

Black_Scholes_Stock_Calls

September 29, 2021

1 Black Scholes Stock Calls Inputs

```
[1]: import numpy as np
import scipy.stats as ss
import matplotlib.pyplot as plt
import yfinance as yf
```

```
[2]: dfo = yf.Ticker("AAPL")
```

```
[3]: dfo.options
```

```
[3]: ('2020-10-15',
      '2020-04-23',
      '2021-09-16',
      '2020-06-18',
      '2020-07-16',
      '2021-06-17',
      '2020-04-30',
      '2020-05-07',
      '2022-06-16',
      '2020-05-14',
      '2020-04-16',
      '2020-09-17',
      '2020-05-28',
      '2021-01-14',
      '2020-05-21',
      '2022-01-20',
      '2020-12-17')
```

```
[4]: dfo_exp = dfo.option_chain('2020-05-28')
```

```
[5]: dfo_exp.calls
```

```
[5]:
```

	contractSymbol	lastTradeDate	strike	lastPrice	bid	ask	\
0	AAPL200529C00230000	2020-04-09 19:39:18	230.0	43.00	41.00	44.80	
1	AAPL200529C00242500	2020-04-09 14:05:04	242.5	33.28	30.60	34.80	
2	AAPL200529C00252500	2020-04-09 19:45:27	252.5	25.49	23.50	27.20	

3	AAPL200529C00255000	2020-04-09	15:46:43	255.0	23.62	21.80	24.75
4	AAPL200529C00257500	2020-04-09	15:47:48	257.5	21.80	20.30	22.95
5	AAPL200529C00265000	2020-04-09	18:22:32	265.0	16.62	16.45	17.65
6	AAPL200529C00267500	2020-04-09	19:06:43	267.5	15.24	14.95	16.20
7	AAPL200529C00270000	2020-04-09	19:04:16	270.0	13.80	13.55	14.75
8	AAPL200529C00272500	2020-04-09	19:41:31	272.5	13.10	12.30	13.40
9	AAPL200529C00275000	2020-04-09	19:51:26	275.0	11.45	10.95	12.10
10	AAPL200529C00277500	2020-04-09	18:40:19	277.5	10.50	9.80	10.95
11	AAPL200529C00280000	2020-04-09	19:59:54	280.0	9.05	8.65	9.40
12	AAPL200529C00282500	2020-04-09	15:05:57	282.5	7.75	7.70	8.75
13	AAPL200529C00287500	2020-04-09	18:48:52	287.5	6.03	5.75	6.85
14	AAPL200529C00290000	2020-04-09	19:59:54	290.0	5.37	4.95	5.90
15	AAPL200529C00295000	2020-04-09	19:49:46	295.0	3.90	3.55	4.50
16	AAPL200529C00300000	2020-04-09	17:54:32	300.0	2.72	2.47	3.35
17	AAPL200529C00305000	2020-04-09	19:42:12	305.0	2.03	1.64	2.39
18	AAPL200529C00310000	2020-04-09	18:42:02	310.0	1.28	1.05	1.64
19	AAPL200529C00315000	2020-04-09	16:19:40	315.0	0.95	0.74	0.99
20	AAPL200529C00320000	2020-04-09	16:25:36	320.0	0.68	0.45	0.67
21	AAPL200529C00325000	2020-04-09	19:44:51	325.0	0.42	0.29	0.48
22	AAPL200529C00330000	2020-04-09	19:42:12	330.0	0.30	0.20	0.36
23	AAPL200529C00335000	2020-04-09	16:31:55	335.0	0.21	0.21	0.30

	change	percentChange	volume	openInterest	impliedVolatility	inTheMoney	\
0	43.00	Infinity	25	NaN	0.569096	True	
1	33.28	Infinity	4	NaN	0.528081	True	
2	25.49	Infinity	3	NaN	0.490178	True	
3	23.62	Infinity	5	NaN	0.462957	True	
4	21.80	Infinity	10	NaN	0.452947	True	
5	16.62	Infinity	2	NaN	0.418219	True	
6	15.24	Infinity	63	NaN	0.412207	True	
7	13.80	Infinity	9	NaN	0.404669	False	
8	13.10	Infinity	56	NaN	0.398077	False	
9	11.45	Infinity	28	NaN	0.391119	False	
10	10.50	Infinity	5	NaN	0.386420	False	
11	9.05	Infinity	14	NaN	0.369330	False	
12	7.75	Infinity	2	NaN	0.374396	False	
13	6.03	Infinity	1	NaN	0.363105	False	
14	5.37	Infinity	2	NaN	0.354438	False	
15	3.90	Infinity	4	NaN	0.345954	False	
16	2.72	Infinity	31	NaN	0.337714	False	
17	2.03	Infinity	7	NaN	0.328010	False	
18	1.28	Infinity	6	NaN	0.318244	False	
19	0.95	Infinity	16	NaN	0.302375	False	
20	0.68	Infinity	1	NaN	0.298347	False	
21	0.42	Infinity	10	NaN	0.298835	False	
22	0.30	Infinity	1	NaN	0.302253	False	
23	0.21	Infinity	1	NaN	0.310554	False	

