

TISBOA
SCFHOOT OF
BCONOMICS \&
MANACHMENF

## Corporate Investment Appraisal <br> Masters in Finance <br> 2014-2015 <br> Fall Semester <br> Clara C Raposo

## Problem Set 3: Valuation of Financial Options

## Guidelines to Solutions

1. The annual volatility of the return of company CJ's stock is $40 \%$. Currently CJ's stock price is $€ 4.25$. The risk-free interest rate is $2 \%$ per annum (continuous).

| Stock |
| :--- |
| Sigma |
| S |

Interest Rate
Rf 2\%
(a) Compute the risk neutral probability of the scenario "up" in the context of the binomial model (1 year time step).

U $\quad 1,491825$
D $\quad 0,67032$
P 0,425903
(b) What is the value of a European call option on a share of company CJ, with a strike price of $€ 5.2$ and time to maturity of 1 year? Use the binomial model.

| Call |  |
| :--- | ---: |
| K | 5,2 |
| T | 1 |


| Stock Tree | Year | 0 | 1 |
| :--- | ---: | ---: | ---: |
|  |  | 4,25 | 6,340255 |
|  |  |  | 2,84886 |
|  |  |  |  |
| Call | Year | 0 | 1 |
| Tree |  | 0,476022 | 1,140255 |
|  |  |  | 0 |

(c) 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 €5.0.

Put

| K | 5 |
| :--- | :--- |
| T | 3 |

\(\left.\begin{array}{lrrrrr}Stock Tree \& Year \& 0 \& 1 \& 2 \& 3 <br>
\& \& 4,25 \& 6,340255 \& 9,458549 \& 14,1105 <br>
\& \& \& 2,84886 \& 4,25 \& 6,340255 <br>
Put Tree \& \& \& 1,909648 \& 2,84886 <br>
\& \& \& \& \& 1,280075 <br>

\& \& \& \& 1 \& 2\end{array}\right]\)| 3 |
| :--- |
|  |

2. The shares of firm MC have an annual volatility of $30 \%$ and are currently priced at \$5.0. There is no expectation of a dividend in the coming year. The riskless annual interest rate is $3 \%$ (continuous).

## Stock

| Sigma | $30 \%$ |
| :--- | ---: |
| S | 5 |

Interest
Rate
Rf
3\%
(a) What is the value (BS) of a call option on share of firm MC, for a maturity of 1 year and an exercise price of $\$ 6.5$ ?

| Call |  |
| :--- | ---: |
| T | 1 |
| K | year |

Using Black-Scholes

| d1 | $-0,62455$ |
| :--- | :--- |
| d2 | $-0,92455$ |
|  |  |
| $N(d 1)$ | 0,266134 |
| $N(d 2)$ | 0,177601 |

Call 0,210384
(b) What is the value (BS) of a European put option on a share of Firm MC, with expiry date in 5 months time, and with an exercise price of $\$ 6.5$ ?

| Put |  |
| :--- | ---: |
| T | 0,42 |
| K | 6,5 |


| d1 | $-1,19347$ |
| :--- | :--- |
| d2 | $-1,38712$ |


| $N(d 1)$ | 0,116343 |
| :--- | :--- |
| $N(d 2)$ | 0,082703 |


| Call | 0,05 |
| :--- | :--- |
| Put | 1,47 |

3. Consider again the data of problem 1, regarding company CJ: The annual stock volatility is $40 \%$ and the stock price is currently $€ 4.25$. No dividend is expected for the coming year. The riskless annual interest rate is $2 \%$ (continuous).

Re-compute the value of a call option with maturity of 1 year, with an exercise price of $€ 5.2$, based on the binomial model, considering bi-monthly intervals (each branch is 2 months long).


## Stock Tree

| Month | 0 | 2 | 4 | 6 | 8 | 10 | 12 |
| :--- | ---: | ---: | ---: | ---: | ---: | ---: | ---: |
|  | 4,25 | 5,003903 | 5,891541 | 6,936636 | 8,167119266 | 9,615877 | 11,32163 |
|  | 3,609682 | 4,25 | 5,003903 | 5,89154113 | 6,936636 | 8,167119 |  |
|  |  | 3,065836 | 3,609682 | 4,25 | 5,003903 | 5,891541 |  |
|  |  |  | 2,603928 | 3,065836188 | 3,609682 | 4,25 |  |
|  |  |  |  |  | 2,211612126 | 2,603928 | 3,065836 |
|  |  |  |  |  |  | 1,878404 | 2,211612 |
|  |  |  |  |  |  | 1,595398 |  |

Call Tree

| 0,414304 | 0,711271 | 1,190167 | 1,928844 | 3,001670634 | 4,433181 | 6,121628 |
| ---: | ---: | ---: | ---: | ---: | ---: | ---: |
|  | 0,154152 | 0,292013 | 0,544065 | 0,991731252 | 1,75394 | 2,967119 |
|  | 0,033141 | 0,070831 | 0,151387337 | 0,323559 | 0,691541 |  |
|  |  | 0 | 0 | 0 | 0 |  |
|  |  |  | 0 | 0 | 0 |  |
|  |  |  |  | 0 | 0 |  |
|  |  |  |  |  | 0 |  |

