 ***European Option Valuation Without Dividends***



 gives the probability that the standardised normally distributed random variable with mean 0 and variance 1 is less than :

It’s normally looked up on the standard normal Z table. It can also be calculated in MS Excel using the ‘=normsdist()’ function.

 ***Probability***

 for a European call option, which is the probability that the call option ends up being in the money at maturity in a risk-neutral world where all assets earn the risk free rate r.



 for a European put option, which is the probability that the put option ends up being in the money at maturity in a risk-neutral world.

To get the risk-averse probability in the real world, replace r in with the underlying asset’s forecast natural logarithm of arithmetic average gross discrete returns (LAAGDR):

See the lecture on return distributions for more detail.

 ***Option Delta Δ***

, the European call option Delta at the current underlying asset price which has time until maturity.

The Delta is a tangential gradient, it’s the increase (rise) in option price divided by the increase (run) of the underlying asset price .

For every 1 cent increase in the underlying asset price, the option price will increase by Delta cents.



***Portfolio Delta***

If a portfolio’s Delta is zero then a small change in the underlying asset price will lead to no change in the value of the portfolio, so it’s hedged. The Delta of a portfolio is simply the sum of the assets’ Deltas. Let be the number of asset 1’s, and let m be the total number of assets. Then the portfolio Delta () is:

***Relationship to the No-arbitrage Binominal Option pricing Delta***

This Black-Scholes-Merton Delta is the same Delta as the No-arbitrage Binominal Option pricing formula’s delta: