Lab08

April 5, 2019

```
In [ ]: '''
                                    MA374 | Lab 08
                       Deepak Kumar Gouda | 160123054
        '''
```

```
In [1]: import numpy as np
        from pandas import read_csv
```

```
In [2]: from scipy.stats import norm
```

```
In [3]: from mpl_toolkits.mplot3d import Axes3D
        import matplotlib.pyplot as plt
```

```
In [4]: %matplotlib inline
```

```
In [5]: def getS0(name='', market='BSE', index=False):
            fields=['Close']
            if index:
                data = read_csv('./Data/'+market.lower()+'data1.csv', usecols=fields, index_col
            else:
                data = read_csv('./Data/'+market+'Data/'+name+'.csv', usecols=fields, index_col
            return data.iloc[-1]['Close']
```

```
In [6]: def getHistoricalVolatility(data):
            close = np.array(data['Close'])
            change = np.zeros(len(close)-1)
            for i in range(1, len(close)):
                change[i-1] = (close[i]-close[i-1])/close[i-1]*100
            historicalVolatility = np.std(change)*(252**0.5)
            return historicalVolatility
```

```
In [7]: def getCall(S, K, r, t, sig):
            d1 = (np.log(S/K)+t*(r+(sig**2)/2))/(sig*(t**0.5))
            d2 = d1-sig*(t**0.5)
            Nd1 = norm.cdf(d1)
            Nd2 = norm.cdf(d2)
    #       print(d1, Nd1, d2, Nd2)
            C = S*Nd1 - K*np.exp(-r*t)*Nd2
            return C
```

1

```
In [8]: def getPut(S, K, r, t, sig):
            d1 = (np.log(S/K)+t*(r+(sig**2)/2))/(sig*(t**0.5))
            d2 = d1-sig*(t**0.5)
            Nd1 = norm.cdf(-d1)
            Nd2 = norm.cdf(-d2)
        #     print(d1, Nd1, d2, Nd2)
            P = K*np.exp(-r*t)*Nd2 - S*Nd1
            return P

In [9]: def model(name='', market='BSE', index=False, num_fig=0):
            fields=['Close']
            if index:
                data = read_csv('./Data/'+market.lower()+'data1.csv', usecols=fields, index_col
            else:
                data = read_csv('./Data/'+market+'Data/'+name+'.csv', usecols=fields, index_col

            if(index):
                print('\t\t'+market+'Index')
            else:
                print('\t\tStock : '+stock+' Market : '+market)
            ################Q1##################
            lastMonth = data.iloc[len(data)-21:]
            sig = getHistoricalVolatility(lastMonth)
            print("Historical Volatility = ", sig)

            ################Q2##################
            S0 = lastMonth.iloc[-1]['Close']
            A = np.arange(0.5, 1.6, 0.1)
            K = S0
            r = 0.05
            t = 126/252

            callPrice = np.zeros(len(A))
            putPrice = np.zeros(len(A))

            for i, a in enumerate(A):
                callPrice[i] = getCall(S0, a*K, r, t, sig)
                putPrice[i] = getPut(S0, a*K, r, t, sig)

            print('Call Price = ', end='')
            print(np.round(callPrice, 2))
            print('Put Price = ', end='')
            print(np.round(putPrice, 2))
            print('\n')

            ################Q3##################
            S0 = lastMonth.iloc[-1]['Close']
            A = 1
```

```python
        K = A*S0
        r = 0.05
        T = 21
        start = len(data)-T
        volatility = []
        callPrices = []
        putPrices = []

        while(start >= 0):
            monthlyData = data[start:-1]
            S0 = data.loc[start, 'Close']
            t = (len(data) - start)/252
            sig = getHistoricalVolatility(lastMonth)
            volatility.append(sig)
            C = getCall(S0, K, r, t, sig)
            P = getPut(S0, K, r, t, sig)
            callPrices.append(C)
            putPrices.append(P)
            start = start-T

        x = np.arange(1, len(volatility)+1)
        y = np.array(volatility)
        z_call = np.array(callPrices)
        z_put = np.array(putPrices)

        fig = plt.figure()
        ax = fig.add_subplot(111+num_fig, projection='3d')
        ax.scatter(x, y, z_call, c='b', marker='o', label='Call Option')
        ax.scatter(x, y, z_put, c='r', marker='o', label='Put Option')

        ax.set_xlabel('Time (in number of months)')
        ax.set_ylabel('Volatility')
        ax.set_zlabel('Option Prices')
        ax.legend()
        if index:
            plt.title(name+' Market = '+market)
        else:
            plt.title('Stock = '+name+' Market = '+market)
        plt.show()
```

```python
In [10]: stock_name=['ABB', 'AXISBANK', 'BALMLAWRIE', 'BHARTIARTL',
                     'CUMMINSIND', 'EMAMILTD', 'GODREJIND',
                     'HDFCBANK', 'HEROMOTOCO', 'HINDUNILVR',
                     'INFY', 'IOC', 'ITC', 'LUPIN', 'M&M',
                     'MAHABANK', 'NTPC', 'SBIN', 'SHREECEM', 'TCS']

In [11]: market_name = ['BSE', 'NSE']

In [12]: model('', 'BSE', index=True)
```

```
model('', 'NSE', index=True)
```

```
                BSEIndex
Historical Volatility =  15.047750489169973
Call Price = [36068.33 36068.33 36068.33 36068.33 36068.33 36068.33 36068.33 36068.33
 36068.33 36068.33 36068.33]
Put Price = [17588.9  21106.68 24624.46 28142.24 31660.02 35177.8  38695.58 42213.36
 45731.14 49248.92 52766.7 ]
```
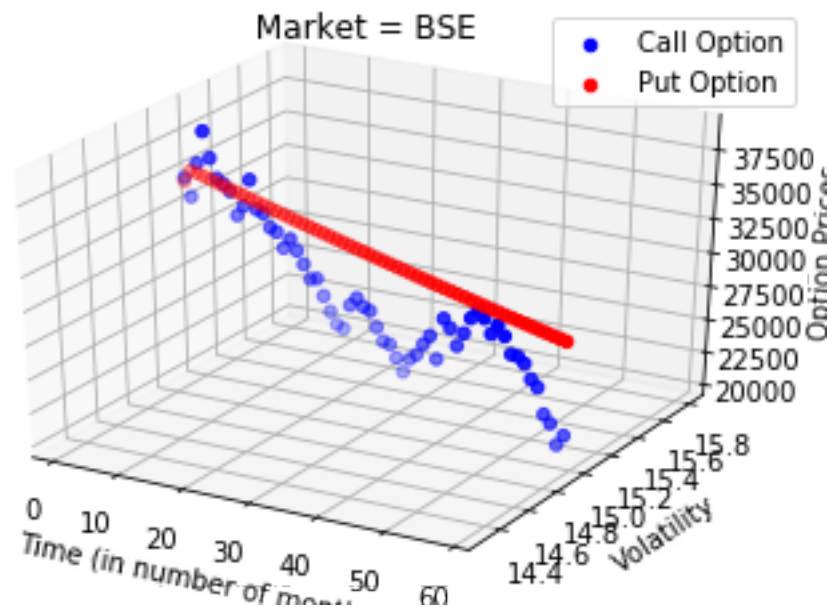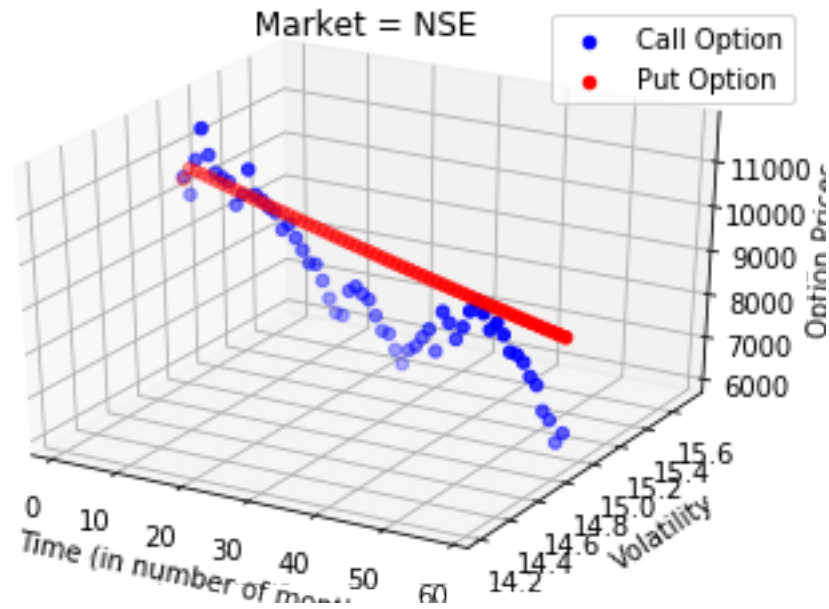


```
                NSEIndex
Historical Volatility =  14.973524282252493
Call Price = [10862.55 10862.55 10862.55 10862.55 10862.55 10862.55 10862.55 10862.55
 10862.55 10862.55 10862.55]
Put Price = [ 5297.18  6356.61  7416.05  8475.48  9534.92 10594.35 11653.79 12713.22
 13772.66 14832.09 15891.53]
```
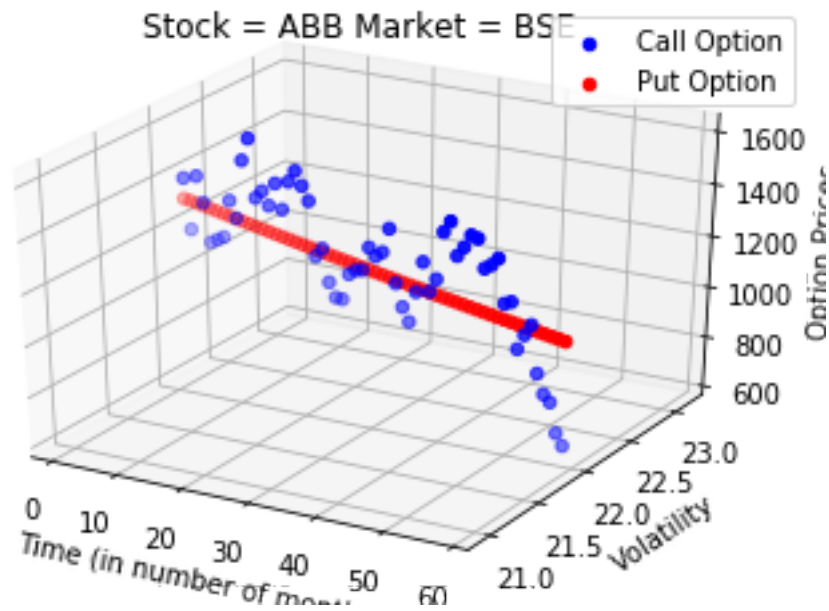
Market = NSE

```
In [13]: for i, market in enumerate(market_name):
             for j, stock in enumerate(stock_name):
                 model(stock, market, num_fig=0)

             Stock : ABB Market : BSE
Historical Volatility =  22.04350528926635
Call Price = [1332. 1332. 1332. 1332. 1332. 1332. 1332. 1332. 1332. 1332. 1332.]
Put Price = [ 649.56  779.47  909.38 1039.29 1169.2  1299.11 1429.02 1558.94 1688.85
 1818.76 1948.67]
```

Stock : AXISBANK Market : BSE
Historical Volatility = 23.191847071770173
Call Price = [619.8 619.8 619.8 619.8 619.8 619.8 619.8 619.8 619.8 619.8 619.8]
Put Price = [302.25 362.7 423.15 483.6 544.05 604.5 664.95 725.4 785.85 846.3
 906.75]
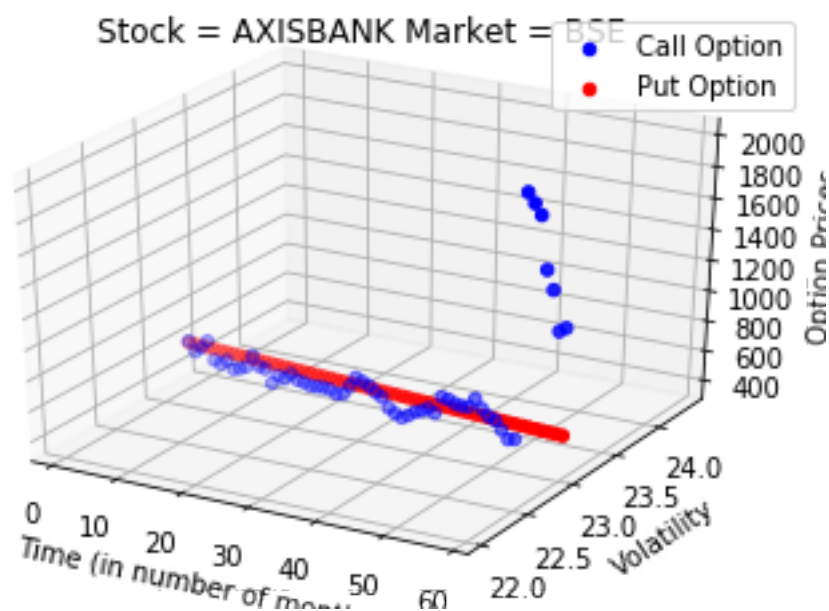
```
                 Stock : BALMLAWRIE Market : BSE
Historical Volatility =   51.414465768311146
Call Price = [203.65 203.65 203.65 203.65 203.65 203.65 203.65 203.65 203.65 203.65
 203.65]
Put Price = [ 99.31 119.17 139.04 158.9  178.76 198.62 218.48 238.35 258.21 278.07
 297.93]
```
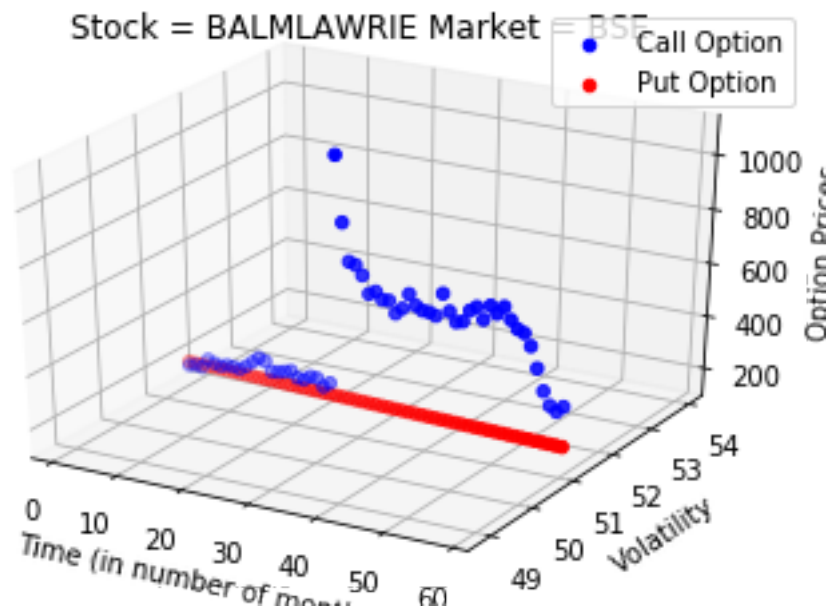


```
                 Stock : BHARTIARTL Market : BSE
Historical Volatility =   38.68887999630001
Call Price = [312.9 312.9 312.9 312.9 312.9 312.9 312.9 312.9 312.9 312.9 312.9]
Put Price = [152.59 183.1  213.62 244.14 274.66 305.17 335.69 366.21 396.73 427.24
 457.76]
```

Stock = BHARTIARTL Market = BSE
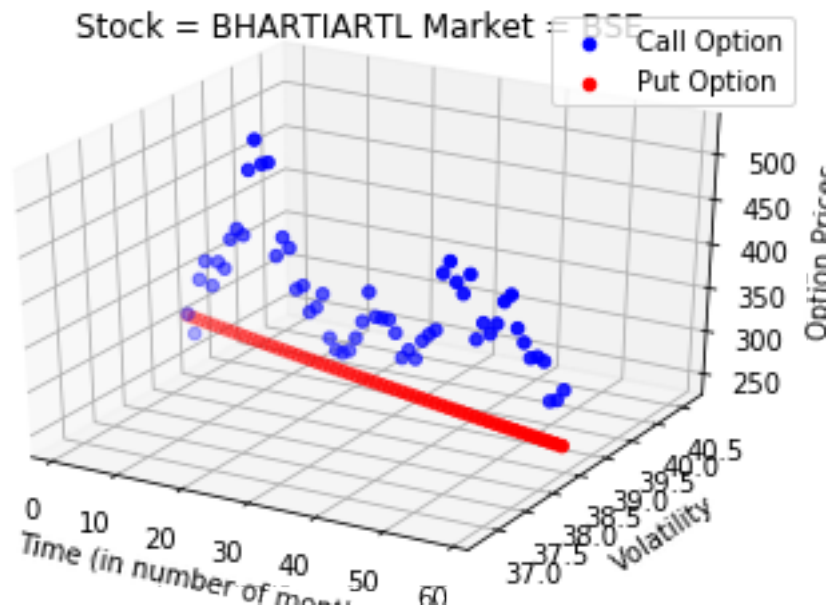
Stock : CUMMINSIND Market : BSE
Historical Volatility = 33.321625770482505
Call Price = [848.75 848.75 848.75 848.75 848.75 848.75 848.75 848.75 848.75 848.75
 848.75]
Put Price = [413.9   496.68 579.46 662.24 745.01 827.79 910.57 993.35 1076.13
 1158.91 1241.69]

Stock = CUMMINSIND Market = BSE
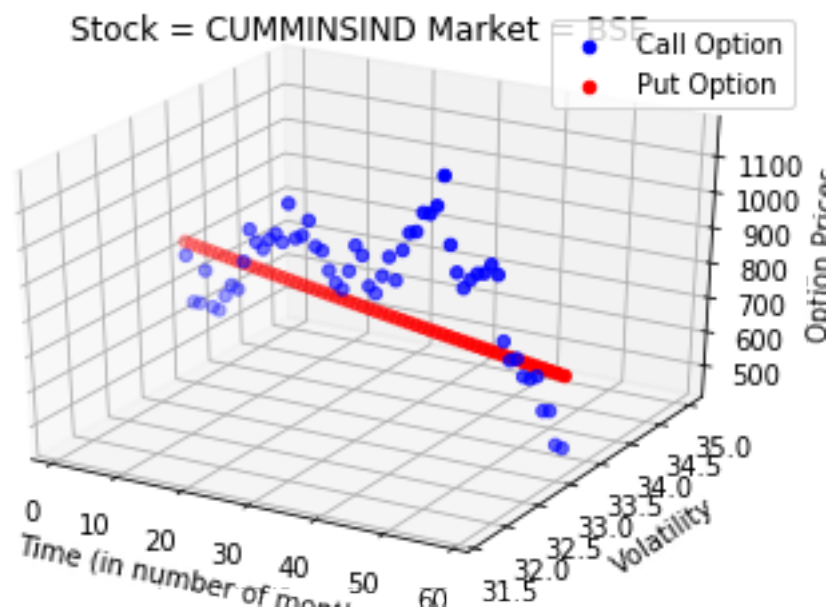
```
                Stock : EMAMILTD Market : BSE
Historical Volatility =  31.778766748294185
Call Price = [418.2 418.2 418.2 418.2 418.2 418.2 418.2 418.2 418.2 418.2 418.2]
Put Price = [203.94 244.72 285.51 326.3  367.09 407.87 448.66 489.45 530.24 571.02
 611.81]
```
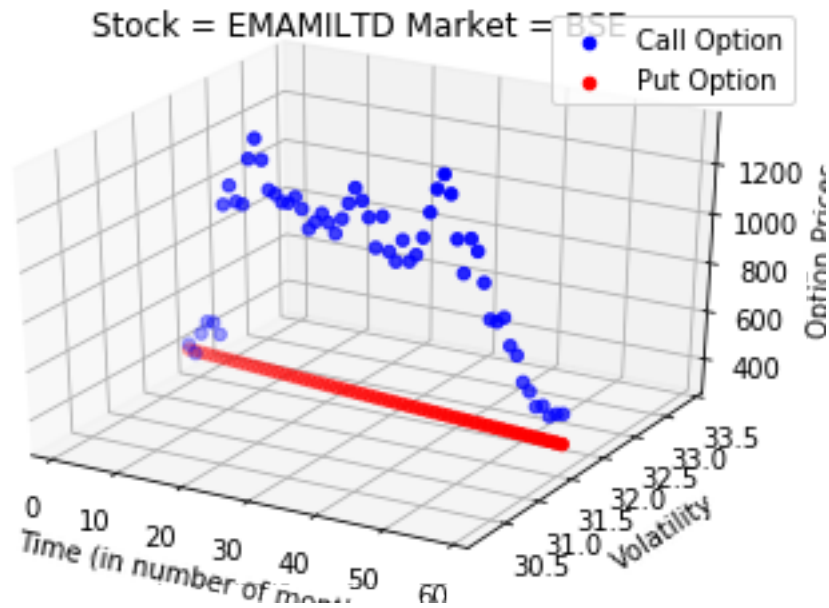


```
                Stock : GODREJIND Market : BSE
Historical Volatility =  23.381713370724466
Call Price = [546.15 546.15 546.15 546.15 546.15 546.15 546.15 546.15 546.15 546.15
 546.15]
Put Price = [266.33 319.6  372.87 426.13 479.4  532.67 585.93 639.2  692.47 745.73
 799.  ]
```

