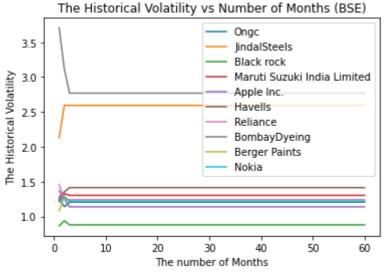
```
#Question No: 03
import numpy as np
import matplotlib.pyplot as plt
import pandas as pd
from math import erf
plt.rcParams.update({'figure.max open warning': 0})
def clean data(X):
    y = [x \text{ for } x \text{ in } X \text{ if not np.isnan}(x)]
    return y
def read data(filename):
    df = pd.read csv(filename)
    df.set_index('Date',inplace=True)
    data = df.to dict()
    for key, vals in data.items():
        data[key] = clean data(list(vals.values()))
    return data
def historical volatility(prices, duration):
    required price = prices[-duration:]
    R = []
    for i in range(1, len(required price)):
        r = (required_price[i] - required_price[i-1])/required_price[i-1]
        R.append(r)
    var = np.var(R)
    sigma d = np.sqrt(var)
    sigma_a = np.sqrt(252)*sigma_d
    return sigma a
def D plus_and_minus(x, tau, sig, K, r):
    D plus = (1/(sig*np.sqrt(tau)))*(np.log(x/K) + tau*(r + (sig*sig)/2))
    D minus = (1/(sig*np.sqrt(tau)))*(np.log(x/K) + tau*(r - (sig*sig)/2))
    return D_plus, D_minus
def Normal(x):
  return 0.5*(1 + erf(x/np.sqrt(2)))
def Call(t, x, T, sig, K, r):
    if x == 0:
        return 0
    if t == T:
        return max(x - K, 0)
    tau = T-t
    D_plus, D_minus = D_plus_and_minus(x, tau, sig, K, r)
    price = x*Normal(D plus) - K*np.exp(-r*tau)*Normal(D minus)
    return nrice
```

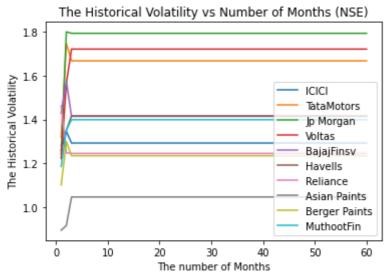
```
. . . . . . . . . . . . . . . .
def Put(t, x, T, sig, K, r):
    call = Call(t,x,T,sig,K,r)
    put = call + K*np.exp(-r*(T-t)) - x
    return put
bse data = read data('bsedata1.csv')
nse data = read data('nsedata1.csv')
r = 0.05
T = 0.5
t = 0
n days month = 20
A = np.arange(0.5, 1.51, 0.1)
for company, prices in bse data.items():
    months = range(1, 61)
    vols = []
    for i in range(1, 61):
        days in month = i*n days month
        vol = historical_volatility(prices, days_in_month)
        vols.append(vol)
    plt.plot(months, vols, label = company)
plt.xlabel("The number of Months")
plt.ylabel("The Historical Volatility")
plt.title("The Historical Volatility vs Number of Months (BSE)")
plt.legend(loc = "best")
plt.show()
plt.savefig("q3 BSE volatility")
plt.clf()
for company, prices in nse_data.items():
    months = range(1, 61)
    vols = []
    for i in range(1, 61):
        days in month = i*n days month
        vol = historical_volatility(prices, days_in_month)
        vols.append(vol)
    plt.plot(months, vols, label = company)
plt.xlabel("The number of Months")
plt.ylabel("The Historical Volatility")
plt.title("The Historical Volatility vs Number of Months (NSE)")
plt.legend(loc = "best")
plt.show()
plt.savefig("q3_NSE_volatility")
plt.clf()
for company, prices in bse_data.items():
    S0 = prices[-1]
```

```
months = range(1,61)
    fig = plt.figure(figsize=(5.6,4.2))
    for a in A:
        K = a*S0
        call prices= []
        for i in range(1,61):
            days in month = i*n days month
            sig = historical volatility(prices, days in month)
            call = Call(t, S0, T, sig, K, r)
            call prices.append(call)
        plt.plot(months, call prices, label = "K = %.1fS0"%a)
    plt.xlabel("The number of Months")
    plt.ylabel("The call Price")
    plt.title(f"The Call Price vs Historical Volatility for {company} (BSE)")
    plt.legend(loc = "best")
    plt.show()
    plt.clf()
for company, prices in nse data.items():
    S0 = prices[-1]
    months = range(1,61)
    fig = plt.figure(figsize=(5.6,4.2))
    for a in A:
        K = a*S0
        call prices= []
        for i in range(1,61):
            days in month = i*n days month
            sig = historical volatility(prices, days in month)
            call = Call(t, S0, T, sig, K, r)
            call prices.append(call)
        plt.plot(months, call prices, label = "K = %.1fS0"%a)
    plt.xlabel("The number of Months")
    plt.ylabel("The call Price")
    plt.title(f"The call Price vs Historical Volatility for {company} (NSE)")
    plt.legend(loc = "best")
    plt.show()
    plt.clf()
for company, prices in bse_data.items():
    S0 = prices[-1]
    months = range(1,61)
    fig = plt.figure(figsize=(5.6,4.2))
    for a in A:
        K = a*S0
        put_prices= []
        for i in range(1,61):
            days_in_month = i*n_days_month
            sig = historical_volatility(prices, days_in_month)
            put = Put(t, S0, T, sig, K, r)
            put prices.append(put)
```

