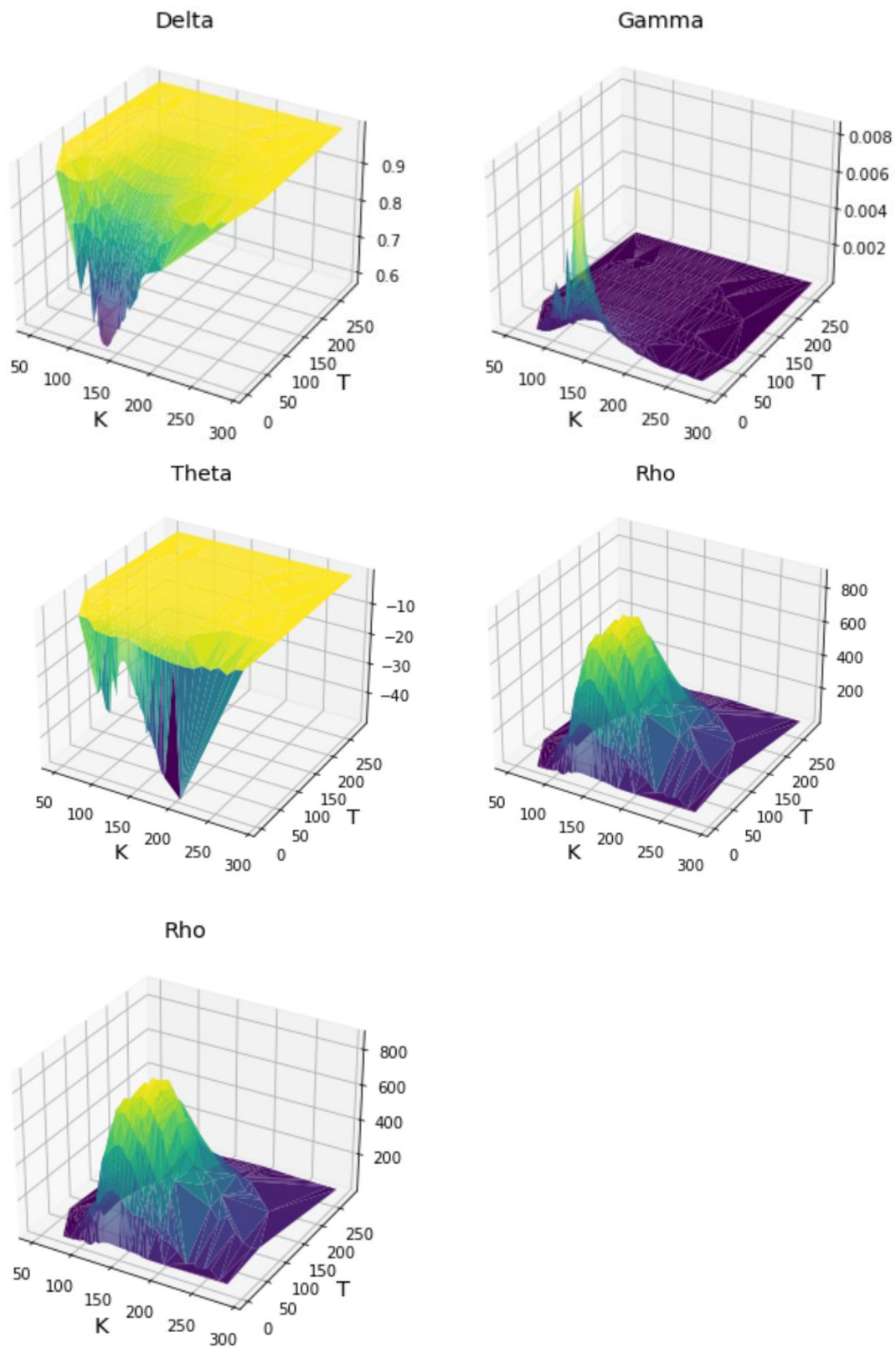
369 rows × 11 columns



The volatility smile effect can be easily seen if we change the angle we are looking at the plot.



Now we should calculate Greeks and check their smoothness for large T:



As we can see for all of the Greeks, we have the smoothness of Greeks as T tends to large values.

PART 3

In this last part we are supposed to first, estimate the historical volatility of the asset chosen in the previous part, Then we price the ATM call option for different maturities and compare them to their real values. Finally, we visualize the difference between ATM Imp. volatility vs Hist. Volatility.

