AS251- Final Exam

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Exercise

Prices for a stock are modeled with a 1-period binomial tree with $u = 1.2$, $d = 0.7$, and a period of 3 months.

A European call option on the stock expires in 3 months.

You are given:

1. The stock's initial price is \$50.
2. The stock pays no dividends.
3. The strike price for the call option is \$55.
4. The price of the call option is \$3.10.

Determine the continuously compounded risk-free interest rate.

(a) 5.5555

(b) 5.7555

(c) 5.9555

(d) 6.1555

(e) 5.3555

$$C_u = \max\{0, uS - K\} = \max\{0, 5\} = 5$$

$$C_d = \max\{0, dS - K\} = \max\{0, -20\} = 0$$

$$C = e^{-rh}\left[p^* C_u + (1-p^*) C_d\right] = 5p^* e^{-rh}$$

$$p^* = \frac{e^{rh} - d}{u - d} = \frac{e^{rh} - 0.7}{0.5}$$

$$\Rightarrow \quad C = 5 \times \frac{e^{rh} - 0.7}{0.5} \times e^{-rh} = 10\left(1 - 0.7e^{-rh}\right)$$

$$= 10 - 7e^{-rh} = 3.1$$

$$\Rightarrow \quad e^{-rh} = \frac{10 - 3.1}{7} \Rightarrow rh = -\ln\left(\frac{10-3.1}{7}\right)$$

$$\Rightarrow \quad r = -\frac{1}{h}\ln\left(\frac{10-3.1}{7}\right) = 0.5755$$

1/4

Exercise

S T

A stock currently has a price of \$45.00 and pays no dividends. One year from now, there is a risk-neutral probability of 50% that the price of the stock will be \$30.00 and a risk-neutral probability of 50% that it will be greater than \$40.00.

The effective annual risk-free interest rate is 4%. i K

Calculate the price of a one-year European call option with an exercise price of \$40.00. Then,

(a) 4.81

(b) 6.35

(c) 9.81

(d) 10.00

(e) 11.35

$$p^* = 0.5;$$

$$C_d = \max\{0, 30-K\} = \max\{0,-10\} = 0$$

$$C_d\,? \qquad i = 4\%$$

$$S = \left((uS)\times p^* + (dS)\times(1-p^*)\right)e^{-rh}$$

$$= (uS\times 0.5 + 30\times 0.5)\times 1.04^{-1}$$

$$\Rightarrow uS = \frac{S\times 1.04}{0.5} - 30 = 63.6$$

$$\Rightarrow C_u = \max\{0, uS-40\} = 23.6$$

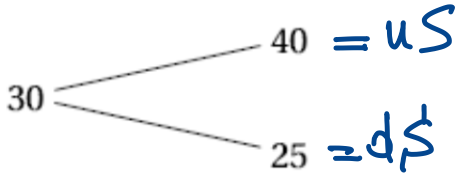
$$\Rightarrow C_0 = e^{-rh}\left[p^* C_u + (1-p^*)C_d\right]$$

$$= 1.04^{-1}\left[0.5\times 23.6 + 0.5\times 0\right]$$

$$= 11.346$$

Exercise

The price of a non-dividend-paying stock is modeled by the following 1-period binomial tree, with each period being one year:



A European call option expiring in one year on the stock has a strike price of \$30.
The continuously compounded risk-free interest rate is 4%.
Determine the number of shares of stock in the replicating portfolio for the call option.

(a) 1/3

(b) 2/3

(c) 4/3

(d) 5/3

(e) 3/5

$K=30$; $r=4\%$; $\delta=0$

$C_u=10$; $C_d=0$;

$$\Delta = e^{-\delta h} \times \frac{C_u - C_d}{S(u-d)} = e^{-0} \times \frac{10-0}{40-25}$$

$$= 10/15 = 2/3$$

Exercise

For a 6-month European put option on a stock, you are given:

- The stock price is 150.
- The strike price is 160.
- $u = 1.3$ and $d = 0.7$.
- The continuously compounded risk-free rate is 6%.
- There are no dividends.

The option is modeled with a 2-period binomial tree.

Determine the option premium.