Stock = GODREJIND Market = BSE
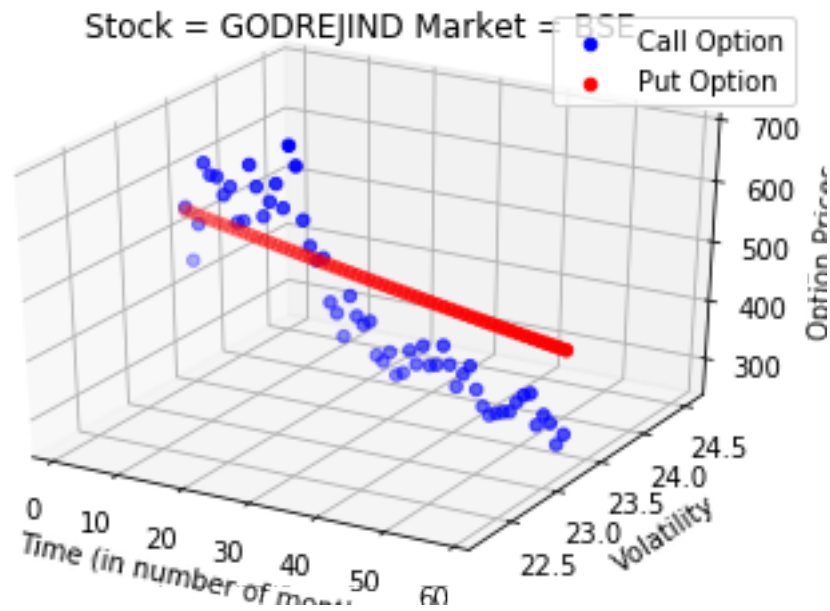
Stock : HDFCBANK Market : BSE
Historical Volatility = 14.773366367738122
Call Price = [2122.45 2122.45 2122.45 2122.45 2122.45 2122.45 2122.45 2122.45 2122.45
 2122.45 2122.45]
Put Price = [1035.02 1242.03 1449.03 1656.04 1863.04 2070.05 2277.05 2484.06 2691.06
 2898.06 3105.07]

Stock = HDFCBANK Market = BSE
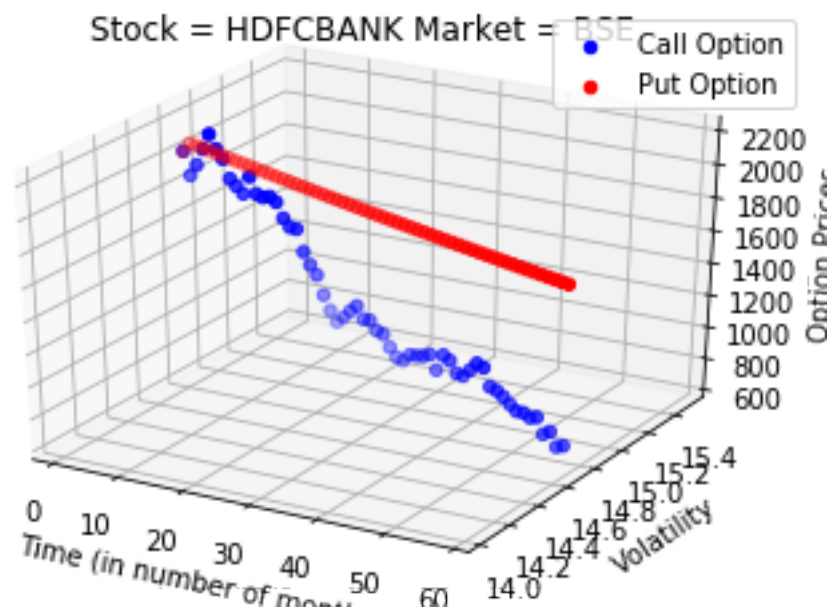
```
            Stock : HEROMOTOCO Market : BSE
Historical Volatility =  34.260498848332
Call Price = [3105.7 3105.7 3105.7 3105.7 3105.7 3105.7 3105.7 3105.7 3105.7 3105.7
 3105.7]
Put Price = [1514.51 1817.41 2120.31 2423.22 2726.12 3029.02 3331.92 3634.82 3937.73
 4240.63 4543.53]
```
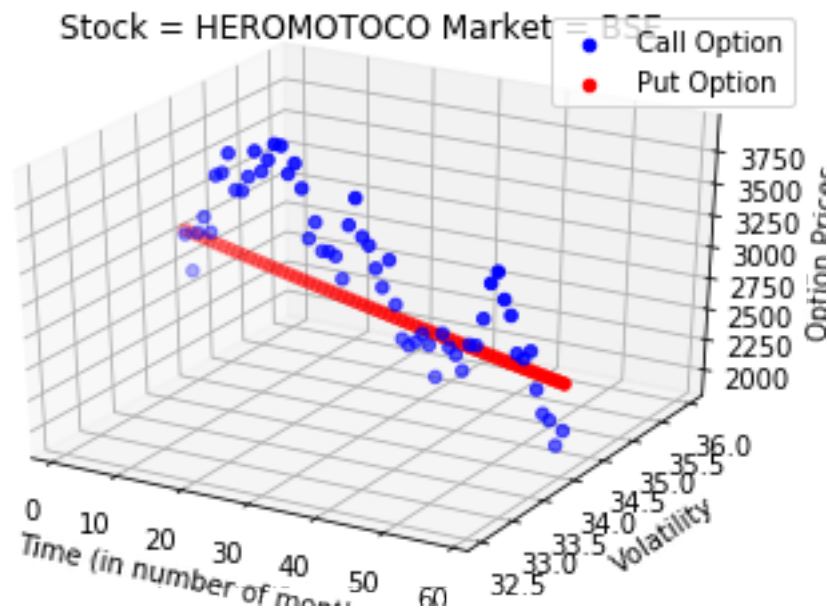


```
            Stock : HINDUNILVR Market : BSE
Historical Volatility =  23.541954658753678
Call Price = [1818.05 1818.05 1818.05 1818.05 1818.05 1818.05 1818.05 1818.05 1818.05
 1818.05 1818.05]
Put Price = [ 886.58 1063.9  1241.21 1418.53 1595.85 1773.16 1950.48 2127.79 2305.11
 2482.43 2659.74]
```
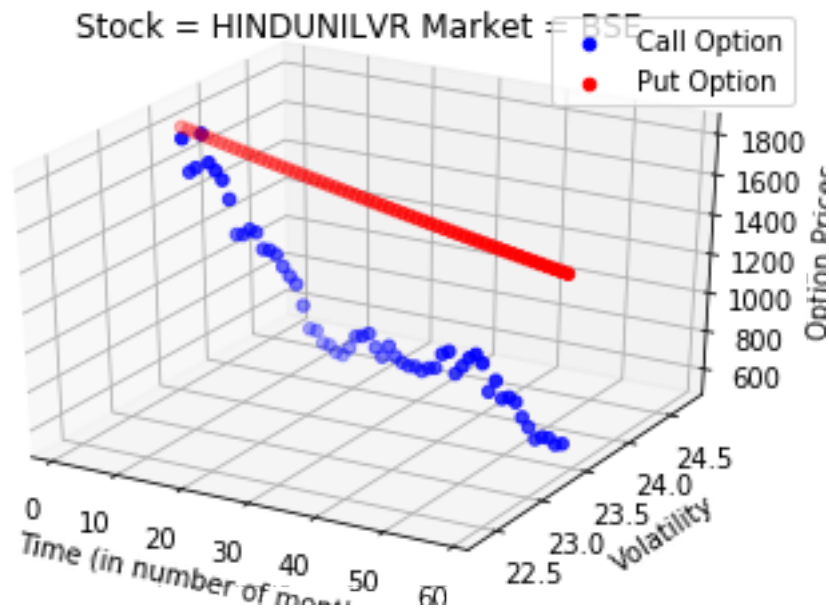
Stock : INFY Market : BSE
Historical Volatility = 25.836442452883546
Call Price = [659.85 659.85 659.85 659.85 659.85 659.85 659.85 659.85 659.85 659.85
 659.85]
Put Price = [321.78 386.13 450.49 514.85 579.2 643.56 707.91 772.27 836.63 900.98
 965.34]
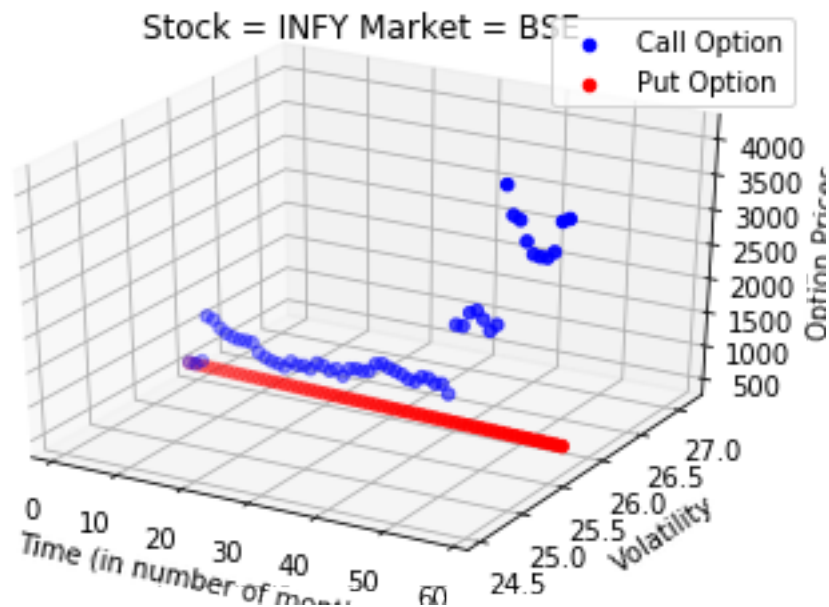
```
                    Stock : IOC Market : BSE
Historical Volatility =  35.362198620971746
Call Price = [137.1 137.1 137.1 137.1 137.1 137.1 137.1 137.1 137.1 137.1 137.1]
Put Price = [ 66.86  80.23  93.6   106.97 120.34 133.71 147.09 160.46 173.83 187.2
 200.57]
```


Stock = IOC Market = BSE
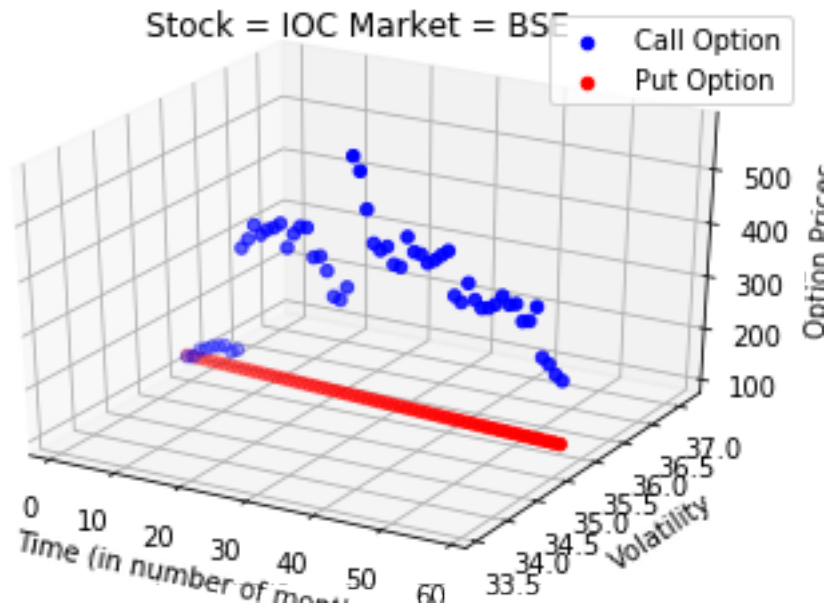
```
                    Stock : ITC Market : BSE
Historical Volatility =  18.46213526698629
Call Price = [281.65 281.65 281.65 281.65 281.65 281.65 281.65 281.65 281.65 281.65
 281.65]
Put Price = [137.35 164.82 192.29 219.76 247.23 274.7  302.17 329.64 357.1  384.57
 412.04]
```
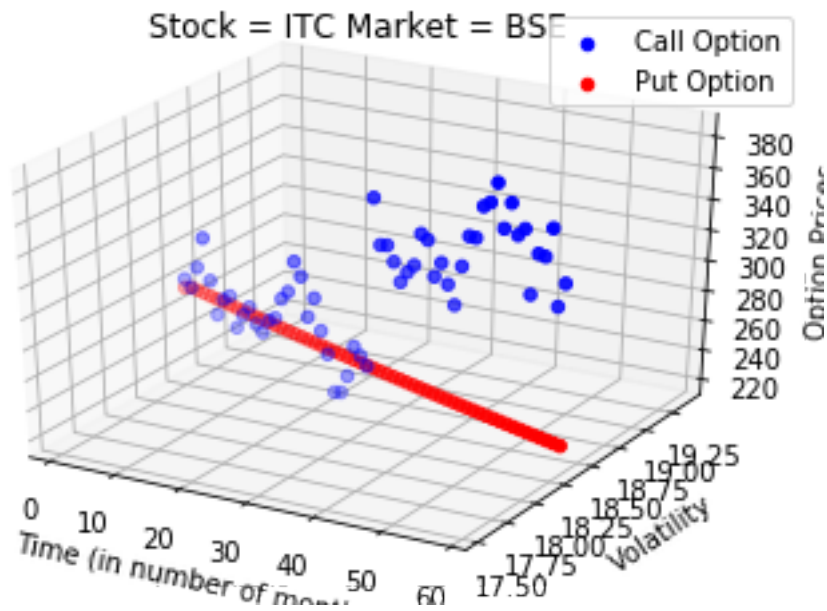
Stock : LUPIN Market : BSE
Historical Volatility = 25.729316420726818
Call Price = [845.6 845.6 845.6 845.6 845.6 845.6 845.6 845.6 845.6 845.6 845.6]
Put Price = [412.36 494.83 577.31 659.78 742.25 824.72 907.19 989.67 1072.14
 1154.61 1237.08]
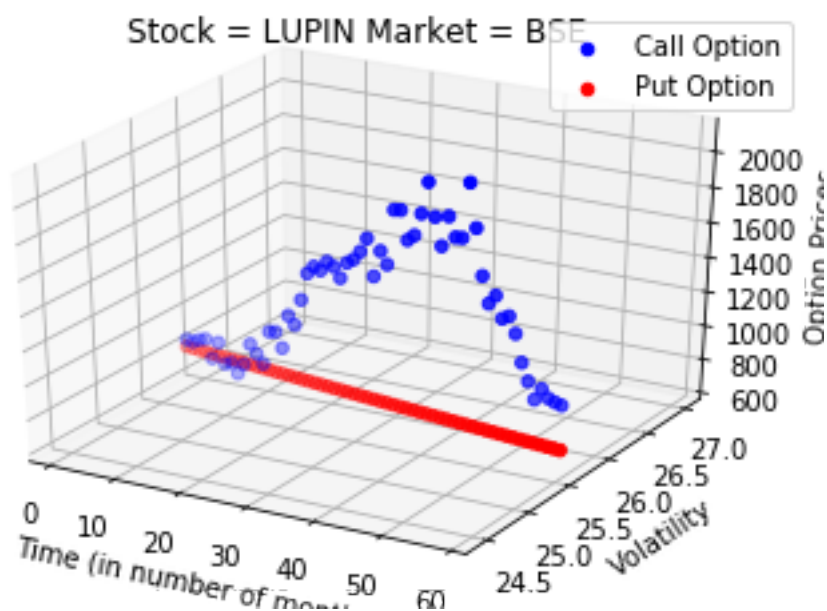
```
            Stock : M&M Market : BSE
Historical Volatility =  29.112452755951715
Call Price = [803.7 803.7 803.7 803.7 803.7 803.7 803.7 803.7 803.7 803.7 803.7]
Put Price = [ 391.93  470.31  548.7   627.09  705.47  783.86  862.24  940.63 1019.01
 1097.4  1175.78]
```
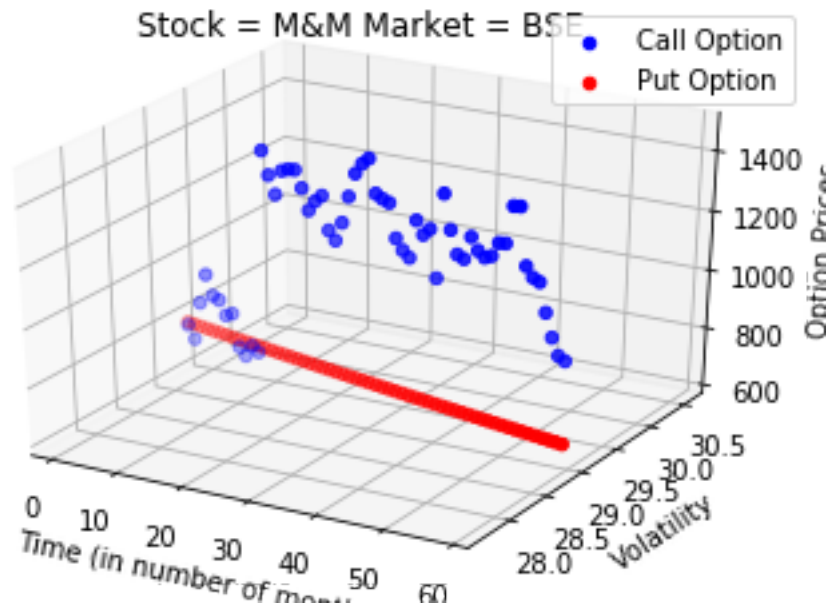


```
          Stock : MAHABANK Market : BSE
Historical Volatility =  53.16142070390872
Call Price = [14.89 14.89 14.89 14.89 14.89 14.89 14.89 14.89 14.89 14.89 14.89]
Put Price = [ 7.26  8.71 10.17 11.62 13.07 14.52 15.97 17.43 18.88 20.33 21.78]
```

Stock = MAHABANK Market = BSE
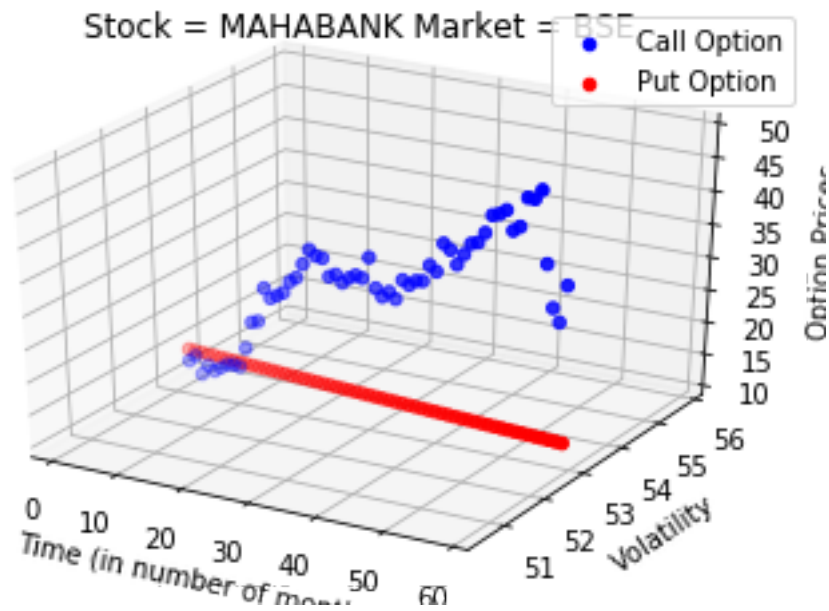
Stock : NTPC Market : BSE
Historical Volatility = 24.56098091947936
Call Price = [148.65 148.65 148.65 148.65 148.65 148.65 148.65 148.65 148.65 148.65
 148.65]
Put Price = [72.49 86.99 101.49 115.98 130.48 144.98 159.48 173.98 188.47 202.97
 217.47]

Stock = NTPC Market = BSE
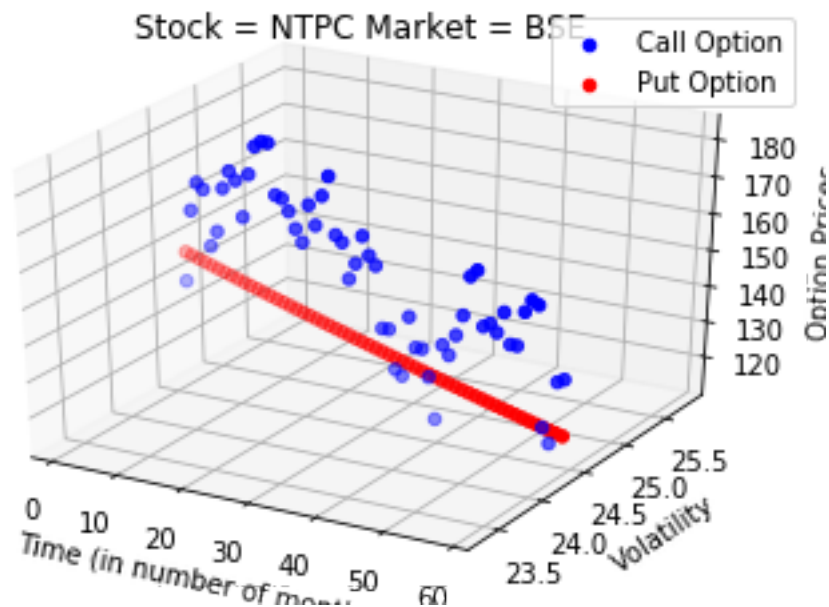
```
            Stock : SBIN Market : BSE
Historical Volatility =  20.734423437060688
Call Price = [295.65 295.65 295.65 295.65 295.65 295.65 295.65 295.65 295.65 295.65
 295.65]
Put Price = [144.18 173.01 201.85 230.68 259.52 288.35 317.19 346.02 374.86 403.69
 432.53]
```
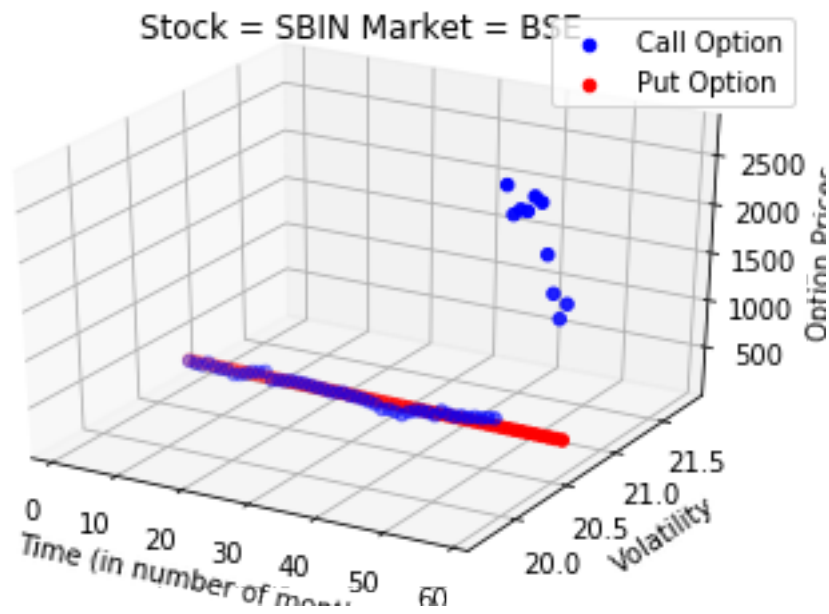


```
           Stock : SHREECEM Market : BSE
Historical Volatility =  26.75417420284937
Call Price = [17212.45 17212.45 17212.45 17212.45 17212.45 17212.45 17212.45 17212.45
 17212.45 17212.45 17212.45]
Put Price = [ 8393.74 10072.48 11751.23 13429.98 15108.73 16787.47 18466.22 20144.97
 21823.72 23502.46 25181.21]
```

Stock = SHREECEM Market = BSE
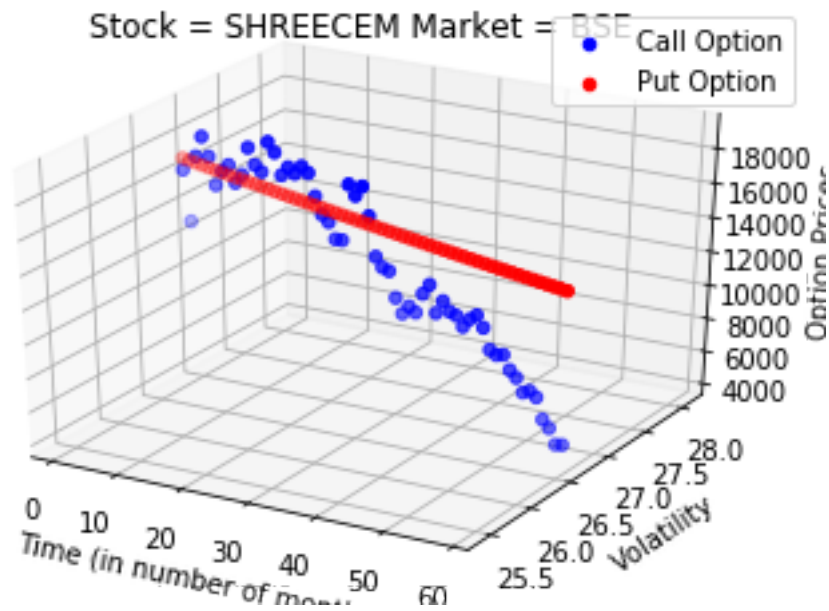
Stock : TCS Market : BSE
Historical Volatility =   17.29911714041277
Call Price = [1893.55 1893.55 1893.55 1893.55 1893.55 1893.55 1893.55 1893.55 1893.55
 1893.55 1893.55]
Put Price = [923.4 1108.08 1292.76 1477.44 1662.12 1846.8 2031.48 2216.16 2400.84
 2585.52 2770.2]

Stock = TCS Market = BSE
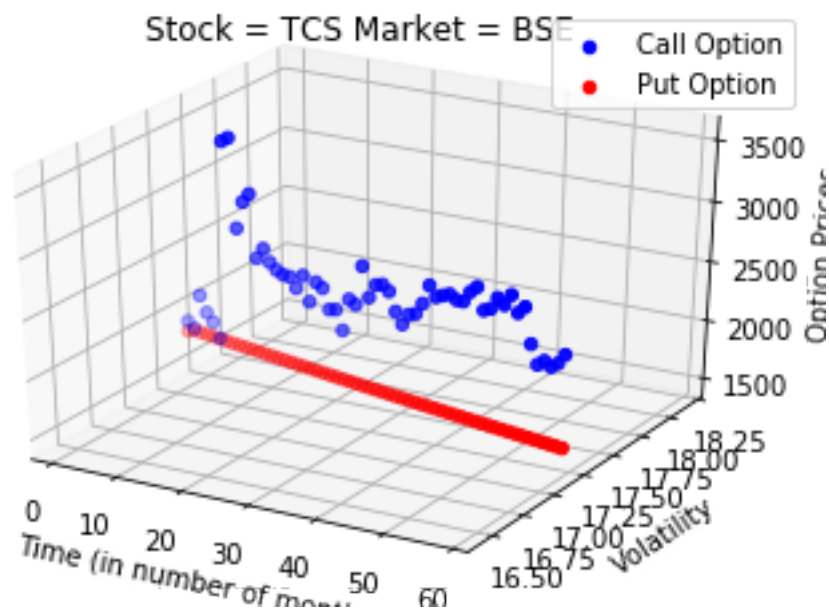
```
            Stock : ABB Market : NSE
Historical Volatility =  23.21887504090842
Call Price = [1336.75 1336.75 1336.75 1336.75 1336.75 1336.75 1336.75 1336.75 1336.75
 1336.75 1336.75]
Put Price = [ 651.87  782.25  912.62 1043.   1173.37 1303.75 1434.12 1564.49 1694.87
 1825.24 1955.62]
```


