Black−Scholes Plots

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```
<< Statistics`NormalDistribution`
```

```
? CDF
```

```
CDF[distribution, x] gives the cumulative distribution function of the specified
  statistical distribution evaluated at x.  For continuous distributions, this is
  defined as the integral of the probability density function from the lowest value
  in the domain to x.  For discrete distributions, this is defined as the sum of
  the probability density function from the lowest value in the domain to x.
```

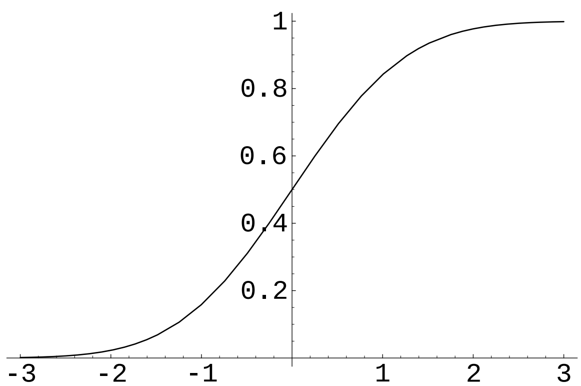
```
? NormalDistribution
```

```
NormalDistribution[mu, sigma] represents the normal (Gaussian) distribution with
  mean mu and standard deviation sigma.
```

```
pdfn[y_] = PDF[NormalDistribution[0, 1], y]
```

$$\frac{E^{-\frac{y^2}{2}}}{\sqrt{2\pi}}$$

```
Plot[normalint[y], {y, -3, 3}]
```



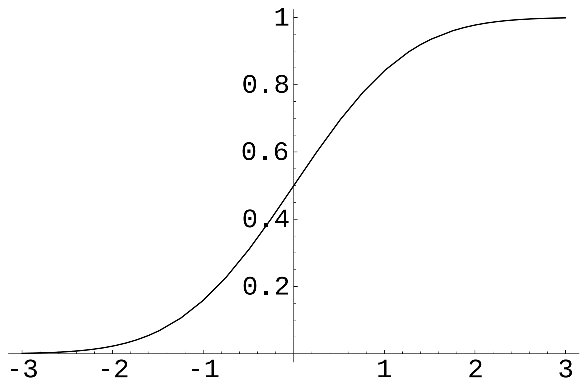

```
- Graphics -
```

```
nd[d_] := CDF[NormalDistribution[0, 1], d]
```

```
nd[0]
```

$$\frac{1}{2}$$

```
Plot[nd[y], {y, -3, 3}]
```



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Interest rate :

```
r = 0.05 / 365
```

0.000136986

```
v = Sqrt[.3 * 2 * r]
```

0.00906597

v^2 is the variance rate of the square of the relative stock price fluctuations, assuming a random walk Gaussian distribution with the variance spreading proportional to the time. Here we take $v^2/2 = 0.3\,r$, or a v of about 1 % fluctuation per day.

```
v^2 / (2 * r)
```

0.3

We take the maturity time tmat of 90 days :

```
tmat = 90
```

90

```
d1 := (Log[xc] + (r + v^2 / 2) (tmat - t)) / (v * Sqrt[tmat - t])
```

```
d2 := (Log[xc] + (r - v^2 / 2) (tmat - t)) / (v * Sqrt[tmat - t])
```

Scale the call option price ω by the strike price c and call it the relative call value wc = ω / c .

Scale the stock price x by the strike price c and call it the relative stock value xc = x / c .

The scaled solution to the Black - Scholes equation is then

```
wc := xc * nd[d1] - Exp[-r (tmat - t)] nd[d2]
```

```
wc
```

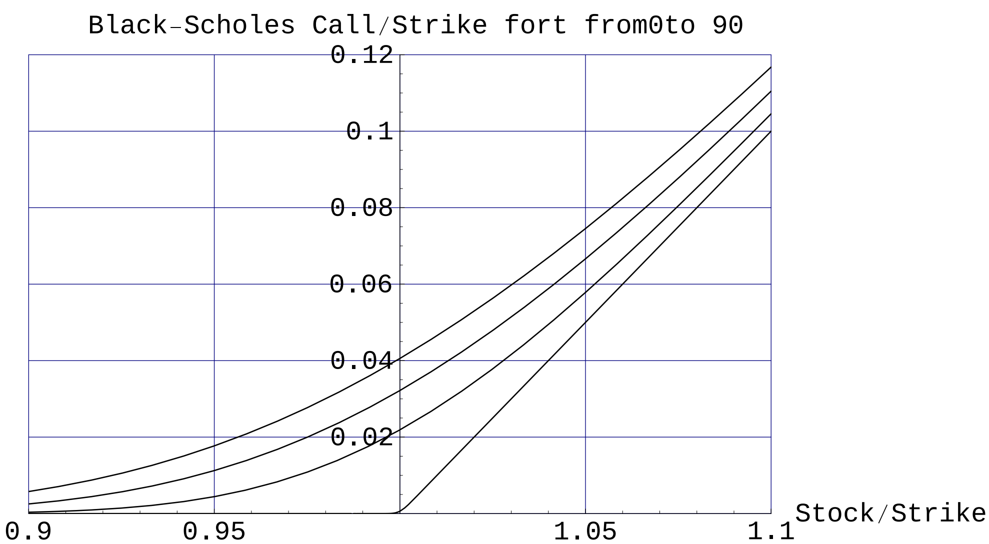
$$-\frac{1}{2}\,E^{-0.000136986\,(90-t)}\left(1+\mathrm{Erf}\left[\frac{77.9957\,(0.0000958904\,(90-t)+\mathrm{Log}[xc])}{\sqrt{90-t}}\right]\right)+\frac{1}{2}\,xc\left(1+\mathrm{Erf}\left[\frac{77.9957\,(0.000178082\,(90-t)+\mathrm{Log}[xc])}{\sqrt{90-t}}\right]\right)$$

```
timetable := Table[wc, {t, 0, tmat, 29.99}]
```

```
t =.
```

```
bs := Plot[Evaluate[timetable], {xc, 0.9, 1.1},
  AxesLabel -> {"Stock/Strike", ""}, PlotRange -> {{0.9, 1.1}, {0.0, 0.12}},
  GridLines -> Automatic,
 PlotLabel -> "Black-Scholes Call/Strike for t from 0 to 90"]
```

```
bs
```



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