Stochastic methods for finance, Report 4

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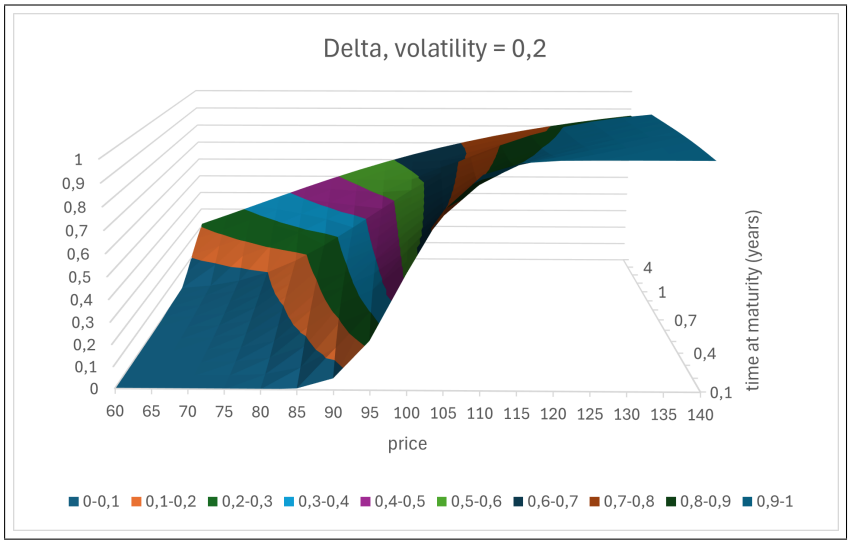
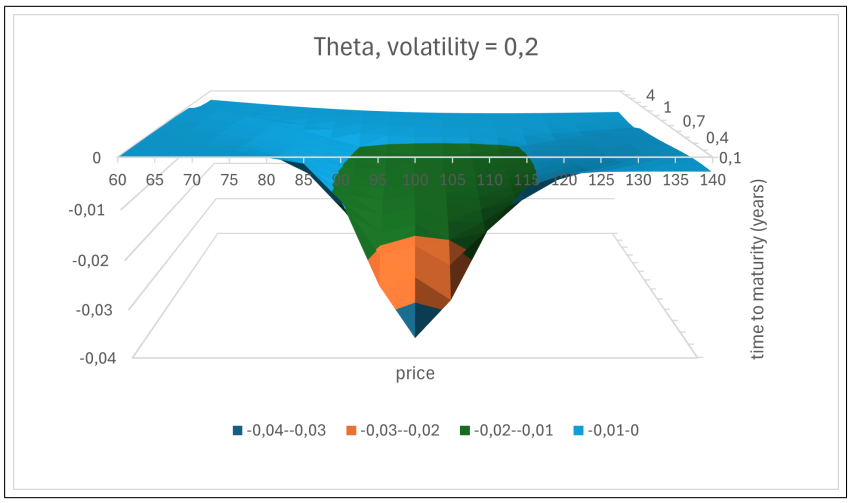
1 Part 1

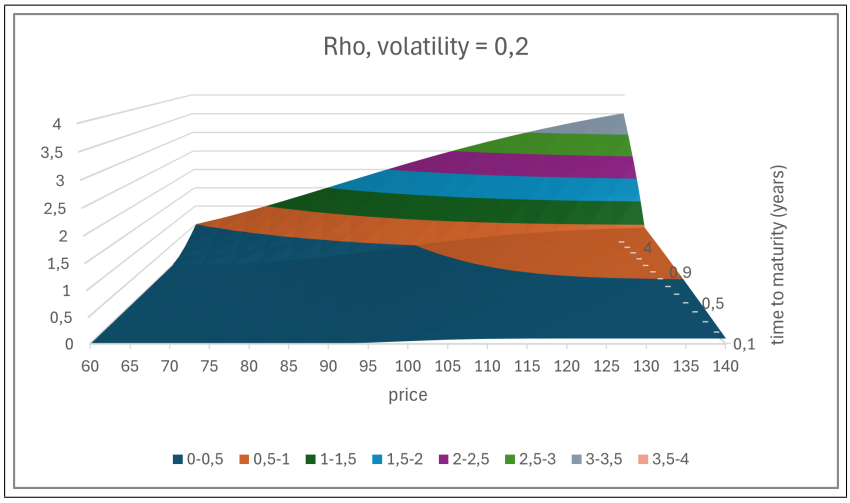
In this exercise we had to implement the code to compute the Greeks in VBA, and compute them in order to obtain surfaces in function of the strike price and time to maturity. We had to do so and plot these surfaces for call and put options with these parameters: $S = 100$, $r = 1\%$, $\sigma = 20\%$. And also plot the results for a volatility shock $\sigma = \pm 50\%$

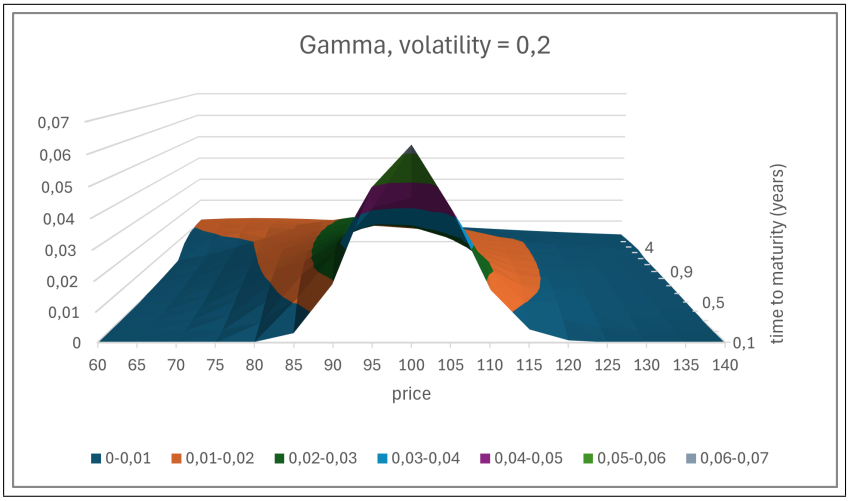
I calculated these values implementing the relative functions with VBA in excel. I report the results below.

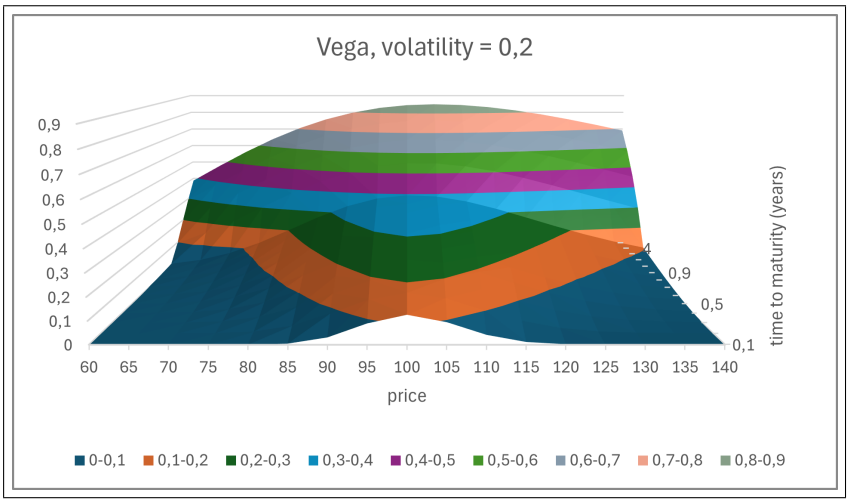
1.1 Call Results




Theta, volatility = 0,2
0
-0,01
-0,02
-0,03
-0,04
60 65 70 75 80 85 90 95 100 105 110 115 120 125 130 135 140
price
4
1
0,7
0,4
0,1
time to maturity (years)
-0,04--0,03
-0,03--0,02
-0,02--0,01
-0,01-0


Rho, volatility = 0,2
4
3,5
3
2,5
2
1,5
1
0,5
0
60 65 70 75 80 85 90 95 100 105 110 115 120 125 130 135 140
price
4
0,9
0,5
0,1
time to maturity (years)
0-0,5
0,5-1
1-1,5
1,5-2
2-2,5
2,5-3
3-3,5
3,5-4

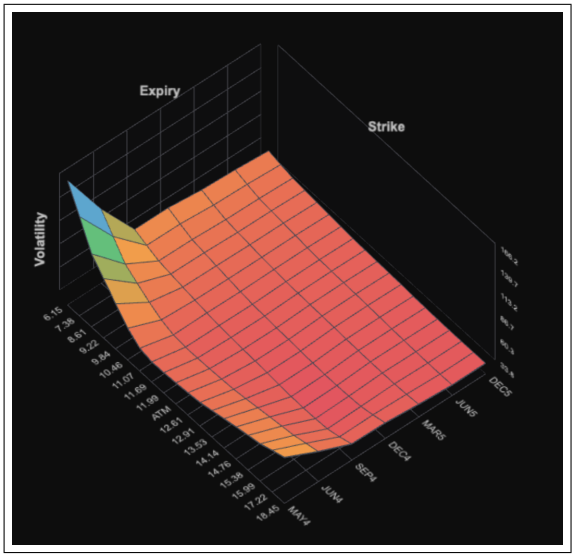




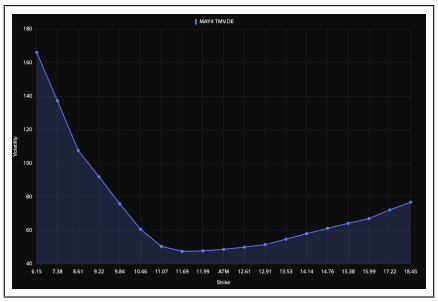
I report the plots only for the case of the call option with volatility $\sigma = 20\%$, to avoid having a 50 pages report, since these plots are also present in the excel file.

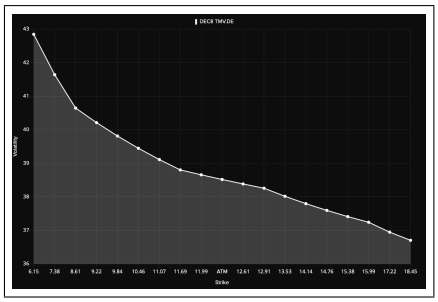
2 Part 2

In this section we had to find data on the Refinitiv platform, we had to choose an asset with an european options book with no dividends yeld. I find out the TeamViewer SA stock, which respects these criteria, so i navigated to the options window in the Refinitiv web workspace and visualized the implied volatility surface, as a function of the strikes and time to maturity.

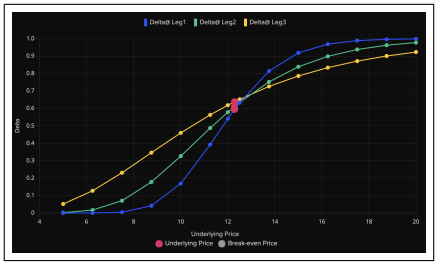


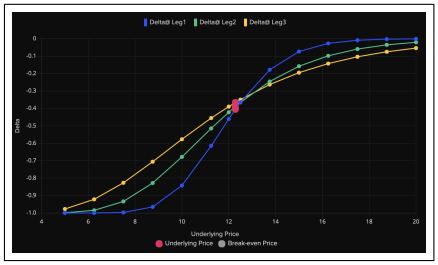
Then i checked the presence of the volatility smile/skew, and as expected, plotting the implied volatility for different expiration dates gave very different "smiles". In the left image the option expires in 1 month , while in the right one it expires in 8 months, as we see the more "skewed" profile of the implied volatility.

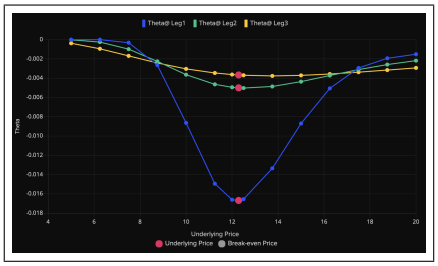


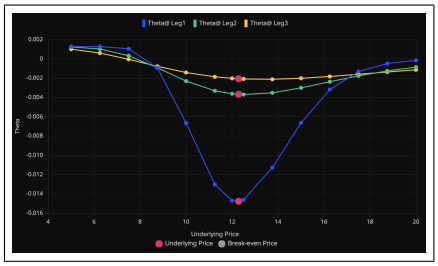


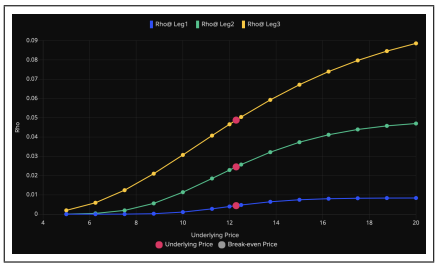
Then, i checked the smoothness of the greeks as time to maturity increases, using the option pricer integrated in the Refinitiv workspace, i plotted the greeks for different times to maturity, (blue = 1 month, green = 6 months, yellow = 12 months) for both Calls and Puts, except for Gamma and Vega which are option independent:

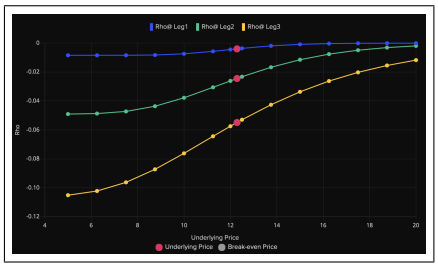

Delta@ Leg1
Delta@ Leg2
Delta@ Leg3
Delta
Underlying Price
Underlying Price
Break-even Price

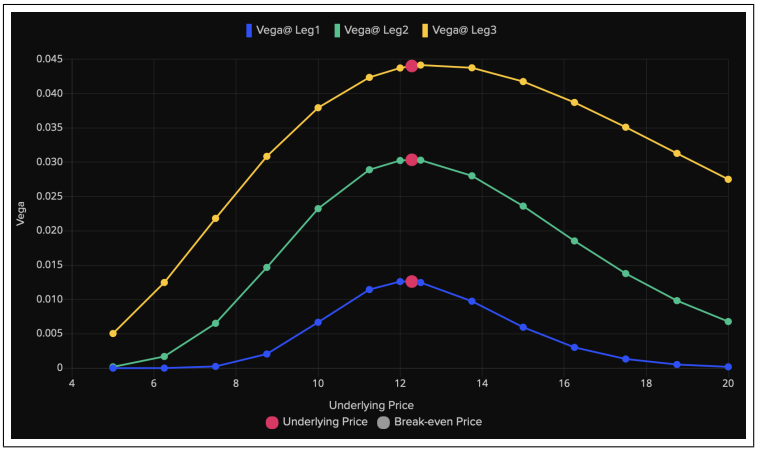

Delta@ Leg1
Delta@ Leg2
Delta@ Leg3
Delta
Underlying Price
Underlying Price
Break-even Price

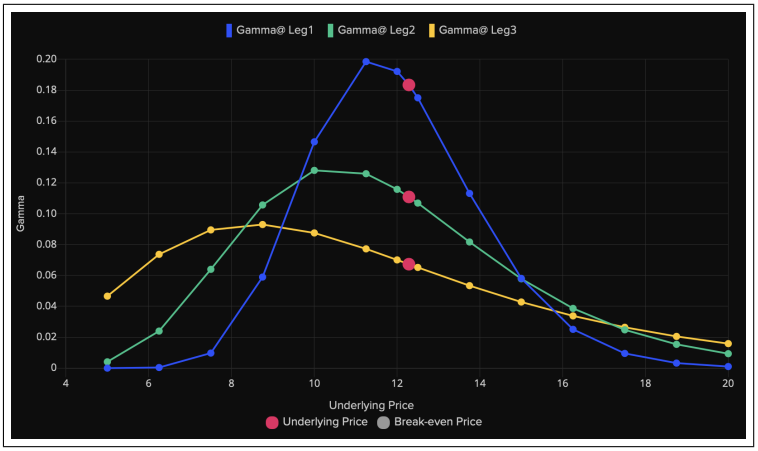

Theta@ Leg1
Theta@ Leg2
Theta@ Leg3
Theta
Underlying Price
Underlying Price
Break-even Price


Theta@ Leg1
Theta@ Leg2
Theta@ Leg3
Theta
Underlying Price
Underlying Price
Break-even Price


Rho@ Leg1
Rho@ Leg2
Rho@ Leg3
Rho
Underlying Price
Underlying Price
Break-even Price


Rho@ Leg1
Rho@ Leg2
Rho@ Leg3
Rho
Underlying Price
Underlying Price
Break-even Price


Vega@ Leg1
Vega@ Leg2
Vega@ Leg3
Vega
Underlying Price
Underlying Price
Break-even Price

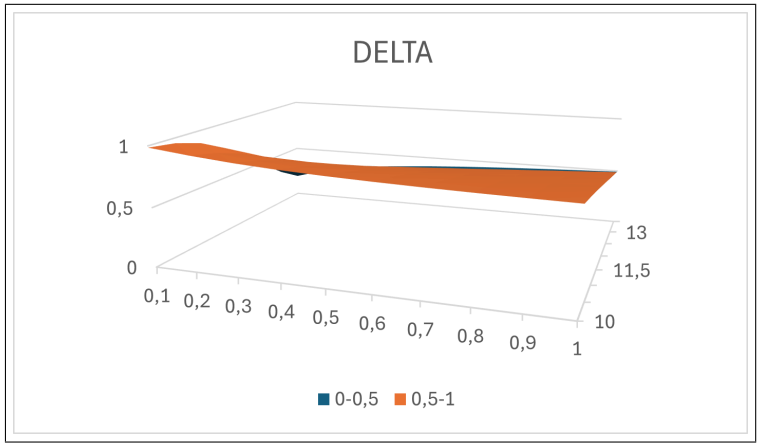


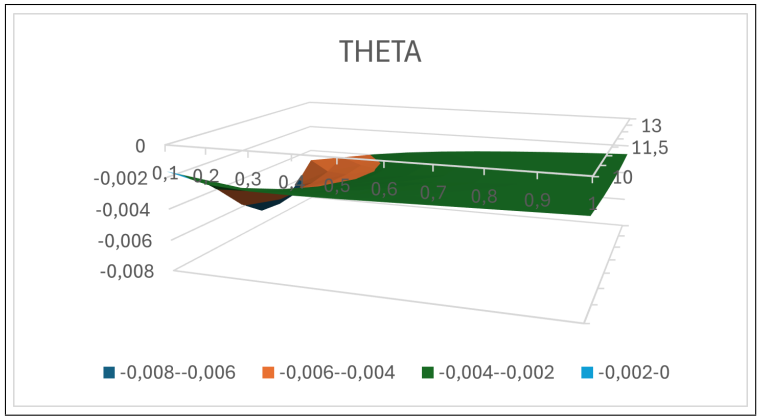
3 Part 3

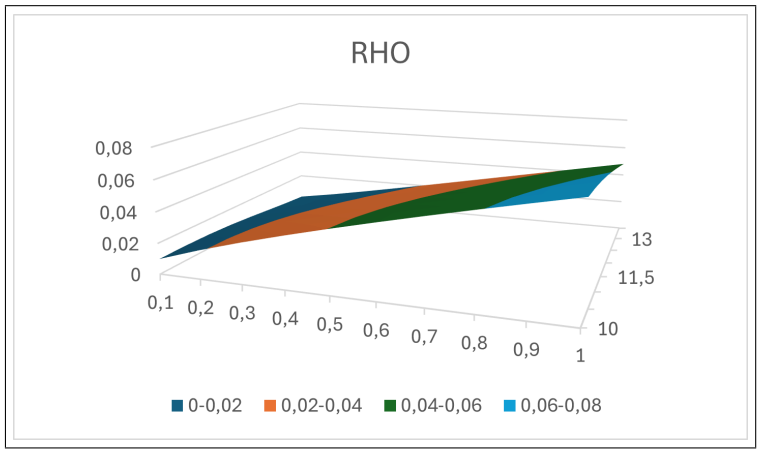
In this part we had to compute the Greeks for the chosen asset with the code implemented in part 1, compare the results with those found on Refinitiv for an ATM option with time to maturity equal to 3 months, then change the maturity and plot the surfaces of the Greeks as in part 1. I illustrate the results for a Call option.

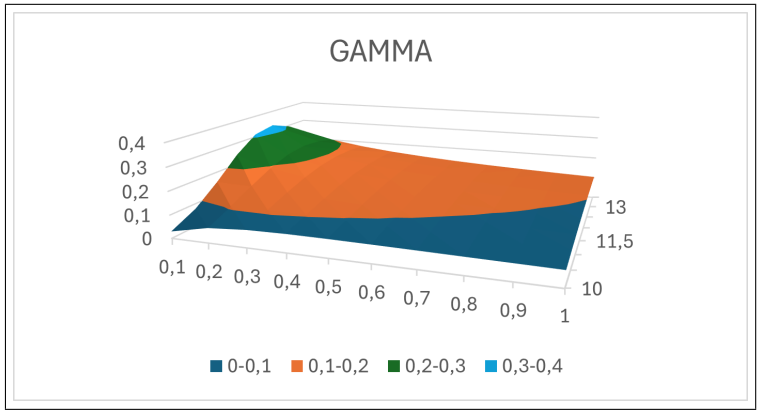
	Refinitiv	Black-Scholes	Relative error
Δ	0,61	0,60861	0,227%
Γ	0,16	0,16331	2,07%
$Vega$	0,0215	0,02362	9,86%
Θ	-0,006	-0,00563	6,22%
ρ	0,016	0,01585	0,91%

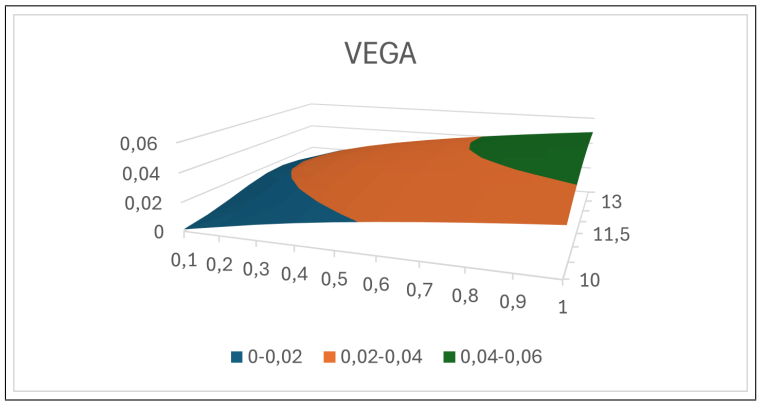
Then i computed the greeks also for different times to maturity and plotted the surfaces over different strikes, like i did in part 1 of the report.


DELTA
1
0,5
0
0,1 0,2 0,3 0,4 0,5 0,6 0,7 0,8 0,9 1
13
11,5
10
0-0,5
0,5-1


THETA
0
-0,002
-0,004
-0,006
-0,008
13
11,5
10
-0,008--0,006
-0,006--0,004
-0,004--0,002
-0,002-0


RHO
0,08
0,06
0,04
0,02
0
0,1 0,2 0,3 0,4 0,5 0,6 0,7 0,8 0,9 1
13
11,5
10
0-0,02
0,02-0,04
0,04-0,06
0,06-0,08


GAMMA
0,4
0,3
0,2
0,1
0
0,1 0,2 0,3 0,4 0,5 0,6 0,7 0,8 0,9 1
13
11,5
10
0-0,1
0,1-0,2
0,2-0,3
0,3-0,4


VEGA
0,06
0,04
0,02
0
0,1 0,2 0,3 0,4 0,5 0,6 0,7 0,8 0,9 1
13
11,5
10
0-0,02
0,02-0,04
0,04-0,06