Stock = ABB Market = NSE
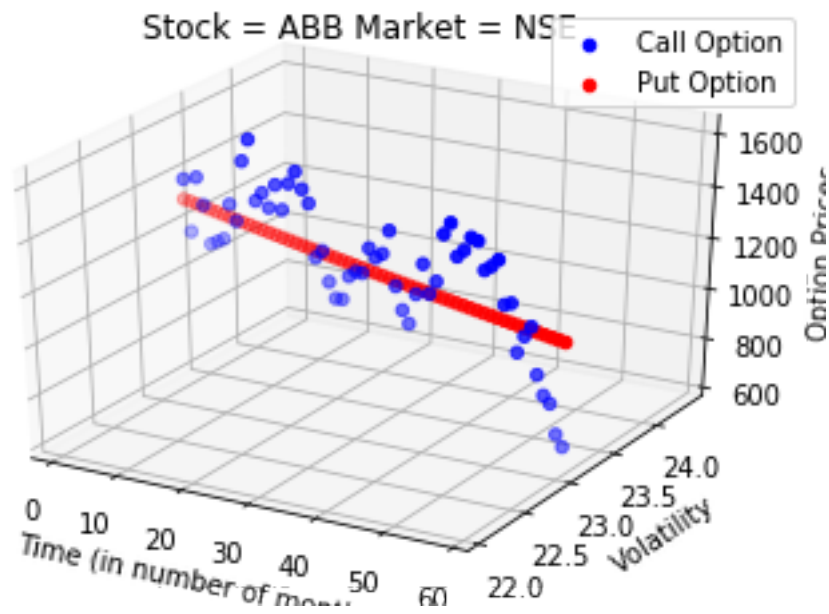
```
            Stock : AXISBANK Market : NSE
Historical Volatility =  24.613044466769015
Call Price = [619.9 619.9 619.9 619.9 619.9 619.9 619.9 619.9 619.9 619.9 619.9]
Put Price = [302.3  362.76 423.22 483.68 544.14 604.59 665.05 725.51 785.97 846.43
 906.89]
```
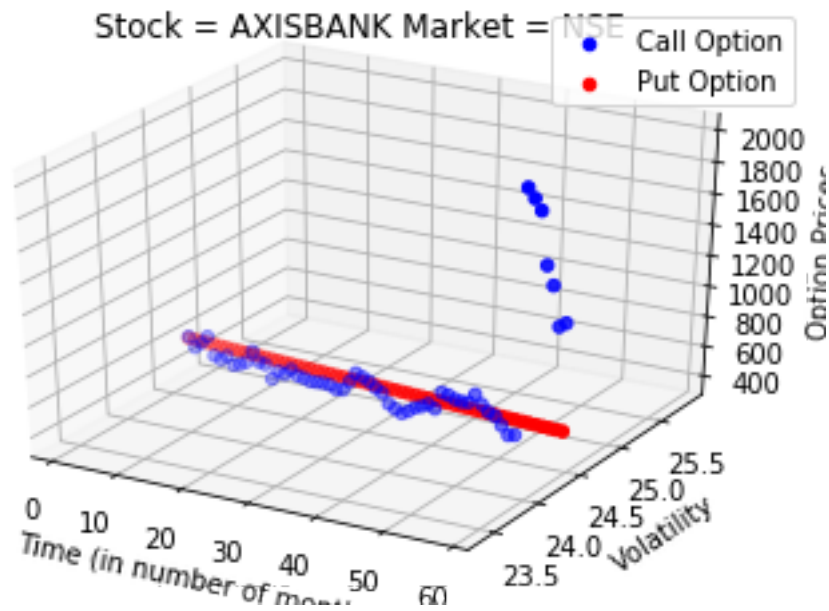
Stock : BALMLAWRIE Market : NSE
Historical Volatility = 50.978778624723994
Call Price = [203.3 203.3 203.3 203.3 203.3 203.3 203.3 203.3 203.3 203.3 203.3]
Put Price = [99.14 118.97 138.8 158.62 178.45 198.28 218.11 237.94 257.76 277.59
 297.42]
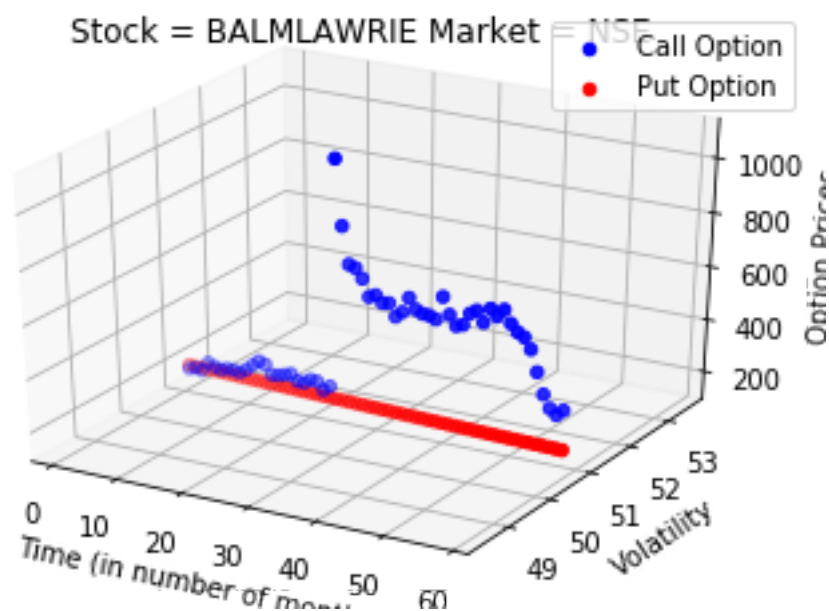
Stock : BHARTIARTL Market : NSE
Historical Volatility = 38.201575550206734
Call Price = [312.5 312.5 312.5 312.5 312.5 312.5 312.5 312.5 312.5 312.5 312.5]
Put Price = [152.39 182.87 213.35 243.83 274.31 304.78 335.26 365.74 396.22 426.7
 457.18]
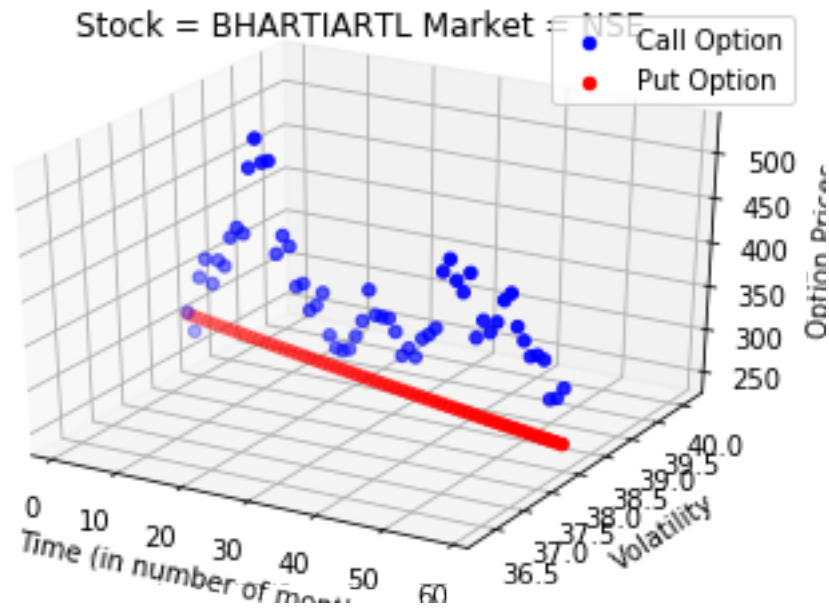
Stock : CUMMINSIND Market : NSE
Historical Volatility = 33.670776726535756
Call Price = [849.7 849.7 849.7 849.7 849.7 849.7 849.7 849.7 849.7 849.7 849.7]
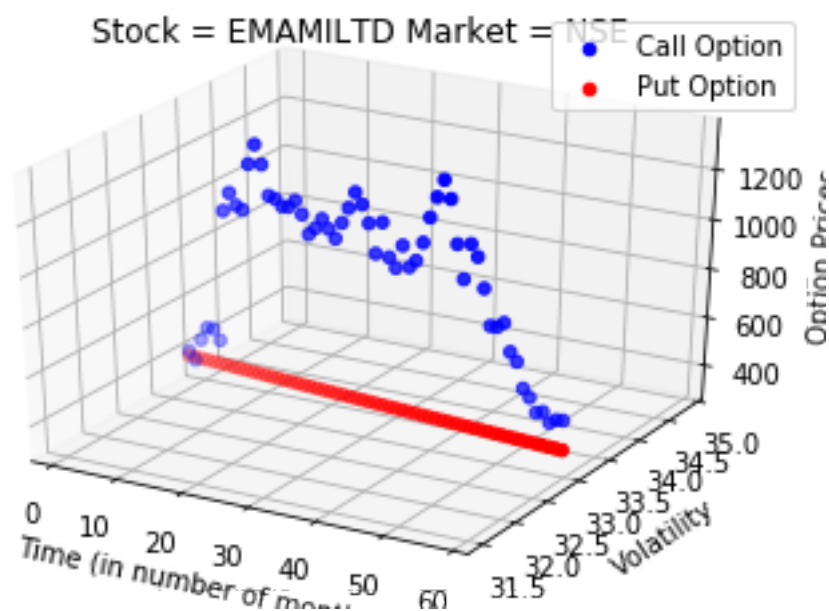Put Price = [414.36 497.23 580.1   662.98 745.85 828.72 911.59 994.46 1077.34
 1160.21 1243.08]
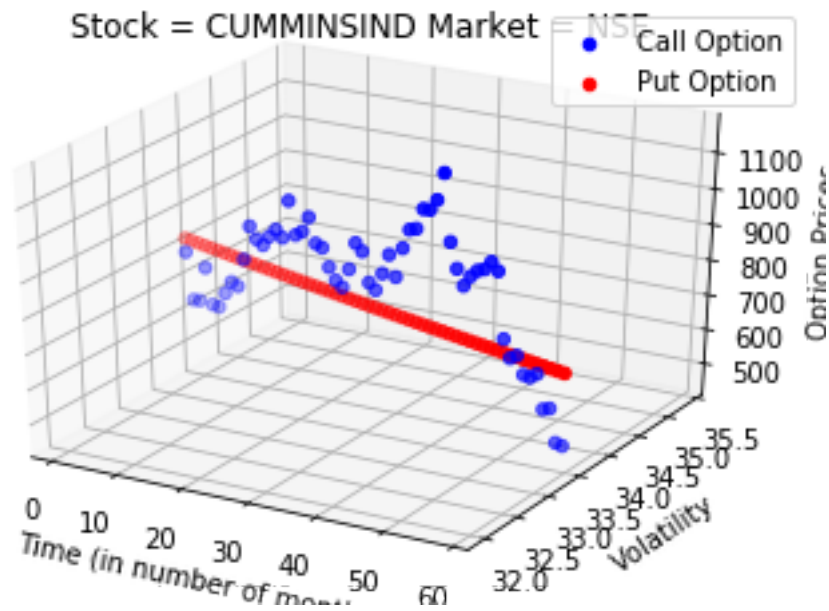
Stock : EMAMILTD Market : NSE
Historical Volatility =   33.178811085067444
Call Price = [420.1 420.1 420.1 420.1 420.1 420.1 420.1 420.1 420.1 420.1 420.1]
Put Price = [204.86 245.84 286.81 327.78 368.75 409.73 450.7 491.67 532.65 573.62
 614.59]

```
                Stock : GODREJIND Market : NSE
Historical Volatility =   23.639492041416933
Call Price = [546.45 546.45 546.45 546.45 546.45 546.45 546.45 546.45 546.45 546.45
 546.45]
Put Price = [266.48 319.77 373.07 426.37 479.66 532.96 586.25 639.55 692.85 746.14
 799.44]
```
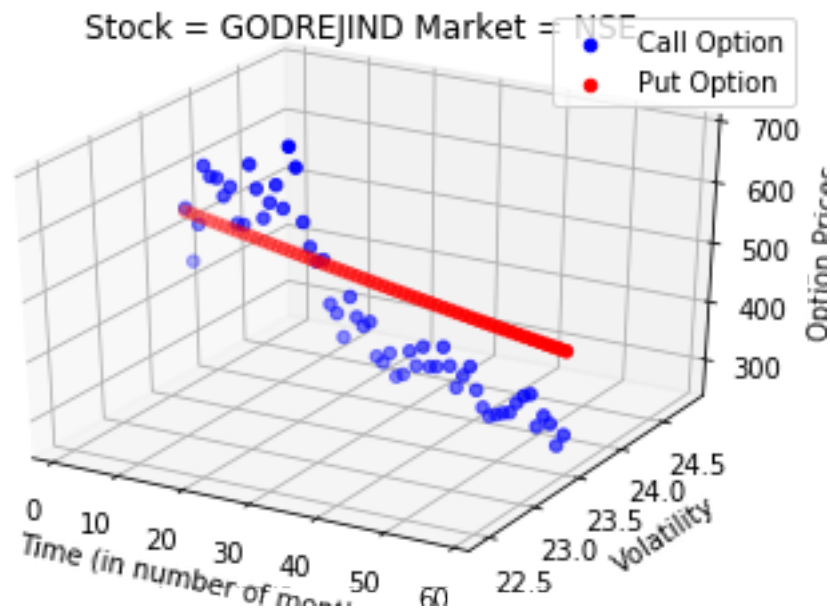


```
                Stock : HDFCBANK Market : NSE
Historical Volatility =   16.041713566298245
Call Price = [2121.7 2121.7 2121.7 2121.7 2121.7 2121.7 2121.7 2121.7 2121.7 2121.7
 2121.7]
Put Price = [1034.66 1241.59 1448.52 1655.45 1862.38 2069.32 2276.25 2483.18 2690.11
 2897.04 3103.97]
```
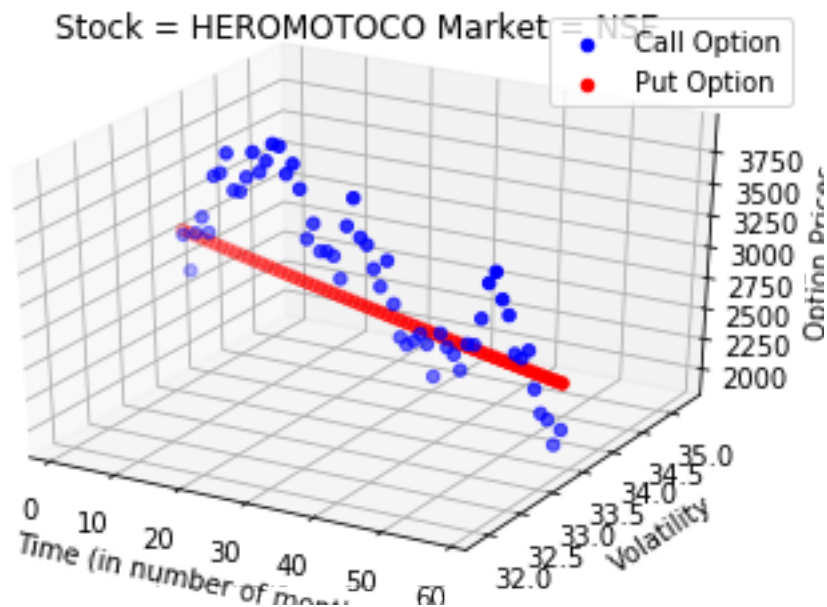
Stock = HDFCBANK Market = NSE
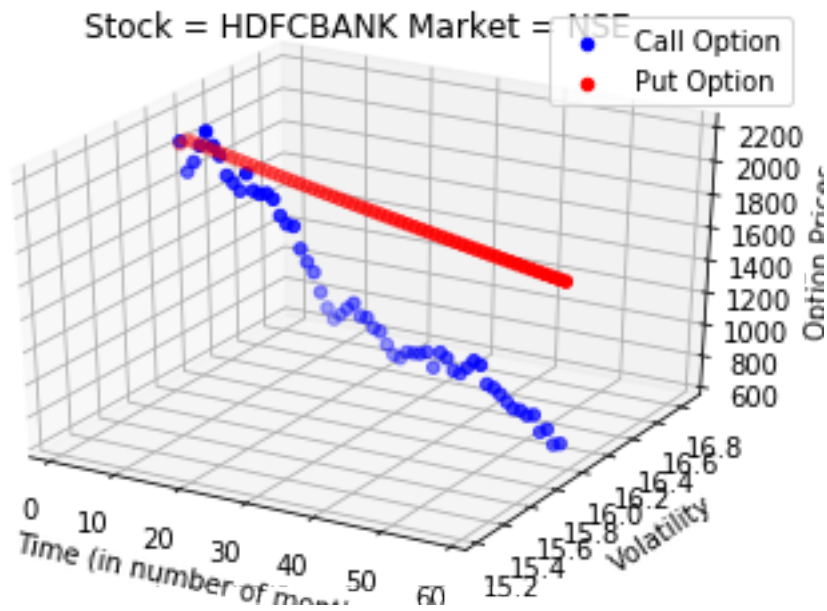
Stock : HEROMOTOCO Market : NSE
Historical Volatility = 33.57726068524632
Call Price = [3104.25 3104.25 3104.25 3104.25 3104.25 3104.25 3104.25 3104.25 3104.25
 3104.25 3104.25]
Put Price = [1513.8 1816.56 2119.32 2422.08 2724.85 3027.61 3330.37 3633.13 3935.89
 4238.65 4541.41]