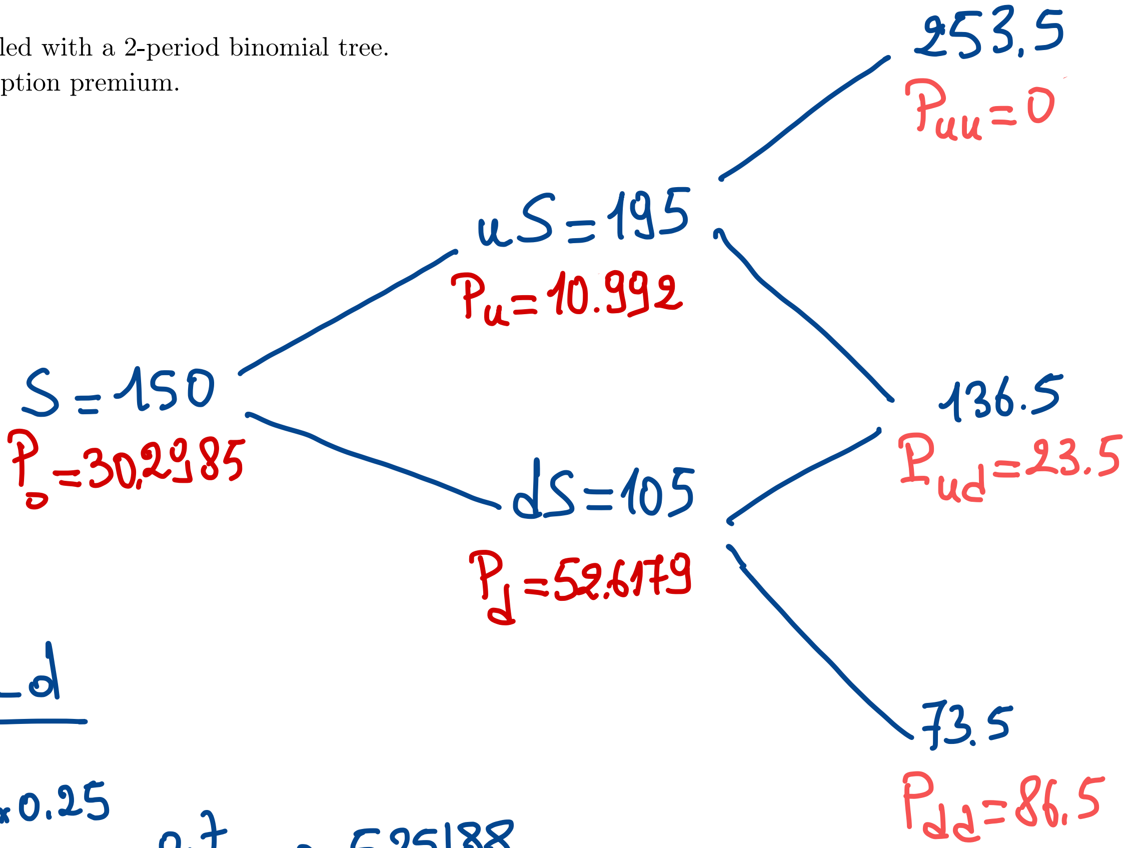
(a) 17.15

(b) 21.38

(c) 27.23

(d) 30.29

(e) 37.11



$$p^* = \frac{e^{(r-\delta)h} - d}{u-d} = \frac{e^{0.06\times 0.25} - 0.7}{1.3-0.7} = 0.525188$$

$$P_u = e^{-rh}\left[P_{uu}\,p^* + P_{ud}\,(1-p^*)\right] = 10.992$$

$$P_d = e^{-rh}\left[P_{ud}\,p^* + P_{dd}\,(1-p^*)\right] = 52.6179$$

$$P_0 = e^{-rh}\left[P_u\,p^* + P_d\,(1-p^*)\right] = 30.2985$$

Exercise

For a 6-month American put option on a stock, you are given:

- The stock price is 150.
- The strike price is 160.
- $u = 1.3$ and $d = 0.7$.
- The continuously compounded risk-free rate is 6%.
- There are no dividends.

The option is modeled with a 2-period binomial tree.

Determine the option premium.

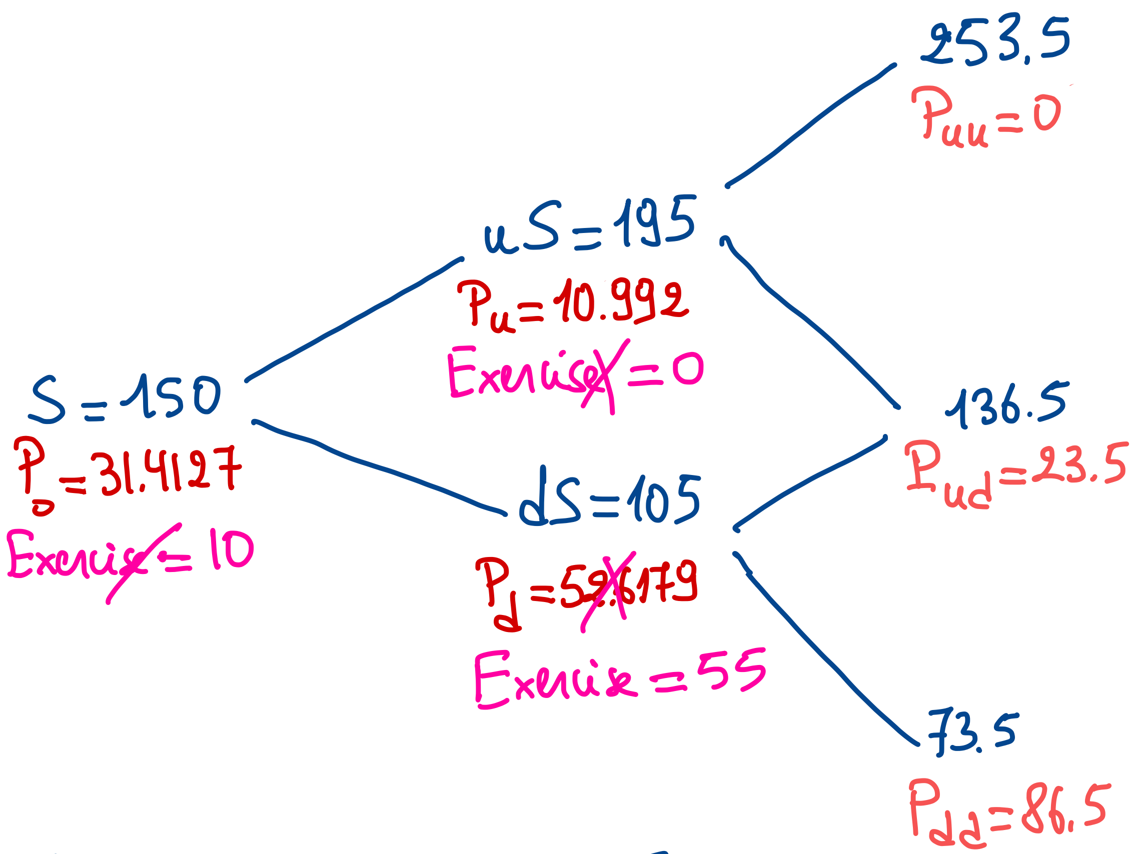
(a) 21.38

(b) 23.18

(c) 27.23

(d) 30.11

(e) 31.14



$$P_0 = e^{-rh}\left[10.992\, p^* + 55 \times (1-p^*)\right]$$

$$= 31.4127$$

Exercise

The spot exchange rate of dollars for euros is $x_0 = 1.15$. A 6-month American call option allows purchase of euros at 1.25 dollar for 1 euro. You are given:

- $r_d = 0.05$ $\rightsquigarrow r$
- $r_e = 0.04$ $\rightsquigarrow \delta$
- The annual volatility of the exchange rate is 0.1. $\rightsquigarrow \sigma$

$h = 1/4$

A 2-period binomial tree based on forward prices is used to value the option. Then $u + d =$

(a) 2.0075

(b) 2.2375

(c) 2.4575

(d) 2.6975

(e) 2.8775

$$u = e^{(r-\delta)h + \sigma\sqrt{h}} = 1.0539$$

$$d = e^{(r-\delta)h - \sigma\sqrt{h}} = 0.95361$$

Exercise

Future prices of dollars expressed in euros are modeled with a 2-period binomial tree, with each period being 6 months.

You are given:

$h = 0.5$

$T = 1$

1. The spot exchange rate is 0.9. ~ x
2. The tree has $u = 1.1$ and $d = 0.9$.
3. The continuously compounded risk-free interest rate for euros is 0.07. ~ r
4. The continuously compounded risk-free interest rate for dollars is 0.05. ~ δ

A euro-denominated American put option on dollars expiring in 1 year has a strike price of 0.95 euro. Determine the option's premium.