	contractSize	currency
0	REGULAR	USD
1	REGULAR	USD
2	REGULAR	USD
3	REGULAR	USD
4	REGULAR	USD
5	REGULAR	USD
6	REGULAR	USD
7	REGULAR	USD
8	REGULAR	USD
9	REGULAR	USD
10	REGULAR	USD
11	REGULAR	USD
12	REGULAR	USD
13	REGULAR	USD
14	REGULAR	USD
15	REGULAR	USD
16	REGULAR	USD
17	REGULAR	USD
18	REGULAR	USD
19	REGULAR	USD
20	REGULAR	USD
21	REGULAR	USD
22	REGULAR	USD
23	REGULAR	USD

```
[6]: symbol = 'AAPL'
      start = '2019-12-01'
      end = '2020-04-02'
```

```
[7]: df = yf.download(symbol,start,end)
```

```
[*****100%*****] 1 of 1 completed
```

```
[8]: df.head()
```

```
[8]:
```

	Adj Close	Close	High	Low	Open \
Date					
2019-12-02	263.534546	264.160004	268.250000	263.450012	267.269989
2019-12-03	258.835724	259.450012	259.529999	256.290009	258.309998
2019-12-04	261.120270	261.739990	263.309998	260.679993	261.070007
2019-12-05	264.951172	265.579987	265.890015	262.730011	263.790009
2019-12-06	270.069031	270.709991	271.000000	267.299988	267.480011

	Volume
Date	

```

2019-12-02 23621800
2019-12-03 28607600
2019-12-04 16795400
2019-12-05 18606100
2019-12-06 26518900

```

```
[9]: df.tail()
```

```

[9]:
      Adj Close      Close      High      Low      Open \
Date
2020-03-26  258.440002  258.440002  258.679993  246.360001  246.520004
2020-03-27  247.740005  247.740005  255.869995  247.050003  252.750000
2020-03-30  254.809998  254.809998  255.520004  249.399994  250.740005
2020-03-31  254.289993  254.289993  262.489990  252.000000  255.600006
2020-04-01  240.910004  240.910004  248.720001  239.130005  246.500000

      Volume
Date
2020-03-26  63021800
2020-03-27  51054200
2020-03-30  41994100
2020-03-31  49250500
2020-04-01  44054600

```

```
[10]: returns = df['Adj Close'].pct_change().dropna()
```

```

[11]: from datetime import datetime
      from dateutil import relativedelta

      d1 = datetime.strptime(start, "%Y-%m-%d")
      d2 = datetime.strptime('2020-05-28', "%Y-%m-%d")
      delta = relativedelta.relativedelta(d2,d1)
      print('How many years of investing?')
      print('%s years' % delta.years)

```

```

How many years of investing?
0 years

```

```

[12]: maturity_days = (df.index[-1] - df.index[0]).days
      print('%s days' % maturity_days)

```

```
121 days
```

```

[13]: S0 = df['Adj Close'][-1]
      K = dfo_exp.calls['strike'][1]
      r = 0.1
      sigma = returns.std()

```

```
T = maturity_days/252
```

```
[14]: print("S0\tCurrent Stock Price:", S0)
      print("K\tStrike Price:", K)
      print("r\tContinuously compounded risk-free rate:", r)
      print("sigma\tVolatility of the stock price per year:", sigma)
      print("T\tTime to maturity in trading years:", T)
```

```
S0      Current Stock Price: 240.91000366210938
K        Strike Price: 242.5
r        Continuously compounded risk-free rate: 0.1
sigma    Volatility of the stock price per year: 0.0369388726875486
T        Time to maturity in trading years: 0.4801587301587302
```

```
[15]: def d1(S0, K, r, sigma, T):
      d1 = (np.log(S0/K) + (r + sigma**2 / 2) * T)/(sigma * np.sqrt(T))
      return d1
```

```
[16]: def d2(S0, K, r, sigma, T):
      d2 = (np.log(S0 / K) + (r - sigma**2 / 2) * T) / (sigma * np.sqrt(T))
      return d2
```

```
[17]: def BlackScholesCall(S0, K, r, sigma, T):
      BSC = S0 * ss.norm.cdf(d1(S0, K, r, sigma, T)) - K * np.exp(-r * T) * ss.
      ↪norm.cdf(d2(S0, K, r, sigma, T))
      return BSC
```

```
[18]: def BlackScholesPut(S0, K, r, sigma, T):
      BSP = K * np.exp(-r * T) * ss.norm.cdf(-d2(S0, K, r, sigma, T)) - S0 * ss.
      ↪norm.cdf(-d1(S0, K, r, sigma, T))
      return BSP
```

```
[19]: Call_BS = BlackScholesCall(S0, K, r, sigma, T)
      Call_BS
```

```
[19]: 9.912965733098048
```