LISBON SCHOOL OF ECONOMICS & MANAGEMENT
UNIVERSIDADE DE LISBOA

Corporate Investment Appraisal

Masters in Management

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Fall Semester

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Problem Set 4: Valuation of Financial Options

SOLUTIONS

1. The annual volatility of the return of company CJRD's stock is 45%. Currently CJRD's stock price is €3.75. The risk-free interest rate is 1.5% *per annum* (continuous).

(a) Compute the risk neutral probability of the scenario "up" in the context of the binomial model (1 year time step).

(b)

Stock	
Sigma	0,45
S	3,75

Interest Rate	
Rf	1,5%

u	1,568312185
d	0,637628152
p	0,405599429

(c) What is the value of a European call option on a share of company CJRD, with a strike price of €4.25 and time to maturity of 1 year? Use the binomial model (1 year time step).

Call	
K	4,25
T	1

Stock Tree	Year	0	1
		3,75	5,881170696
			2,391105569

Call Tree	Year	0	1
		0,651751934	1,631170696
			0

(d) Estimate the value of a put option on a share of company CJ, with expiry date in 3 years' time and an exercise price of €4.50 (use the binomial model, with time steps of length dt=1 year).

K	4,5
T	3

Stock Tree	Year	0	1	2	3
		3,75	5,881170696	9,223511667	14,46534574
			2,391105569	3,75	5,881170696
				1,524636224	2,391105569
					0,972150977

Put Tree	Year	0	1	2	3
		1,575018593	0,723076823	0	0
			2,196401667	1,234865452	0
				2,908367504	2,108894431
					3,527849023

2. The shares of firm MC have an annual volatility of 35% and are currently priced at $40. There is no expectation of a dividend in the coming year. The riskless annual interest rate is 1.5% (continuous).

(a) What is the value (BS) of a call option on share of firm MC, for a maturity of 18 months and an exercise price of $45?

Stock	
Sigma	35%
S	40

Interest Rate	
Rf	1,5%

Call		
T	1,5	year
K	45	

Using Black-Scholes

d1	-0,007950427
d2	-0,436611132
N(d1)	0,496828272
N(d2)	0,331196694
Call	5,300871896

(b) What is the value (BS) of a European put option on a share of Firm MC, with expiry date in 3 years' time, and with an exercise price of $45?

Put	
T	3,00
K	45

d1	0,183048019
d2	-0,423169763

N(d1)	0,572619829
N(d2)	0,336085703

Call	8,45
Put	11,47

3. Consider again the data of problem 1, regarding company CJRD: The annual stock volatility is 45% and the stock price is currently €3.75. No dividend is expected for the coming year. The riskless annual interest rate is 1.5% (continuous).

   Re-compute the value of a call option with maturity of 1 year, with an exercise price of €4.25, based on the binomial model, considering time intervals of 1 month (each branch is 1 month long).

Stock	
Sigma	0,45
S	3,75

Rf	1,5%

Number of Intervals	N	12			
Time to maturity	T	1	Dt	0,083333333	Time Step
Strike Price	K	4,25			

u	1,1387188
d	0,8781799

p	0,4723704

Stock Tree

Month	0	1	2	3	4	5	6	7	8	9	10	11	12
	3,75	4,2701957	4,8625523	5,5370799	6,305177254	7,1798242	8,1758011	9,3099388	10,601403	12,072017	13,746633	15,65355	17,824993
		3,2931746	3,75	4,2701957	4,862552283	5,5370799	6,3051773	7,1798242	8,1758011	9,3099388	10,601403	12,072017	13,746633
			2,8919998	3,2931746	3,75	4,2701957	4,8625523	5,5370799	6,3051773	7,1798242	8,1758011	9,3099388	10,601403
				2,539696	2,891999753	3,2931746	3,75	4,2701957	4,8625523	5,5370799	6,3051773	7,1798242	8,1758011
					2,230310019	2,539696	2,8919998	3,2931746	3,75	4,2701957	4,8625523	5,5370799	6,3051773
						1,9586134	2,23031	2,539696	2,8919998	3,2931746	3,75	4,2701957	4,8625523
							1,7200149	1,9586134	2,23031	2,539696	2,8919998	3,2931746	3,75
								1,5104825	1,7200149	1,9586134	2,23031	2,539696	2,8919998
									1,3264754	1,5104825	1,7200149	1,9586134	2,23031
										1,164884	1,3264754	1,5104825	1,7200149
											1,0229777	1,164884	1,3264754
												0,8983585	1,0229777
													0,7889204

Call Tree

Month	0	1	2	3	4	5	6	7	8	9	10	11	12
	0,5221569	0,7774182	1,1323855	1,6107947	2,234047723	3,0175356	3,9682643	5,0864184	6,3725997	7,8379247	9,5072451	11,40886	13,574993
		0,2948672	0,4614698	0,7067651	1,05663409	1,5379113	2,1735311	2,9766228	3,946998	5,0758464	6,3620145	7,8273262	9,4966333
			0,146412	0,2429585	0,395213721	0,6282664	0,9725064	1,4597006	2,1149323	2,9457318	3,9364128	5,0652479	6,3514027
				0,0603239	0,107225137	0,1875058	0,3215683	0,538642	0,8765523	1,3761569	2,065789	2,9351333	3,9258011
					0,018477687	0,0356065	0,0679283	0,1279913	0,2373983	0,4313498	0,762013	1,2923891	2,0551773
						0,0031866	0,0067543	0,0143167	0,0303461	0,0643224	0,1363398	0,2889901	0,6125523
							0	0	0	0	0	0	0
								0	0	0	0	0	0
									0	0	0	0	0
										0	0	0	0
											0	0	0
												0	0
													0