$K = 0.95$

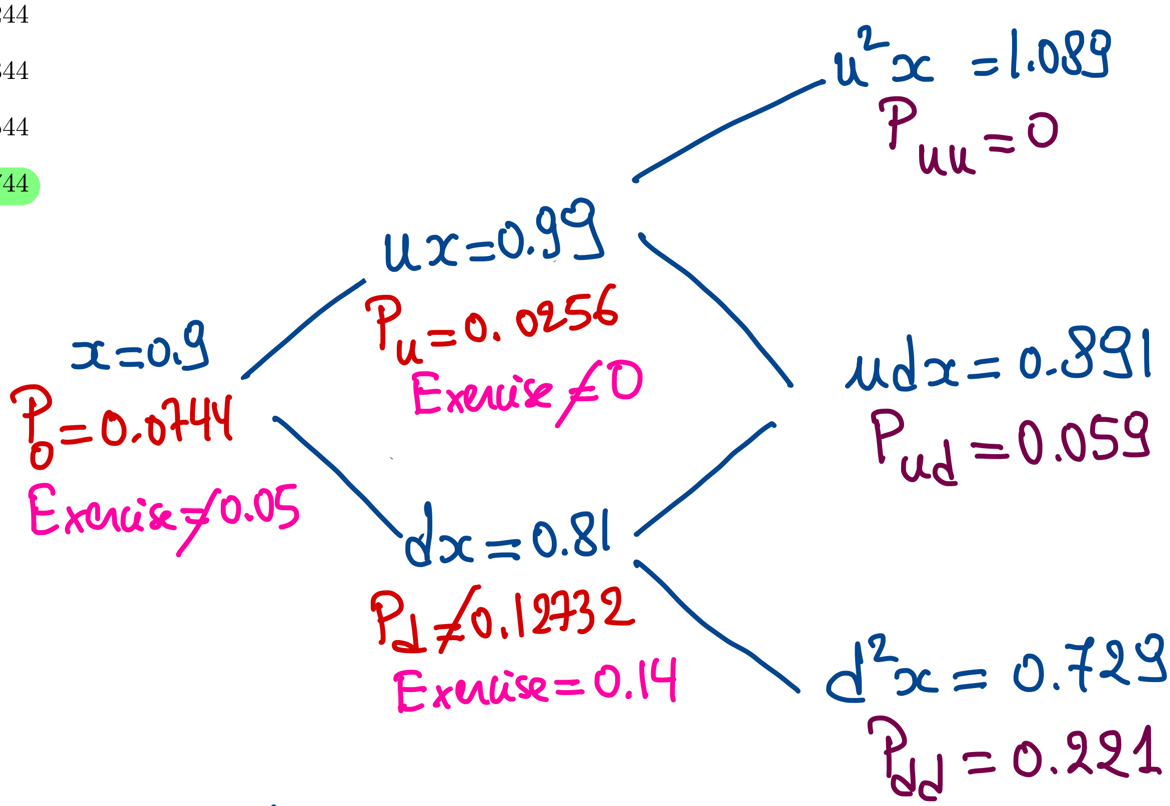
(a) 0.0144

(b) 0.0244

(c) 0.0344

(d) 0.0544

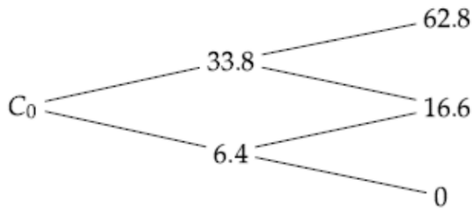
(e) 0.0744



$$p^* = \frac{e^{(r-\delta)h} - d}{u-d} = 0.55025$$

Exercise

Future prices of a stock are modeled with a 2-period binomial tree. The risk-neutral probabilities of up movements at all nodes of the tree are equal. A European option on the stock has the following prices Determine C_0, the price of the option at the initial node.



(a) 8.23

(b) 11.54

(c) 16.73

(d) 27.18

(e) 35.12

$$33.8 = e^{-rh}\left[62.8p^* + 16.6(1-p^*)\right]$$

$$= e^{-rh} \times \left[16.6 + 46.2p^*\right] \quad (1)$$

$$6.4 = e^{-rh}\left[16.6p^*\right] \quad (2)$$

$$\frac{(1)}{(2)} \Rightarrow \frac{16.6+46.2p^*}{16.6p^*} = \frac{33.8}{6.4}$$

$$\Rightarrow (16.6+46.2p^*)\times 6.4 = (16.6p^*)\times 33.8$$

$$\Rightarrow p^* = 0.4003$$

$$(2) \Rightarrow e^{-rh} = \frac{6.4}{16.6p^*} = 0.963133$$

$$C_0 = e^{-rh}\left[p^* \times 33.8 + (1-p^*) \times 6.4\right]$$

$$= 16.73$$

Exercise

A non-dividend paying stock has a current value of 100. In each of the next six-month periods, the stock price could rise by 25% or fall by 25%. The risk-free interest rate is 6% per year.

Consider a European call on this stock with an exercise price of 90. Then, $C_u + C_d =$

one year

(a) 35.62

(b) 36.62

(c) 37.62

(d) 38.62

(e) 39.62

$h = 0.5$; $T = 1$; $K = 90$

$S = 100$

$uS = 125$
$C_u = 37.66$

$dS = 0.75$
$C_d = 2.041$

156.25
$C_{uu} = 66.25$

93.75
$C_{du} = 3.75$

56.25
$C_{dd} = 0$

$r = 6\%$
$\delta = 0\%$
$u = 1.25$; $d = 0.75$

$$p^* = \frac{e^{(r-\delta)h} - d}{u - d} = 0.560909$$

Exercise

For an American call option on a stock:

(i) The stock price is \$50. ~ S

(ii) The strike price is \$45. ~ K

(iii) There are 3 months to expiry. ~ $T = 1/4$

(iv) The stock is about to pay a dividend of D.

(v) $r = 0.04$.

Determine the least upper bound of values for D such that immediate exercise is definitely not optimal.

(a) $D < 0.447757$

(b) $D > 0.447757$

(c) $D < 0.847757$

(d) $D > 0.847757$

(e) $D > 1.247757$

Present value of K is

$$K(1-e^{-rT}) = 0.447757$$

Present value of dividends is D

$$D < 0.447757$$

Exercise

$S_0 = 80$

S_t is the price of a non-dividend-paying stock at time t. S_t follows a lognormal model.
You are given:

- The continuously compounded annual rate of return on the stock is 0.15.
- The stock's volatility is 0.3.
- $S_0 = 80$.

Calculate the probability that S_4 is at least 150.

(a) $1 - N(0.14768)$

(b) $N(0.14768)$

(c) $1 - N(0.24768)$

(d) $1 - N(0.34768)$

(e) $1 - N(0.44768)$

$$m = \alpha t - 0.5\sigma^2 t = (0.15 - 0.5 \times 0.3^2) \times 4$$
$$= 0.42$$
$$v = \sigma\sqrt{t} = 0.3\sqrt{4} = 0.6$$

$$\mathbb{P}\{S_4 > 150\} = \mathbb{P}\left\{\frac{S_4}{S_0} > \frac{150}{80} = \frac{15}{8}\right\}$$
$$= \mathbb{P}\{\ln(S_4/S_0) > \ln(15/8)\}$$
$$= \mathbb{P}\left\{\frac{\ln(S_4/S_0) - m}{v} > \frac{\ln(15/8) - m}{v}\right\}$$
$$= 1 - N\left(\frac{\ln(15/8) - m}{v}\right)$$
$$= 1 - N\left(\frac{\ln(15/8) - 0.42}{0.6}\right)$$
$$= 1 - N(0.34768)$$

Exercise

S_t is the price of a non-dividend-paying stock at time t. S_t follows a lognormal model. You are given:

1. $S_0 = 40$.
2. The stock's continuously compounded expected growth rate is $\alpha = 0.15$.
3. The stock's volatility $\sigma = 0.3$.

Determine the median price of the stock after one year.

(a) 44.42

(b) 45.42

(c) 46.42

(d) 47.42

(e) 48.42

$t = 1$;

·) The median of S_1/S_0 is e^m

·) The median of S_1 is

$$S_0 e^m = S_0 e^{\alpha \times t - 0.5\sigma^2 \times t} = 44.42$$

Exercise

S_t is the price of a non-dividend-paying stock at time t. S_t follows a lognormal model. You are given:

1. $S_0 = 40$.
2. The stock's continuously compounded expected growth rate is $\alpha = 0.15$.
3. The stock's volatility $\sigma = 0.3$.

$t = 4$

Determine $E[\ln(S_4/S_0)]$.

(a) 0.33

(b) 0.36

(c) 0.39

(d) 0.42

(e) 0.45

$\ln(S_4/S_0)$ is normally distributed with

mean $m = \alpha \times t - 0.5\sigma^2 \times t = 0.42$

Exercise

A stock's prices follow a lognormal distribution. You are given:

- $\alpha = 0.14$
- $\delta = 0.02$
- $\sigma = 0.3$

Determine the probability that the stock's price at the end of one month will be greater than its current price.