T (Days)	No. of wokting days	Hist. Vol
1	1	0.000564833
7	5	0.036880313
14	10	0.05473668
21	15	0.060331857
28	20	0.085060174
35	25	0.105867112
40	28	0.107069233
67	47	0.138128138
95	67	0.162989667
156	111	0.199087678
192	137	0.212164923
219	156	0.222138381
281	200	0.240633931

Return	s	Hist. Vol.	K	R	Imp. Vol.	S	T (Days)	DeltaC	GammaCP	Vega	Theta	Rho	BSMCall (Using Hist. Vol)	CP Real	Error
-0.035469305	172.95	14%	50	0.0097	102%	50	67	0.9999897	1.10136E-07	0.01884446	-0.000148819	0.035673994	30.4927863	81	166%
-0.026282901	179.31	14%	55	0.0097	94%	55	67	0.9999607	3.85857E-07	0.073847567	-0.000542191	0.150480351	33.54206493	82.11	145%
0.003979915	184.14999	14%	60	0.0097	74%	60	67	0.9991683	7.79815E-06	1.396013707	-0.008246229	3.550171415	36.59134356	71.2	95%
-0.001252361	183.42	14%	65	0.0097	70%	65	67	0.9984998	1.31549E-05	2.596615579	-0.014523454	6.985709574	39.64062219	67.8	71%
-0.003959274	183.64999	14%	70	0.0097	71%	70	67	0.9986428	1.10242E-05	2.551924346	-0.014412144	6.797187361	42.6890083	72	69%
0.041459627	184.38001	14%	75	0.0097	65%	75	67	0.9972197	2.1491E-05	5.244378208	-0.027523696	15.07424835	45.73917946	57.65	26%
0.024536979	177.03999	14%	80	0.0097	64%	80	67	0.9968568	2.28673E-05	6.248063797	-0.032348254	18.21648594	48.78845809	62.6	28%
-0.00011575	172.8	14%	85	0.0097	58%	85	67	0.9937538	4.39125E-05	12.25887234	-0.058407689	39.01745814	51.83773672	48.05	7%
-0.005008895	172.82001	14%	90	0.0097	55%	90	67	0.9915488	5.69466E-05	16.9451625	-0.077494426	56.35157392	54.88701535	41	25%
-0.019310028	173.69	14%	95	0.0097	63%	95	67	0.9967664	1.98289E-05	7.611271714	-0.039280459	22.26526839	57.93629398	41.13	29%
-0.000846181	177.11	14%	100	0.0097	50%	100	67	0.9868757	8.17171E-05	27.62708171	-0.118319777	98.67137232	60.9857261	32.26	47%
0.008476936	177.26	14%	105	0.0097	47%	105	67	0.9818026	0.000110612	38.40208131	-0.155784213	145.675581	64.03485124	28.9	55%
0.010579032	175.77	14%	110	0.0097	42%	110	67	0.9719667	0.000109787	57.9077013	-0.216694324	240.9932746	67.08412987	23.6	65%
-0.014951656	173.92999	14%	115	0.0097	40%	115	67	0.9659021	0.000202534	71.19193137	-0.25578385	310.9895224	70.1334085	20.13	71%
-0.00998037	176.57001	14%	120	0.0097	37%	120	67	0.9593293	0.000237766	85.79439409	-0.296393718	393.2811791	73.18268713	15.58	79%
0.002360552	178.35001	14%	125	0.0097	36%	125	67	0.9534221	0.00026776	99.7067098	-0.333589996	476.0506574	76.23196576	11.85	84%
0.014829128	177.92999	14%	130	0.0097	34%	130	67	0.9470836	0.000300246	114.8075421	-0.372084949	571.5915598	79.28124439	8.4	89%
0.010547562	175.33	14%	135	0.0097	33%	135	67	0.9423821	0.000321119	127.5143908	-0.404195709	654.3579975	82.33052302	6.1	93%
-0.002701621	173.5	14%	140	0.0097	31%	140	67	0.9373663	0.000343998	141.1682543	-0.437488377	747.853763	85.37980165	4.2	95%
0.008989694	173.97	14%	145	0.0097	31%	145	67	0.9363927	0.000338752	147.9769491	-0.456638296	788.7166852	88.42908028	2.83	97%
-0.012768371	172.42	14%	150	0.0097	31%	150	67	0.9344221	0.000340585	156.750967	-0.479611116	845.970069	91.47835891	1.8	98%
-5.73113E-05	174.64999	14%	155	0.0097	31%	155	67	0.9366369	0.00031534	157.7095171	-0.487190583	839.339747	94.52763754	1.19	99%

Finally we visualize the difference between ATM Imp. volatility vs Hist. Volatility.

