Computations related to Table Section 13.2

By Le Chen.

Crated on Tue 19 Oct 2021 08:59:54 AM CDT

In[ ]:=

$$\int_{-\infty}^{d} \frac{1}{\sqrt{2\pi}} \text{Exp}\left[\frac{-x^2}{2}\right] \, dx$$

Out[ ]=

$$\frac{1}{2} \times \left(1 + \text{Erf}\left[\frac{d}{\sqrt{2}}\right]\right)$$

First define functions

In[ ]:=

```
Clear["Global`*"]
```

$$n[d\_] := \frac{1}{2} \times \left(1 + \text{Erf}\left[\frac{d}{\sqrt{2}}\right]\right)$$

$$d1 = \frac{\text{Log}\left[\frac{S}{K}\right] + \left(r - \delta + \frac{1}{2}\sigma^2\right)(T - t)}{\sigma\sqrt{T - t}};$$

$$d2 = d1 - \sigma\sqrt{T - t};$$

$$\text{OptionCall}[S\_, t\_] = S\, e^{-\delta (T-t)}\, n[d1] - K\, e^{-r (T-t)}\, n[d2];$$

$$\text{OptionPut}[S\_, t\_] = K\, e^{-r (T-t)}\, n[-d2] - S\, e^{-\delta (T-t)}\, n[-d1];$$

```
Δ[S_,t_]= D[OptionCall[S,t],S];
Γ[S_,t_]= D[OptionCall[S,t],{S,2}];
θ[S_,t_]= D[OptionCall[S,t],t];
```

Then define the constants (Setup)

In[ ]:=

```
K = 40;
T = 1;
```

$$t = T - \frac{91}{365};$$

```
r = 0.08;
σ = 0.30;
δ = 0;
```

Compute the Greeks and option price

In[ ]:=
```
OptionCall[40, t]
```
Out[ ]= 2.7804

In[ ]:=
```
Δ[40, t]
```
Out[ ]= 0.582404

In[ ]:=
```
Γ[40, t]
```
Out[ ]= 0.0651562

In[ ]:=
```
θ[40, t]
```
Out[ ]= -6.33251

Case S increases to $40 .75
and liquidate the position today

Option price insreased to

In[ ]:=
```
OptionCall[40.75, t]
```
Out[ ]=
```
3.23524
```

Profit should be

In[ ]:=
```
OptionCall[40, t] - OptionCall[40.75, t]
```
Out[ ]=
```
-0.454836
```

If we approximate using Δ, we would have

In[ ]:=
```
-(40.75 - 40) Δ[40, t]
```
Out[ ]=
```
-0.436803
```

New delta at S = 40.75

In[ ]:=
```
Δ[40.75, t]
```
Out[ ]=
```
0.630078
```

Case S decreases to $39 .25 and liquidate the position the same day

Option price declided to

```
In[ ]:= OptionCall[39.25, t]
Out[ ]= 2.36218
```

Profit should be

```
In[ ]:= OptionCall[40, t] - OptionCall[39.25, t]
Out[ ]= 0.418225
```

If we approximate using Δ, we would have

```
In[ ]:= -(39.25 - 40) Δ[40, t]
Out[ ]= 0.436803
```

Hence, we need to use Γ to better approximate the changes.

Finally, plot the Option Call

In[ ]:=
```
Plot[{OptionCall[40, t] - OptionCall[S, t], OptionCall[40, t] - Max[S - K, 0]}, {S, 12, 60}]
```

Out[ ]=