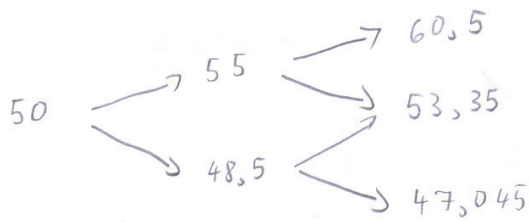
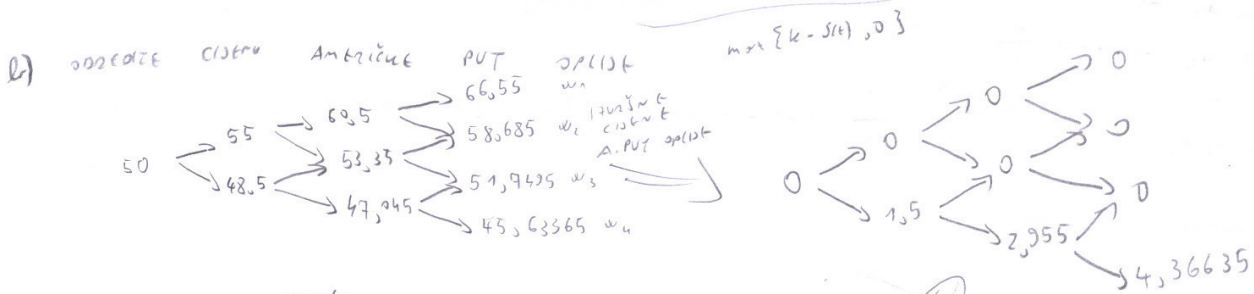


1. $g = 10\%$ $d = -3\%$ $S_0 = 50$ $K = 50$ $r = 6\%$

a)



w_1 $S(1) = S_0 \cdot (g+1)$
 w_2 $S(1) = S_0 \cdot (d+1)$
 w_3



Call = 0 E. PUT payoff

$t=3$
 $w_1 \rightarrow C_3 = (K - S(t))^+ = 50 - 60.55 = 0$
 $w_2 \rightarrow C_3 = 0$
 $w_3 \rightarrow C_3 = 0$
 $w_4 \rightarrow C_3 = 4.36635$

$t=2$

$w_1, w_2 \rightarrow C_2 = E^* \left[\frac{C_3}{1+r} \right] = \frac{1}{1.06} \cdot (0 \cdot p^* + 0 \cdot (1-p^*)) = 0$

$w_3, w_4 \rightarrow C_2 = 0$

$w_1, w_2 \rightarrow C_2 = \frac{1}{1.06} \cdot (0 \cdot p^* + 4.36635 \cdot \frac{1}{13}) = 1.267445573 < 2.955 \Rightarrow 2.955 \checkmark$

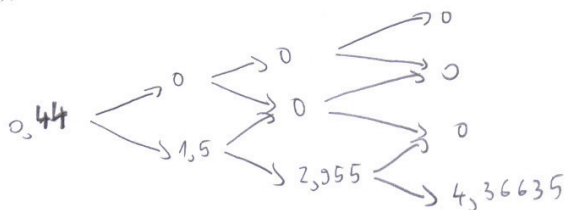
$t=1$

$w_1, w_2, w_3 \rightarrow C_1 = E^* \left[\frac{C_2}{1+r} \right] = \frac{1}{1.06} \cdot (0 \cdot p^* + 2.955 \cdot \frac{1}{13}) = 0.857764876 < 1.5 \Rightarrow 1.5 \checkmark$

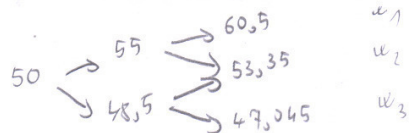
$t=0$

$w_1, w_2, w_3, w_4 \rightarrow C_0 = E^* \left[\frac{C_1}{1+r} \right] = \frac{1}{1.06} \cdot (0 \cdot p^* + 1.5 \cdot \frac{1}{13}) = 0.435413643 > 0 \checkmark$