(a) $1 - N(0.07217)$

(b) $1 - N(-0.07217)$

(c) $1 - N(0.37217)$

(d) $1 - N(-0.37217)$

(e) $1 - N(-0.47217)$

$t = 1/12$

$m = \alpha t - \delta t - 0.5\sigma^2 t = 6.25 \times 10^{-3}$

$v = \sigma\sqrt{t} = 0.0866025$

$\mathbb{P}\{S_t > S_0\} = \mathbb{P}\{S_t/S_0 > 1\}$

$= \mathbb{P}\{\ln(S_t/S_0) > \ln 1 = 0\}$

$= 1 - N\left(\frac{0-m}{v}\right)$

$= 1 - N(-0.07216)$

Exercise

A stock's prices follow a lognormal distribution. You are given:

- $\alpha = 0.14$
- $\delta = 0.02$
- $\sigma = 0.3$
- For a standard normal distribution, the 97.5 percentile is 1.96. $\rightsquigarrow z_{\alpha/2} = 1.96$

$1/12 = t$

Construct a 50% synthetic prediction ~~material~~ interval for the ratio of the stock's price at the end of a month to the current price.

(a) (0.80917, 0.99243).

(b) (0.84917, 0.99243).

(c) (0.80917, 1.19243).

(d) (0.84917, 1.19243).

(e) (0.88917, 1.19243).

$m = 6.25 \times 10^{-3}$

$v = 0.0866025$

The prediction interval is $\left(e^{m - z_{\frac{\alpha}{2}} \times v}, e^{m + z_{\frac{\alpha}{2}} \times v}\right)$

$= (0.84917, 1.19243)$

Exercise

A stock's price follows a lognormal model. You are given:

1. $S_0 = 60$
2. $\alpha = 0.15$
3. $\sigma = 0.2$
4. $\delta = 0.05$

K $\quad T = 1/4$

A European call option on the stock with strike price 70 expires in 3 months.
Calculate the probability that the option pays off.

(a) N(-0.34151)

(b) N(0.34151)

(c) N(-1.34151)

(d) N(1.34151)

(e) N(2.34151)

$\mathbb{P}\{\text{the option pays off}\}$

$= \mathbb{P}\{S_t > K\} = N(\hat{d}_2)$

$$\hat{d}_2 = \frac{\ln(S_0/K) + (\alpha - \delta - 0.5\sigma^2)t}{\sigma\sqrt{t}} = -1.34$$

Exercise

A stock's price follows a lognormal model. You are given:

(i) The stock's initial price is $40.

(ii) $\alpha = 0.10$

(iii) $\sigma = 0.15$

(iv) The stock pays no dividends.

$t = 2$ $\quad$ $S_2 < 50$

Calculate the conditional expected value of the stock after 2 years given that it is less than $50.

Hint: $N(0.00303) = 0.50121$, $N(0.21516) = 0.58518$, $N(0.4) = 0.65542$ and $N(0.6) = 0.72575$

(a) 38.85

(b) 39.85

(c) 40.85

(d) 41.85

(e) 42.85

$$E[S_2 | S_2 < 50] = S_0 e^{(\alpha-\delta)t} \frac{N(-\hat{d}_1)}{N(-\hat{d}_2)}$$

$$\hat{d}_1 = \frac{\ln(S_0/K) + (\alpha - \delta + 0.5\sigma^2)t}{\sigma\sqrt{t}} = -0.00303$$

$$\hat{d}_2 = \hat{d}_1 - \sigma\sqrt{t} = -0.21516$$

$$\Rightarrow E[S_2 | S_2 < 50] = 40 \times e^{0.1 \times 2} \frac{N(0.00303)}{N(0.21516)}$$

$$= 41.85$$

Exercise

$\delta = 0$

For a non-dividend paying stock, you are given:

1. The stock price follows a lognormal model.
2. The current price is 100. S_0
3. The continuously compounded expected rate of return is 0.1. $\alpha = 0.1$
4. The volatility is 0.2.

$t = 1$ K

A European call option on the stock expiring in one year has a strike price of 100. Calculate the expected payoff on the call option.

Hint: $N(0.00303) = 0.50121$, $N(0.21516) = 0.58518$, $N(0.4) = 0.65542$ and $N(0.6) = 0.72575$

(a) 5.78

(b) 9.23

(c) 11.19

(d) 14.67

(e) 28.15

$$\hat{d}_1 = \frac{\ln(S_0/K) + (\alpha + 0.5\sigma^2)t}{\sigma\sqrt{t}} = 0.6$$

$$\hat{d}_2 = \hat{d}_1 - \sigma\sqrt{t} = 0.4$$

Answer $S_0 e^{\alpha t} N(\hat{d}_1) - K N(\hat{d}_2)$

$$= 100 e^{0.1} N(0.6) - 100 N(0.4)$$

$$= 14.67$$

Exercise

A stock's price follows a lognormal distribution. To simulate its price over 10 years, scenarios are generated. In each scenario, the stock price at time t is generated by generating a standard normal random variable Z. Then S_t is set equal to $S_{t-1}e^{0.1+0.2Z}$ for $t = 1, 2, ..., 10$.

Determine the expected value of the ratio $\dfrac{S_{10}}{S_0}$ in this simulation.

(a) 3.320117

(b) 4.320117

(c) 5.320117

(d) 6.320117

(e) 7.320117

$$0.1+0.2Z \sim \mathcal{N}(m_1 = 0.1\ ,\ \sigma_1^2 = 0.2^2)$$

$$E\left[\frac{S_{10}}{S_0}\right] = e^{m_{10}+0.5\sigma_{10}^2}$$

$$= e^{10[m_1+0.5\sigma_1^2]}$$

$$= e^{10[0.1+0.5\times 0.2^2]}$$

$$= 3.32$$

Exercise

$T = 1/4$ $K = 52$

For 3-month 52-strike European call option on a stock, you are given:

(i) The stock's price follows the Black-Scholes framework.

(ii) The stock's price is 50. $\to S$

(iii) The stock's volatility is 0.4. $\to \sigma$

(iv) The stock's continuous dividend rate is 4%. $\to \delta$

(v) The continuously compounded risk-free interest rate is 8%. $\to r$

Determine the premium of the option.

Hint: N(-0.04611)=0.48161, N(-0,24611)=0.40280, N(0,24611)=0.59720, N(0.04611)=0.51839.

(a) 2.31

(b) 3.31

(c) 4.31

(d) 5.31

(e) 6.31

$$d_1 = \frac{\ln(S/K) + \left(r - \delta + \frac{\sigma^2}{2}\right)T}{\sigma\sqrt{T}} = -0.0461$$

$$d_2 = d_1 - \sigma\sqrt{T} = -0.2461$$

$$\text{Call} = Se^{-\delta T}N(d_1) - Ke^{-rT}N(d_2)$$

$$= 50e^{-0.04\times 0.25}N(-0.0461) - 52e^{-0.08\times 0.25}N(-0.2461)$$

$$= 3.31$$

Exercise

$T = 1/4$

For 3-month 52-strike European put option on a stock, you are given:

K

(i) The stock's price follows the Black-Scholes framework.

(ii) The stock's price is 50. $\rightsquigarrow S_0$

(iii) The stock's volatility is 0.4. $\rightsquigarrow \sigma$

(iv) The stock's continuous dividend rate is 4%. $\rightsquigarrow \delta$

(v) The continuously compounded risk-free interest rate is 8%. $\rightsquigarrow r$

Determine the premium of the option.

Hint: N(-0.04611)=0.48161, N(-0,24611)=0.40280, N(0,24611)=0.59720, N(0.04611)=0.51839.

(a) 2.78

(b) 3.78

(c) 4.78

(d) 5.78

(e) 6.78

$$\text{Put} = Ke^{-rT}N(-d_2) - Se^{-\sigma T}N(-d_1)$$

$$= 52e^{-0.08\times 0.25}N(0.2461) - 50e^{-0.04\times 0.25}N(0.0461)$$

$$= 4.78$$

$T = 0.5$

Exercise

A stock has quarterly dividends, paid at the end of 3 months and 6 months from now. You are given:

- The stock price is $S = 42$.
- Quarterly dividends are $D = 0.75$.
- The volatility of a prepaid forward on the stock is $\sigma = 0.3$.
- A 6-month European put option is written on the stock with strike price $K = 40$.
- The continuously compounded risk-free rate is $r = 0.04$.

Calculate the put option's premium with the Black-Scholes formula.

Hint: $N(-0.26149) = 0.39686$, $N(-0.04936) = 0.48032$, $N(-1.68221) = 0.04626$, $N(-1.73221) = 0.04162$

(a) 2.15

(b) 2.25

(c) 2.45

(d) 2.55

(e) 2.75

$$S - PV(divs) = S - 0.75 \times \left(e^{-0.04/4} + e^{-0.04/2}\right) = 40.5223$$

$$d_1 = \frac{\ln\left(\frac{S - PV(divs)}{K}\right) + (r + 0.5\sigma^2)T}{\sigma\sqrt{T}} = 0.2615$$

$$d_2 = d_1 - \sigma\sqrt{T} = 0.04936$$

$$P = Ke^{-rT} N(-d_2) - (S - PV(divs)) N(-d_1)$$

$$= 40e^{-0.04 \times 0.5} \times N(-0.04936) - 40.5223\, N(-0.2615)$$

$$= 2.75$$

Exercise

You are given:

(i) The spot exchange rate for yen in dollars is 0.009 $\rightsquigarrow x$

(ii) $\sigma = 0.05$

(iii) The continuously compounded risk-free rate for yen is 2% $\rightsquigarrow \delta$

(iv) The continuously compounded risk-free rate for dollars is 4% $\rightsquigarrow r$

Calculate the Black-Scholes price for a 1-year ($\rightsquigarrow T$) European dollar-denominated call option on yen with a strike price of 0.010 $\rightsquigarrow K$

Hint: $N(-0.26149) = 0.39686$, $N(-0.04936) = 0.48032$, $N(-1.68221) = 0.04626$, $N(-1.73221) = 0.04162$

(a) 0.0000082

(b) 0.0002082

(c) 0.0030082

(d) 0.0500082

(e) 0.0700082

$$d_1 = \frac{\ln(x/K) + (r - \delta + \sigma^2/2)T}{\sigma\sqrt{T}} = -1.68221$$

$$d_2 = d_1 - \sigma\sqrt{T} = -1.73221$$

$$\text{Call} = xe^{-\delta T}N(d_1) - Ke^{-rT}N(d_2)$$

$$= 0.009e^{-0.02\times 1}N(-1.68221) - 0.010\times e^{-0.04\times 1}N(-1.73221)$$

$$= 0.00000821$$

Exercise

A futures contract on silver has a price of 10 $\rightsquigarrow F$ for delivery at the end of 1 $\rightsquigarrow T$ year. Volatility is 0.25 $\rightsquigarrow \sigma$. The continuously compounded risk-free rate is 4% $\rightsquigarrow r$.

Calculate the premium for a 1-year European call option on the futures contract with a strike price of 10 $\rightsquigarrow K$.

Hint: $N(0.125) = 0.54974$, $N(-0.125) = 0.45026$, $N(0.15) = 0.55962$, $N(-0.15) = 0.44038$

(a) 0.5558

(b) 0.9558

(c) 1.5558

(d) 1.9558

(e) 2.9558

$$d_1 = \frac{\ln(F/K) + \frac{\sigma^2}{2}T}{\sigma\sqrt{T}} = 0.125$$

$$d_2 = d_1 - \sigma\sqrt{T} = -0.125$$

$$\text{Call} = Fe^{-rT}N(d_1) - Ke^{-rT}N(d_2)$$

$$= 10e^{-0.04}N(0.125) - 10e^{-0.04}N(-0.125)$$

$$= 0.9558.$$

Exercise

You are interested in purchasing a call option on a nondividend paying common stock that is currently trading at a price of 100 per share. You are given the following information. $\to \delta = 0$

S

- The standard deviation of the continuously compounded annual rate of return on the stock is 0.4 $\to \sigma$
- The time to maturity of the call is 3 months. $\to T = 1/4$
- $$\ln\left(\frac{\text{Current share price}}{\text{Present value of the exercises price}}\right) = -0.08$$

  at the risk-free rate.

Calculate the price of a call option using Black-Scholes.

Hint: $N(-0.3) = 0.38209$, $N(-0.5) = 0.30854$, $N(-0.80379) = 0.21076$, $N(-0.94813) = 0.17153$

(a) 2.3154

(b) 3.2478

(c) 4.7854

(d) 5.4231

(e) 6.2817

$$d_1 = \frac{\ln\left(\frac{S}{Ke^{-rT}}\right) + \frac{\sigma^2}{2}T}{\sigma\sqrt{T}} = -0.3$$

$$d_2 = d_1 - \sigma\sqrt{T} = -0.5$$

$$\ln\left(\frac{S}{Ke^{-rT}}\right) = -0.08 \Rightarrow \frac{S}{Ke^{-rT}} = e^{-0.08} \Rightarrow Ke^{-rT} = Se^{0.08}$$

$$\text{Call} = Se^{-\delta T}N(d_1) - \underbrace{Ke^{-rT}}N(d_2)$$

$$= SN(-0.3) - Se^{0.08}N(-0.5)$$

$$= 4.785$$