Stock = HEROMOTOCO Market = NSE

```
                Stock : HINDUNILVR Market : NSE
Historical Volatility =  24.09514009820285
Call Price = [1819.65 1819.65 1819.65 1819.65 1819.65 1819.65 1819.65 1819.65 1819.65
 1819.65 1819.65]
Put Price = [ 887.36 1064.83 1242.31 1419.78 1597.25 1774.72 1952.19 2129.67 2307.14
 2484.61 2662.08]
```


Stock = HINDUNILVR Market = NSE
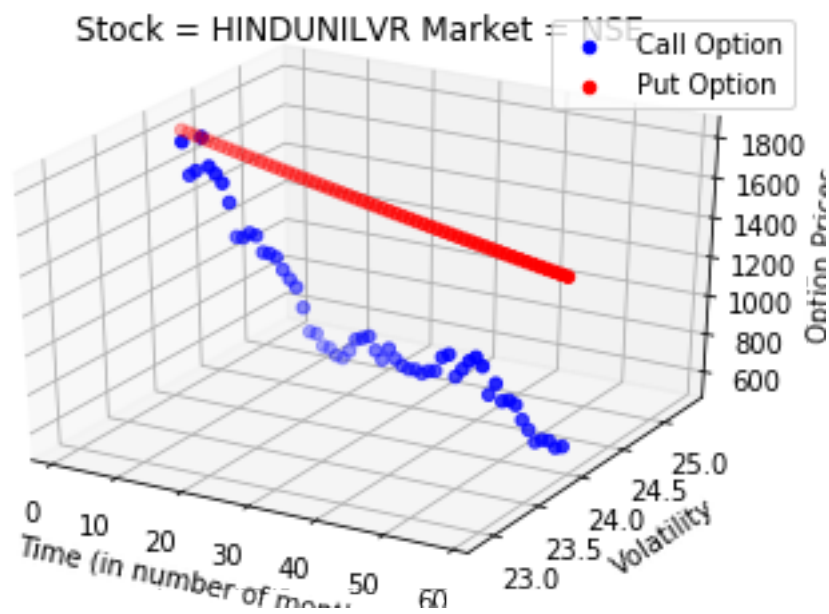
```
                Stock : INFY Market : NSE
Historical Volatility =  26.30940406646563
Call Price = [658.95 658.95 658.95 658.95 658.95 658.95 658.95 658.95 658.95 658.95
 658.95]
Put Price = [321.34 385.61 449.88 514.14 578.41 642.68 706.95 771.22 835.48 899.75
 964.02]
```

Stock = INFY Market = NSE
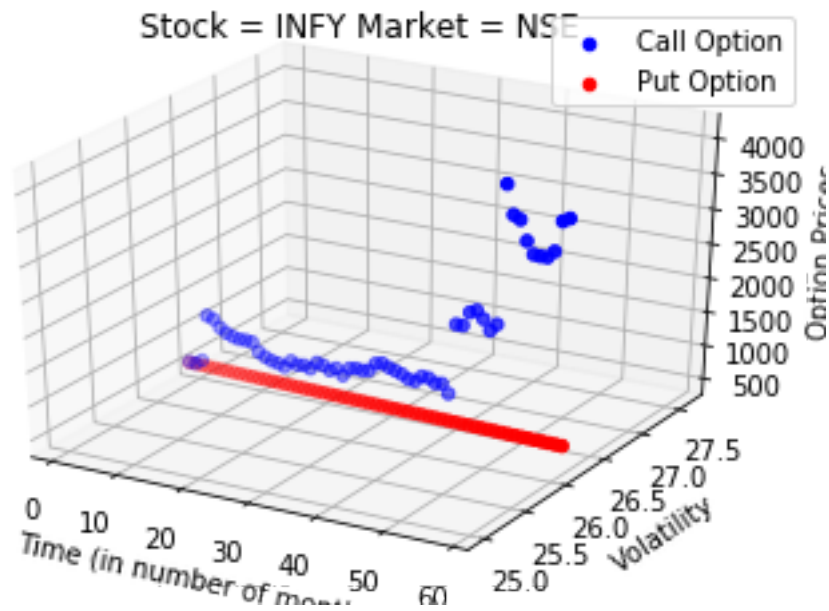
Stock : IOC Market : NSE
Historical Volatility = 36.76042803056978
Call Price = [137.05 137.05 137.05 137.05 137.05 137.05 137.05 137.05 137.05 137.05
  137.05]
Put Price = [66.83 80.2   93.57 106.93 120.3 133.67 147.03 160.4 173.77 187.13
  200.5]

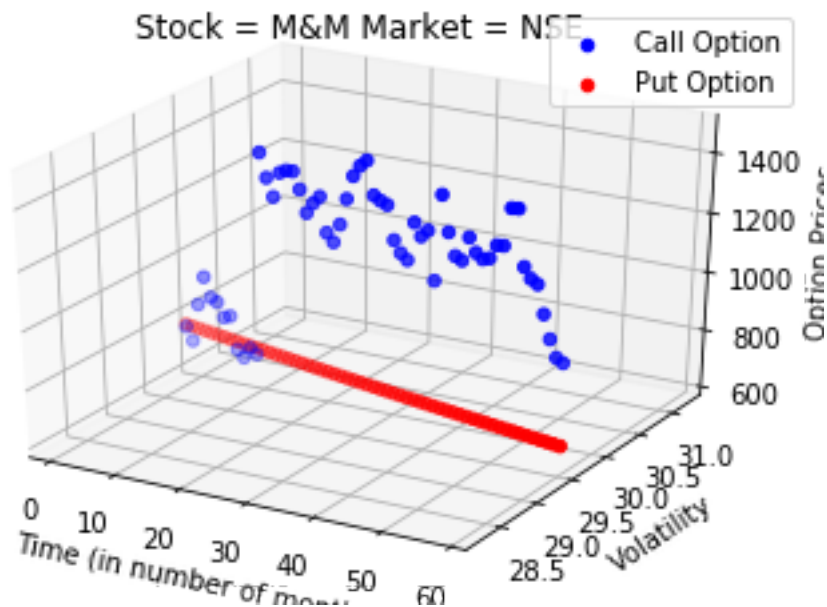Stock = IOC Market = NSE
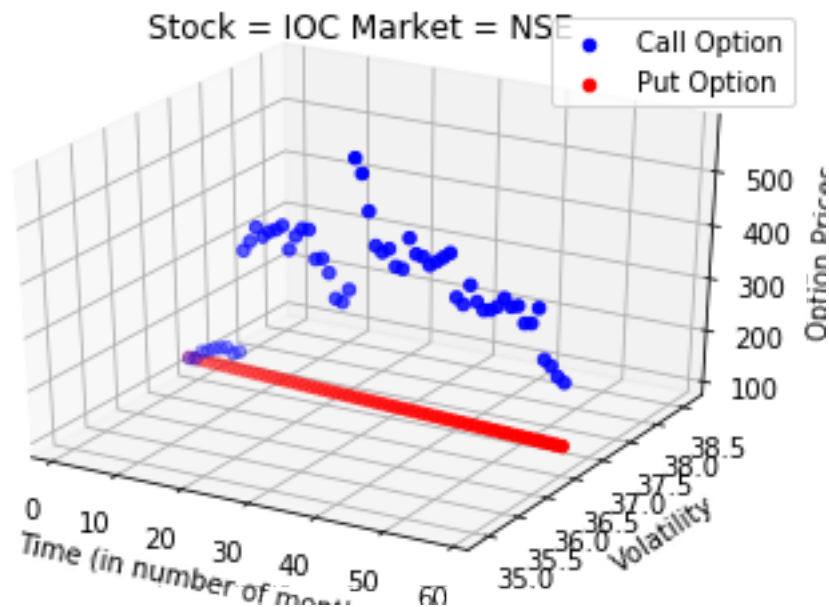
```
              Stock : ITC Market : NSE
Historical Volatility =   17.76490322194474
Call Price = [281.65 281.65 281.65 281.65 281.65 281.65 281.65 281.65 281.65 281.65
 281.65]
Put Price = [137.35 164.82 192.29 219.76 247.23 274.7  302.17 329.64 357.1  384.57
 412.04]
```
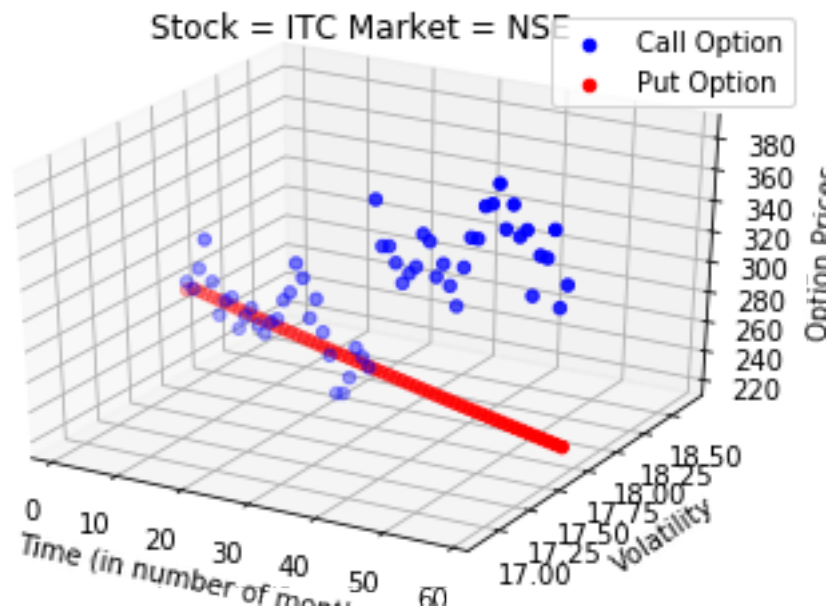


```
              Stock : LUPIN Market : NSE
Historical Volatility =   26.94800572312861
Call Price = [844.3 844.3 844.3 844.3 844.3 844.3 844.3 844.3 844.3 844.3 844.3]
Put Price = [ 411.73  494.07  576.42  658.76  741.11  823.45  905.8   988.14 1070.49
 1152.84 1235.18]
```
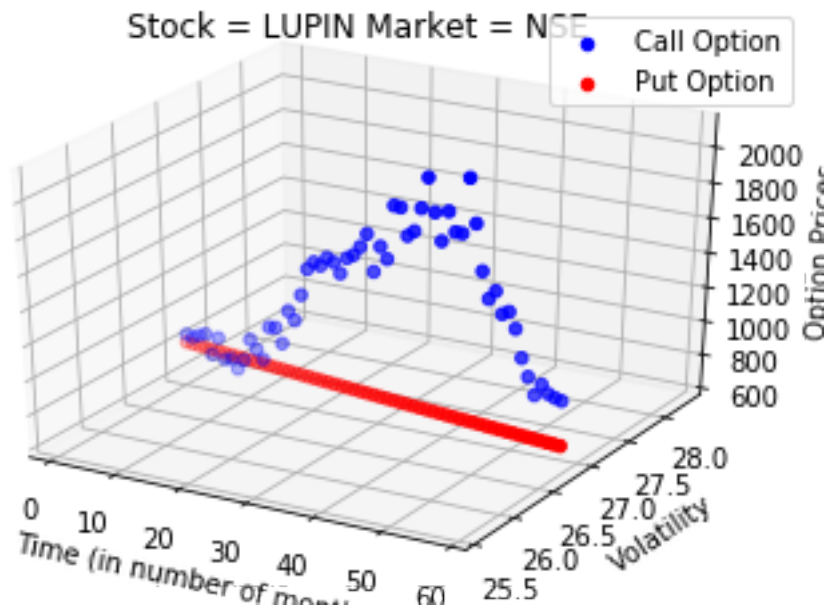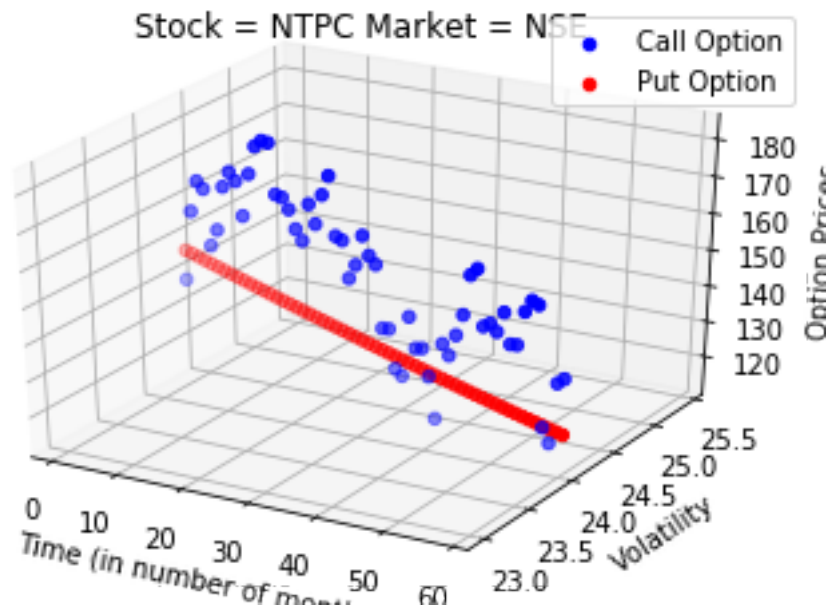
Stock : M&M Market : NSE
Historical Volatility = 29.730785531956336
Call Price = [803.85 803.85 803.85 803.85 803.85 803.85 803.85 803.85 803.85 803.85
 803.85]
Put Price = [392.   470.4 548.8 627.2 705.6 784.   862.4 940.8 1019.2 1097.6
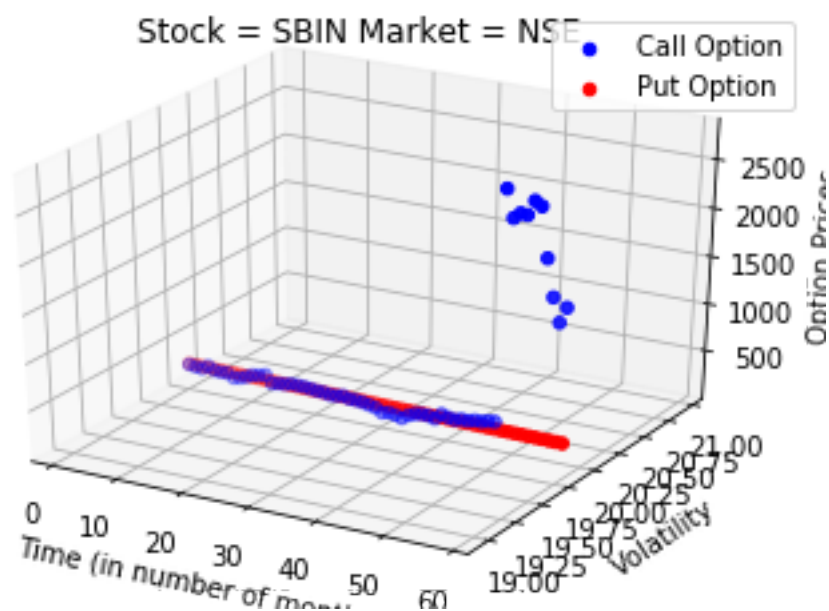 1176.]

```
            Stock : MAHABANK Market : NSE
Historical Volatility =  55.84213685952092
Call Price = [14.9 14.9 14.9 14.9 14.9 14.9 14.9 14.9 14.9 14.9 14.9]
Put Price = [ 7.27  8.72 10.17 11.63 13.08 14.53 15.99 17.44 18.89 20.34 21.8 ]
```
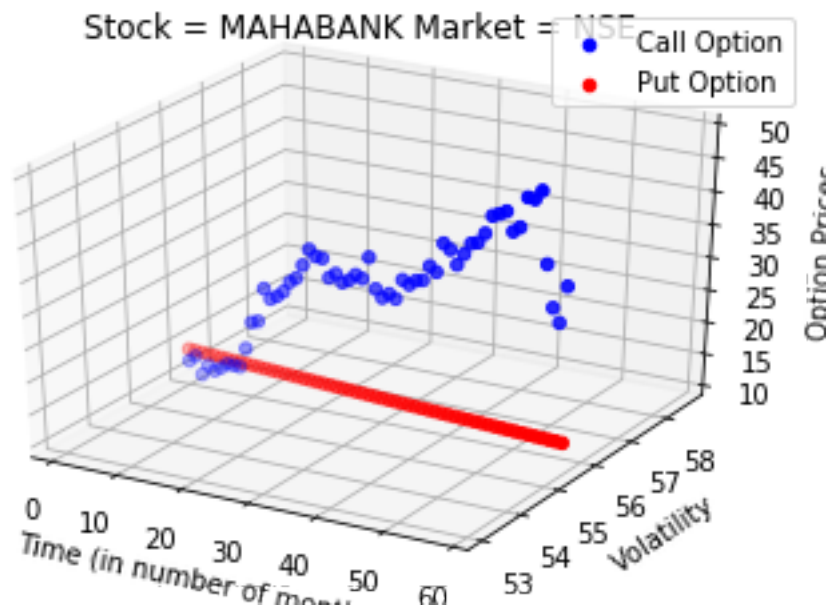


```
            Stock : NTPC Market : NSE
Historical Volatility =  24.20666111229389
Call Price = [149.05 149.05 149.05 149.05 149.05 149.05 149.05 149.05 149.05 149.05
 149.05]
Put Price = [ 72.68  87.22 101.76 116.3  130.83 145.37 159.91 174.44 188.98 203.52
 218.05]
```
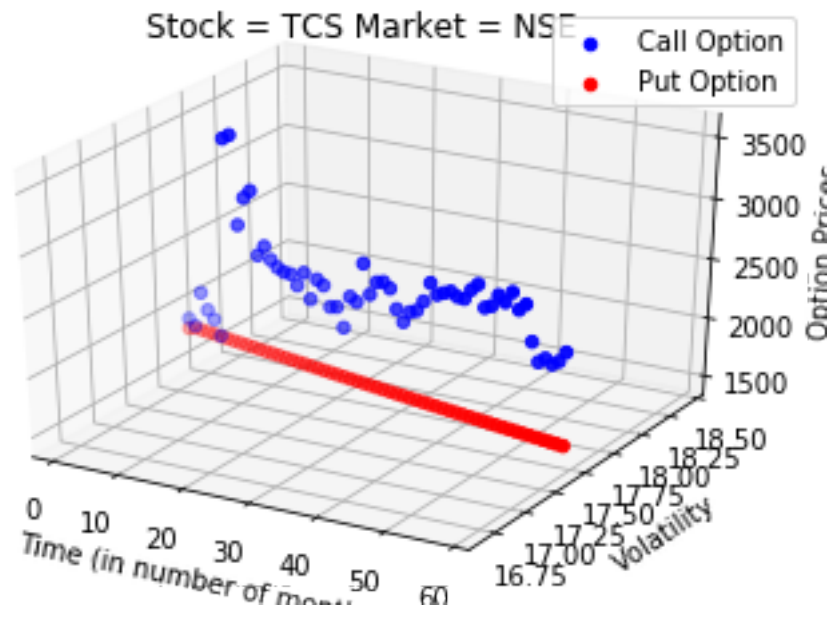
Stock = NTPC Market = NSE

Stock : SBIN Market : NSE
Historical Volatility = 19.95678315241864
Call Price = [295.9 295.9 295.9 295.9 295.9 295.9 295.9 295.9 295.9 295.9 295.9]
Put Price = [144.3 173.16 202.02 230.88 259.73 288.59 317.45 346.31 375.17 404.03
 432.89]

Stock = SBIN Market = NSE

```
           Stock : SHREECEM Market : NSE
Historical Volatility =  26.832251327872143
Call Price = [17236.1 17236.1 17236.1 17236.1 17236.1 17236.1 17236.1 17236.1 17236.1
 17236.1 17236.1]
Put Price = [ 8405.27 10086.32 11767.38 13448.43 15129.49 16810.54 18491.59 20172.65
 21853.7  23534.75 25215.81]
```
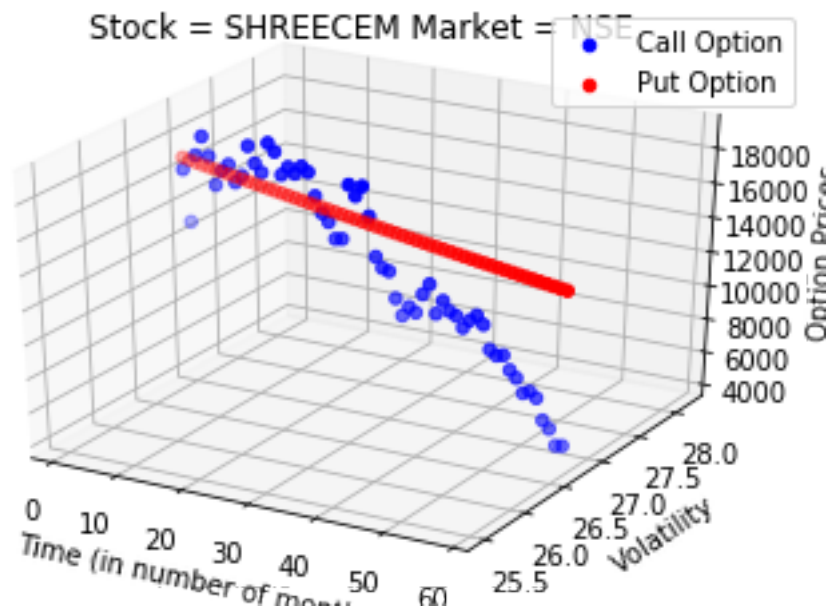


```
           Stock : TCS Market : NSE
Historical Volatility =  17.549101992180123
Call Price = [1893.05 1893.05 1893.05 1893.05 1893.05 1893.05 1893.05 1893.05 1893.05
 1893.05 1893.05]
Put Price = [ 923.16 1107.79 1292.42 1477.05 1661.68 1846.31 2030.94 2215.57 2400.2
 2584.83 2769.47]
```

Stock = TCS Market = NSE

In [ ]: