Financial calculus in Mathematica

Operators

```
In[282]:=
Da[V_] := V /. {c → 0, r → 0.05, S → 100, Ind → Ind0, Event → Event0}

In[2]:= T[index_, power_, V_] := V /. {index → index + power}

In[3]:= T[x, a[y], f[x, y]]

Out[3]= f[x + a[y], y]

In[4]:= Ind0[indicator_] := If[indicator, 1, 0]

In[11]:= Ind[1 > 5]
         Da[%]

Out[11]= Ind[False]

Out[12]= 0

In[8]:= Event0[choice_, V1_, V2_] := Expand[choice * V1 + (1 - choice) * V2]
```

Financial Products and Instruments

Bond deal

```
In[403]:=
bond[V_] := T[c, -90, Theta[T[c, 100, V]]]
```

Coupon bond

```
In[351]:=
cbond[V_] :=
 Nest[Function[w, Theta[T[c, 11, w]]], V, 5]
```

European Option

```
In[277]:=
europt[V_] :=
 Nest[Function[w, Theta[w]],
  Event[Ind[A[V] > B[V]], A[V], B[V]], 5]
```

In[292]:=
```
A[V_] := V
B[V_] := T[c, S - K, V]
K := 130
```

American Option

In[278]:=
```
amopt[V_] :=
 Nest[Function[w, Theta[Event[Ind[w > X[V]], w, X[V]]]], V, 5]
```

In[20]:=
```
X[V_] := T[c, S - K, V]
```

Binomial tree model

Process operator

In[295]:=
```
Theta1[V_] :=
 T[c, r c,
  Event[p, T[S, S * u - S, V], T[S, S / u - S, V]]]
```

Risk neutral probability

In[296]:=
```
Da[Theta1[S]]
```

Out[296]=
$$\frac{100}{u} - \frac{100\,p}{u} + 100\,p\,u$$

In[307]:=
```
Solve[
  {Da[Theta1[S] / (1 + r) == S],
   Da[Theta1[S^2] - Theta1[S]^2 == (40.)^2]}, {p, u}];
p2 := Evaluate[%[[1]]]
p2
```

Out[309]=
```
{p → 0.465854, u → 1.47832}
```

In[310]:=
```
Theta2[V_] := Theta1[V] /. p2
```

In[413]:=
```
Da[Theta2[S]]
Da[T[c, 1, Theta2[c]]]
```

Out[413]=
```
105.
```

Out[414]=
```
1.05
```

In[312]:=
```
Da[Nest[Theta2, S, 5]]
```

Out[312]=
```
127.628
```

Pricing of Stock Options

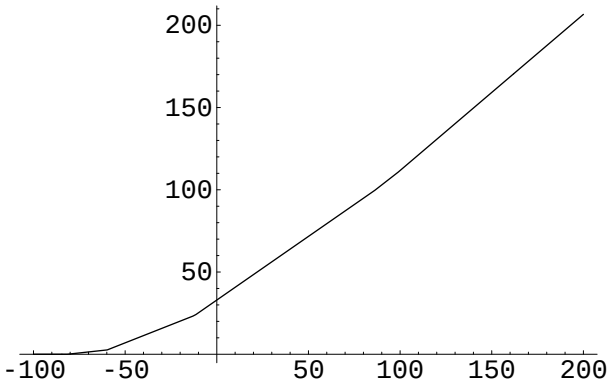
In[418]:=
```
Theta[V_] := Theta2[V] / (1 + r)
```

In[321]:=
```
price := europt[c];
Da[price]
```

Out[322]=
```
32.9616
```

In[323]:=
```
pl := Evaluate[Da[T[S, dS, price]]]
```

In[324]:=
```
Plot[{pl}, {dS, -100, 200}, PlotRange → All]
```



Out[324]=
```
- Graphics -
```

In[325]:=
```
price := amopt[c];
Da[price]
```

Out[326]=
```
32.9616
```

Fixed income

Prices

In[419]:=
```
Da[bond[c]]
```

Out[419]=
```
5.2381
```

In[420]:=
```
Da[cbond[c]]
```

Out[420]=
```
47.6242
```

Sensitivities

In[421]:=
```
Da[D[bond[c], r]]
```

Out[421]=
```
-90.7029
```

In[422]:=
```
Da[D[cbond[c], r]]
```

Out[422]=
```
-131.648
```