57910 Am. r. i. c. u. e PUT O P C I O N E



1. c) ~~12.000~~ EUROPSKA PUT OPCIJA



$$p^* = \frac{9}{13}$$

$$1 - p^* = \frac{4}{13}$$

u $t=2$

$$w_1 \rightarrow C_2 = (K - S(t))^+ = (50 - 60,5)^+ = 0$$

$$w_2 \rightarrow C_2 = 0$$

$$w_3 \rightarrow C_2 = 2,955$$

u $t=1$

$$w_1, w_2 \rightarrow C_1 = E^* \left[\frac{C_2}{1+r} \right] = 0$$

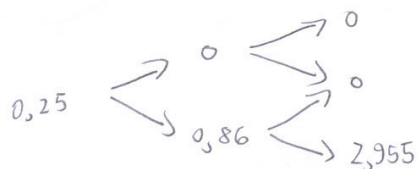
$$w_1, w_2 \rightarrow C_1 = \frac{1}{1,06} \cdot \left(0 \cdot p^* + \frac{4}{13} \cdot 2,955 \right) = 0,857764876$$

$$w_2, w_3 \rightarrow C_1 = \frac{1}{1,06} \cdot \left(0 \cdot p^* + \frac{4}{13} \cdot 2,955 \right) = 0,857764876$$

u $t=0$

$$w_1, w_2, w_3 \rightarrow C_0 = E^* \left[\frac{C_1}{1+r} \right] = \frac{1}{1,06} \cdot \left(0 \cdot p^* + 0,85776 \cdot \frac{4}{13} \right) = 0,248988353$$

STABLO EUROPSKE PUT OPCIJE



1. d) može se primetiti da su cene američkih put opcija veće u početnim periodima, dok se završkom periodu izjednačavaju. Ovo je u skladu sa scenarijem može se dogoditi da su cene opcija u početku veće, a kasnije identične.

1. e) Ako dionica ne isplaćuje dividendu tada će cene američke i evropske call opcije biti jednake.

2. a) EUROPSKA ~~CALL~~ OPција

$$p^* = 0.76$$

$$1 - p^* = 0.24$$

$$T=2$$

$$K=60$$

$$p=?$$

$$r=9\%$$

$$t=2 \quad u_1 \rightarrow C_2 = (66.125 - 60)^* = \underline{6.125}$$

$$u_2 \rightarrow C_2 = (51.75 - 60)^* = \underline{0}$$

$$u_3 \rightarrow C_2 = (40.5 - 60)^* = \underline{0}$$

$$t=1$$

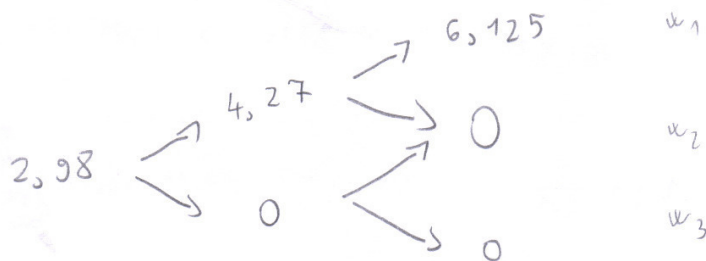
$$u_1, u_2 \rightarrow C_1 = E^* \left[\frac{C_2}{1+r} \right] = \frac{1}{1.09} \cdot (0.76 \cdot 6.125 + 0.24 \cdot 0) = 4.270642202$$

$$u_2, u_3 \rightarrow C_1 = \frac{1}{1.09} \cdot (0.76 \cdot 0 + 0.24 \cdot 0) = 0$$

$$t=0$$

$$u_1, u_2, u_3 \rightarrow C_0 = E^* \left[\frac{C_1}{1+r} \right] = \frac{1}{1.09} \cdot (0.76 \cdot 4.27 + 0.24 \cdot 0) = 2.97769548$$

STABLO EUROPSKE ~~CALL~~ OPcije



2. ~~1~~) EUROPSKA

~~PVT~~ ^{OPCJA}

$$p^* = \frac{r-d}{g-d}$$

$p^* = ?$

$r = 9\%$

$g = \frac{66,125}{54,5} - 1 = \frac{57,5}{50} - 1 = 1,15 - 1 = 15\%$

$d = \frac{45}{50} - 1 = 0,9 - 1 = -10\%$

$$p^* = \frac{r-d}{g-d} = \frac{9 - (-10)}{15 - (-10)} = \frac{19}{25} = 0,76$$

$1-p^* = 0,24$

$57,5 \cdot p^* + 45 \cdot (1-p^*) = 50,109$

$T=2$

$K=60$

$r=?$

$t=2$

$w_1 \rightarrow C_2 = (60 - 66,125)^+ = 0$

$w_2 \rightarrow C_2 = (60 - 51,75)^+ = 8,25$

$w_3 \rightarrow C_2 = (60 - 40,5)^+ = 19,5$

$t=1$

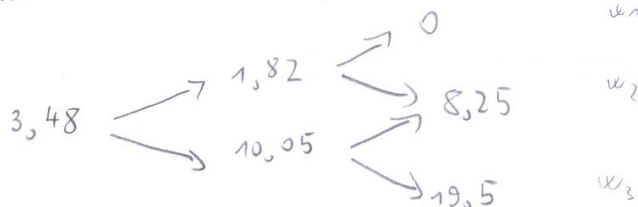
$w_1, w_2 \rightarrow C_1 = E^* \left[\frac{C_2}{1+r} \right] = \frac{1}{1,09} \cdot (0,76 \cdot 0 + 0,24 \cdot 8,25) = 1,816513761$

$w_2, w_3 \rightarrow C_1 = \frac{1}{1,09} \cdot (0,76 \cdot 8,25 + 0,24 \cdot 19,5) = 10,04587156$

$t=0$

$w_1, w_2, w_3 \rightarrow C_0 = E^* \left[\frac{C_1}{1+r} \right] = \frac{1}{1,09} \cdot (0,76 \cdot 1,816513761 + 0,24 \cdot 10,04587156) = 3,47849506$

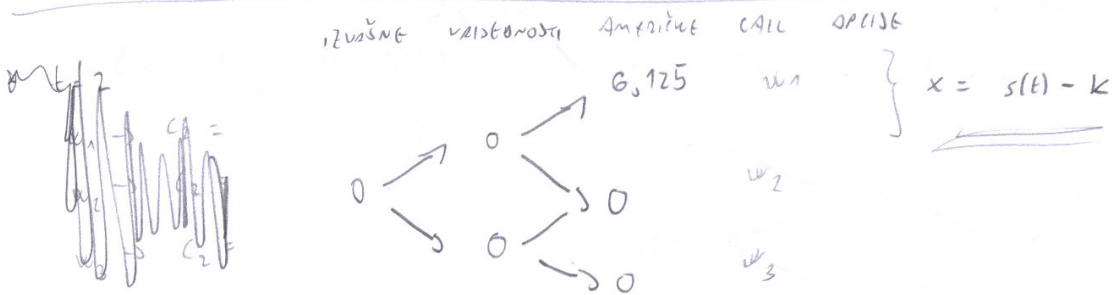
STABLO ~~PVT~~ ^{OPCJA}



2. c) Američka CALL opcija

0,76 i 0,24

$$\max \{ \max \{ \cancel{s_t - K}, 0 \}, (1+r)^{-1} [q_u \cdot \text{value}_{\text{up}} - \text{value}_{\text{down}} - S_t \cdot q_d + q_d \cdot \text{value}_{\text{up}} - \text{value}_{\text{down}} - S_t \cdot q_d] \}$$



$$p = 0,76$$

$$1-p = 0,24$$

$$R = 1,09$$

$$P_{i,j} = \max \left\{ \frac{q \cdot P_{i,j+1} + (1-q) \cdot P_{i,j+1}}{R}, \max (s(t) - K, 0) \right\}$$

✓ $t=2$

$$u_1 \rightarrow C_2 = (66,125 - 60)^+ = 6,125$$

$$u_2 \rightarrow C_2 = (55,875 - 60)^+ = 0$$

$$u_3 \rightarrow C_2 = (46,5 - 60)^+ = 0$$

✓ $t=1$

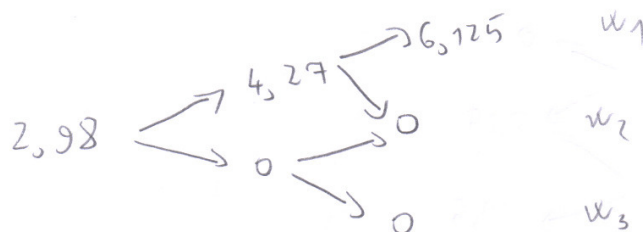
$$u_1, u_2 \rightarrow C_1 = E^* \left[\frac{C_2}{1+r} \right] = \frac{1}{1,09} \cdot (6,125 \cdot 0,76 + 0 \cdot 0,24) = 4,270642202$$

$$u_2, u_3 \rightarrow C_1 = E^* \left[\frac{C_2}{1+r} \right] = \frac{1}{1,09} \cdot (0 \cdot 0,76 + 0 \cdot 0,24) = 0$$

✓ $t=0$

$$u_1, u_2, u_3 \rightarrow C_0 = E^* \left[\frac{C_1}{1+r} \right] = \frac{1}{1,09} \cdot (0,76 \cdot 4,2706 + 0,24 \cdot 0) = 2,97769548$$

stablo Američke CALL opcije



2. d) AMERIČKA PUT OPCLJA

$$K = 60$$

$$S_0 = 50$$

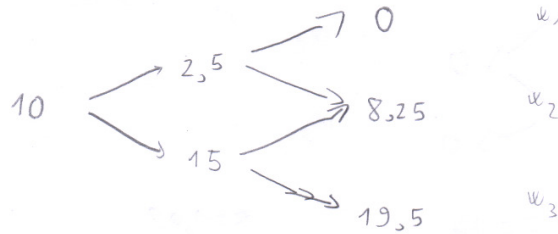
$$u = 1 + j = 1,15$$

$$d = 0,90$$

IZVAJNE VRIJEDNOSTI AMERIČKE OPCLJE PONUDE

$$\max \{ K - S_0 \cdot U^j D^{i-j}, 0 \}$$

$$i \in \{1, 2, \dots, n\} \quad j \in \{1, 2, \dots, i\}$$



VRIJEDNOSTI AMERIČKE OPCLJE PONUDE

$$P_{ij} = \max \left\{ \frac{q \cdot P_{j+1,i+1}^A + (1-q) \cdot P_{j+1,i}^A}{R}, \max \{ K - S_0 \cdot U^j D^{i-j}, 0 \} \right\}$$

$$q = 0,76$$

$$1-q = 0,24$$

$$r = 9\%$$

$t = 2$

$$w_1 \rightarrow C_2 = \max \{ K - S_0 \cdot U^j D^{i-j} \} = (60 - 66,15)^+ = 0$$

$$w_2 \rightarrow C_2 = (60 - 51,75)^+ = 8,25$$

$$w_3 \rightarrow C_2 = (60 - 40,9)^+ = 19,5$$

$t = 1$

$$w_1, w_2 \rightarrow C_1 = \frac{1}{1,09} \left(0,76 \cdot 0 + 0,24 \cdot 8,25 \right) = \frac{1}{1,09} (1,98) = 1,8165 < 2,5 = 2,5$$

$$w_2, w_3 \rightarrow C_1 = \frac{1}{1,09} (8,25 \cdot 0,76 + 19,5 \cdot 0,24) = \frac{1}{1,09} (10,04587) = 9,2164 < 15 = 15$$

$t = 0$

$$w_1, w_2, w_3 \rightarrow C_0 = \frac{1}{1,09} (2,5 \cdot 0,76 + 15 \cdot 0,24) = \frac{1}{1,09} (5,04587) = 4,6292 < 10 = 10$$

STABLO AMERIČKE
PUT OPCLJE

