Question:

Yara Inc is listed on the NYSE with a stock price of \$40 - the company is not known to pay dividends. We need to price a call option with a strike of \$45 maturing in 4 months. The continuously-compounded risk-free rate is 3%/year, the mean return on the stock is 7%/year, and the standard deviation of the stock return is 40%/year. What is the Black-Scholes call price?

Solution:

To calculate the Black-Scholes call price

$$C_o = SoN(d1) - Ke^{(rt)}N(d2)$$

$$d_1 = \frac{\ln\left(\frac{So}{K}\right)+\left(r+\frac{\sigma^2}{2}\right)T}{\sigma\sqrt{T}} \quad , \qquad d_2 = d_1 - \sigma\sqrt{(T)}$$

Where:

C_o = Current stock price

K = strike stock price

σ = represents the underlying volatility

r = risk-free interest rate

t = duration in years

$N(d_1)$ and $N(d_2)$ are cumulative distribution functions for a standard normal distribution

Given:

S_o = \$40, K = \$45, r= 3%, σ = 40%, T= 4 months (1/3 years)

Calculating the d_1 and d_2

$$d_1 = \frac{\ln\left(\frac{So}{K}\right)+\left(r+\frac{\sigma^2}{2}\right)T}{\sigma\sqrt{T}}$$

$$= \frac{\ln\left(\frac{40}{45}\right)+\left(0.03+\frac{0.4^2}{2}\right)0.33}{0.4\sqrt{0.33}}$$

$$= -0.35$$

$$d_2 = d_1 - \sigma\sqrt{(T)}$$

$$= -0.35 - (0.4\sqrt{0.33})$$

$$= -0.58$$

Checking the normal distribution table for $N(d_1)$ and $N(d_2)$

$$N(d1) = 0.3617, \qquad N(d2) = 0.28096$$

Calculating the call price now

Call price (C_o) $= SoN(d1) - Ke^{(rt)}N(d2)$

$= 40N(d1) - 45e^{(0.03*0.333)}N(d2)$

$= (40 * 0.3617) - (45e^{(0.03*0.333)} * 0.28096)$

= 2.009

The call price is <u>$2.009</u>