

Homework 4 Excel Assignment.

This assignment asks you to implement the Black Scholes formula in a Microsoft Excel spreadsheet. A great introduction to Excel is

<http://faculty.fuqua.duke.edu/~pecklund/ExcelReview/ExcelReview.htm>

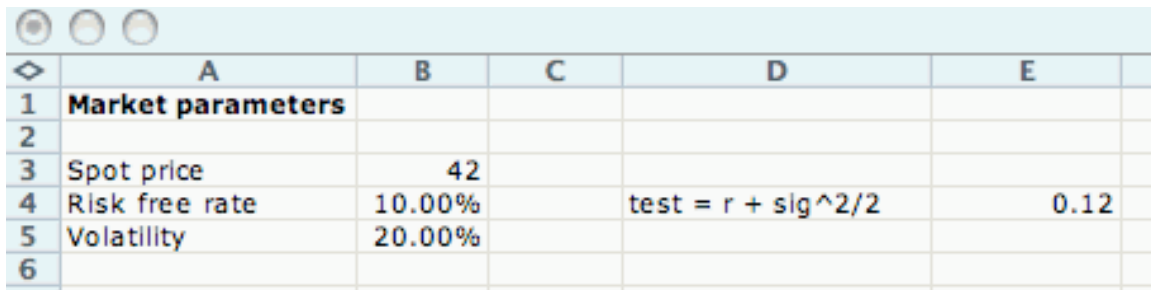
We are going to build on this, so it's important to do it "right". This will make it easy to manipulate and work with in future assignments.

Must read: You will not be asked to hand in your spreadsheets, only a few printouts from them and some descriptions of the results. It will be very easy and tempting to copy a spreadsheet from someone else. Copying a spreadsheet from someone else is a form of cheating. It is unlikely that you will be caught, but you will be penalized if you are. There is almost no benefit from copying a spreadsheet rather than doing it yourself.

Step 1: The first step is to create a column with market parameters. Here, column A is the names of the parameters – plain text – and column B is the parameter values. Give the parameters names. Use the Excel help facility to find out how to do that. The cell E4 is just a test that I was able to create a formula that refers to variables by name rather than by cell address. The formula for E4 is

$$= \text{Rate} + \text{Vol} * \text{Vol} / 2$$

It is convenient to create formulas like this by clicking on the appropriate cells. To create the formula above, I clicked on cell E4 to activate it, then on = to start a formula, then on B4 to get the name of the rate variable (which I had set to **Rate**), then on +, then on B5 to get the vol, then *, then B5 again, then /2, then *return* to tell the computer that the formula was complete. Note that the risk free rate and volatility are given as percentages. Figure out how to do that.



The screenshot shows an Excel spreadsheet with the following data:

	A	B	C	D	E
1	Market parameters				
2					
3	Spot price	42			
4	Risk free rate	10.00%		test = r + sig^2/2	0.12
5	Volatility	20.00%			
6					

Figure 1, for Step 1.

Step 2. Create some cells that implements the Black Scholes formula and the Greeks. Here, column A has the names and column B has the values. The values in the scratch area are intermediate expressions that enter into the Black Scholes formula. I broke them out to simplify the overall work, as they appear in several places in the formulas. The formulas refer to market parameters by name and other by cell address. For example, the formula for cell B19 (the call price) is

$$= \text{Spot} * \text{NORMSDIST}(B28) - \text{EXP}(-\text{Rate} * B10) * B11 * \text{NORMSDIST}(B29)$$

This formula is easy to construct by clicking on cells to get their addresses, as in step 1. You should complete the option value entries by adding formulas for Gamma and Vega and the put Delta. The formulas will be right when they agree with those in the screen capture below.

	A	B	C
1	Market parameters		
2			
3	Spot price	42	
4	Risk free rate	10.00%	
5	Volatility	20.00%	
6			
7			
8	Option parameters		
9			
10	Expiration time	0.5	
11	Strike price	40	
12			
13	Option value		
14			
15	Put price	0.8086	
16	Put Delta		
17	Put Gamma		
18	Put Vega		
19	Call price	4.7594	
20	Call Delta	0.7791	
21	Call Gamma		
22	Call Vega		
23			
24	Scratch area		
25	Sig ² /2	0.02	
26	Moneyness	0.0988	
27	Varlance	0.02	
28	d1	0.7693	
29	d2	0.6278	
30			

Figure 2, for Step 2.

Step 3. First copy the option valuation cells from column B to column D. Check a few of the column D formulas to see that they automatically refer to other values in column D and named values. Then create a cell for a spot price perturbation and a local perturbed spot price to use in the calculations in column D and modify formulas appropriately. Then you can calculate a finite approximation to Delta using

$$=(D19 - B19)/dSpot$$

Other finite difference formulas can be implemented in the same way. You have to create separate columns for each one, but that's done with copy and paste so it does not take much time.

	A	B	C	D	E
1	Market parameters				
2					
3	Spot price	42		42.5	
4	Risk free rate	10.00%		10.00%	
5	Volatility	20.00%		20.00%	
6					
7					
8	Option parameters				
9					
10	Expiration time	0.5		0.5	
11	Strike price	40		40	
12					
13	Option value				
14					
15	Put price	0.8086		0.802673197	
16	Put Delta				
17	Put Gamma				
18	Put Vega				
19	Call price	4.7594		4.753496217	
20	Call Delta	0.7791		0.803155064	
21	Call Gamma				
22	Call Vega				
23					
24	Scratch area				
25	Sig ² /2	0.02		0.02	
26	Moneyness	0.0988		0.110624622	
27	Variance	0.02		0.02	
28	d1	0.7693		0.852944881	
29	d2	0.6278		0.711523524	
30					
31	Perturbations			Approx Call Delta	
32					
33	dSpot	0.5		-0.011852351	
34					
35	dVol	0			
36					

Figure 3, for step 3. There is a mistake in the spreadsheet and the approximate Delta is wrong. Do yours correctly.

Step 4. Here we create portfolio of options. Start from the spreadsheet from Step 2, and create the Option position and Net values entries below it. The net values are just the option positions multiplied by the appropriate number above. For example, the Call Delta in the Net values area is: (number of calls)*(Delta for the call), both taken from

this column. You will get good at creating formulas by clicking on cells to get their addresses. You can check that you're done this right when you check Put/Call parity (give the put position as -1 and the call position as +1).

Once you have done this, you can create a portfolio of options by making several copies of the option pricing column, each next to the other as in Figure 4. Note that references by cell address are adjusted correctly and references by named value do not change. This is exactly what we want. Create totals using the sum command (look it up) to sum a range of values. If you do this, you can add another column – another position in the portfolio – and the sums will include the new column.

Create a butterfly spread centered on strike 40 by adjusting the strikes and put and call positions as appropriate.

	A	B	C	D	E	F	G	H	I	J
1	Market parameters									
2										
3	Spot price	42								
4	Risk free rate	10.00%								
5	Volatility	20.00%								
6										
7										
8	Option parameters									
9										
10	Expiration time	0.5	0.5	0.5						
11	Strike price	38	40	42						
12										
13	Option value									
14										
15	Put price	0.4073	0.8086	1.428313						
16	Put Delta									
17	Put Gamma									
18	Put Vega									
19	Call price	6.2606	4.75942	3.476678						
20	Call Delta	0.8712	0.77913	0.664313						
21	Call Gamma									
22	Call Vega									
23										
24	Option positions									
25										
26	Number of puts	0	-2	0						
27	Number of calls	1	0	1						
28										
29	Net Values					Put and call totals			Portfolio totals	
30										
31	Put value	0	-1.6172	0		Puts	-1.6171987		Values	8.12009598
32	Put Delta					Put Deltas			Deltas	1.53548796
33	Put Gamma					Put Gammas			Gammas	
34	Put Vega					Put Vegas			Vegas	
35	Call value	6.2606	0	3.476678		Calls	9.73729472			
36	Call Delta	0.8712	0	0.664313		Call Deltas	1.53548796			
37	Call Gamma					Call Gammas				
38	Call Vega					Call Vegas				
39										
40	Scratch area									
41	Sig ² /2	0.02	0.02	0.02						
42	Moneyiness	0.1501	0.09879	0.05						
43	Variance	0.02	0.02	0.02						
44	d1	1.132	0.76926	0.424264						
45	d2	0.9905	0.62784	0.282843						
46										

Figure 4, the spreadsheet at the end of Step 4.