Call pricing — $n = 1, 2, 3, 4$

$q = .5418$

Risk neutral valuation

$n = 1 \rightarrow C_u = \$5$
$C_d = 0$

$C = e^{-r\delta t}[qC_u + (1-q)C_d]$
$= e^{-.05/12}(.5418(5)) = \$2.70$

$n = 2 \rightarrow C_{uu} = 10.25$
all others zero

$C = e^{-2r\delta t} q^2 C_{uu}$
$= e^{-.05/6}(.5418^2(10.25)) = 2.98$

$n = 3$ $C_{uuu} = 15.76$
$C_{uud} = 4.74$

$C = e^{-.05/4}[q^3 C_{uuu} + 3q^2(1-q)C_{uud}]$
$= e^{-.05/4}[.5418^3(15.76) + 3[.5418^2(.4582)]4.74]$
$= 4.36$

$n = 4$ $C_{uuuu} = 21.55$
$C_{uuud} = 9.97$

$C = e^{-.05/3}[.5418^4(21.55) + 4(.5418^3)(.4582)9.97]$
$= \$4.68$

Put pricing

$n = 4$ time-steps

$P_{uudd} = .50$

$P_{udud} = 9.98$

$P_{dddd} = 18.5$

$$P = e^{-.05/3}\left[6(.5418^2)(.4582^2)(.5) + 4(.5418)(.4582^3)\,9.98 + .4582^4(18.5)\right] = \$3.03$$

(risk neutral valuation)

$\text{Prob}(uudd) = 6q^2(1-q)^2 =$

$\text{Prob}(udud) = 4q(1-q)^3$

$\text{Prob}(dddd) = (1-q)^4$

(put-call parity)

$$C + Ke^{-rnt} = P + S$$

$$P = 4.68 + 100e^{-.05/3} - 100$$

$$= \$3.03$$