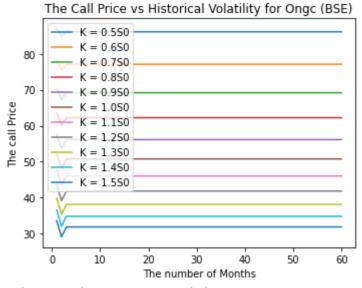
-- p. ---- _ _ _ _ _

```
plt.plot(months, put prices, label = "K = %.1fS0"%a)
    plt.xlabel("The number of Months")
    plt.ylabel("The Put Price")
    plt.title(f"The Put Price vs Historical Volatility for {company} (BSE)")
   plt.legend(loc = "best")
    plt.show()
    plt.clf()
for company, prices in nse_data.items():
    S0 = prices[-1]
    months = range(1,61)
    fig = plt.figure(figsize=(5.6,4.2))
    for a in A:
       K = a*S0
        put prices= []
        for i in range(1,61):
            days in month = i*n days month
            sig = historical volatility(prices, days in month)
            put = Put(t, S0, T, sig, K, r)
            put prices.append(put)
        plt.plot(months, put_prices, label = "K = %.1fS0"%a)
    plt.xlabel("The number of Months")
    plt.ylabel("The Put Price")
    plt.title(f"The Put Price vs Historical Volatility for {company} (NSE)")
    plt.legend(loc = "best")
    plt.show()
    plt.clf()
```

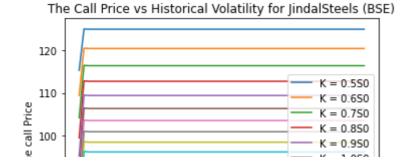


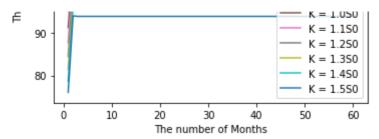


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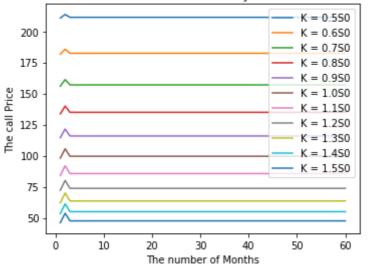
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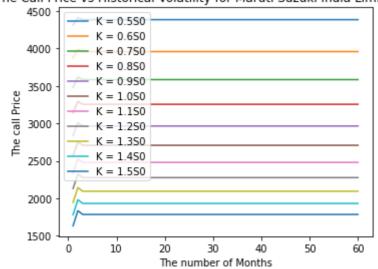
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The Call Price vs Historical Volatility for Black rock (BSE)

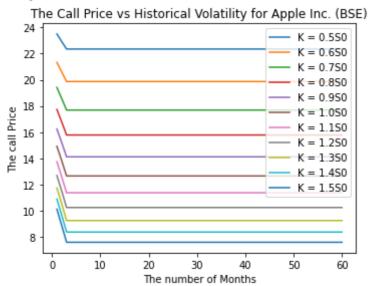


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The Call Price vs Historical Volatility for Maruti Suzuki India Limited (BSE)



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The Call Price vs Historical Volatility for Havells (BSE) K = 0.550400 = 0.650K = 0.750= 0.850350 = 0.950The call Price = 1.050= 1.150300 = 1.250= 1.350250 K = 1.450K = 1.550200 150

30

The number of Months

40

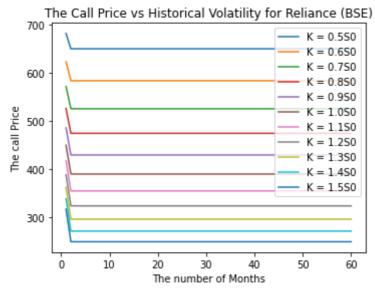
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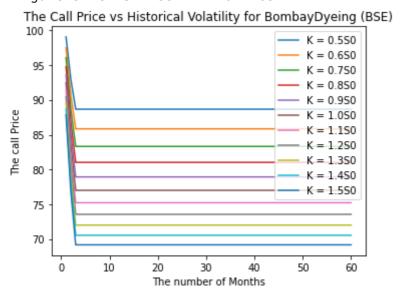
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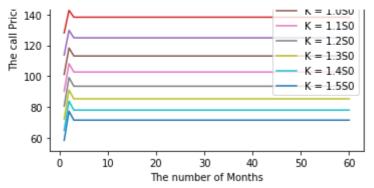


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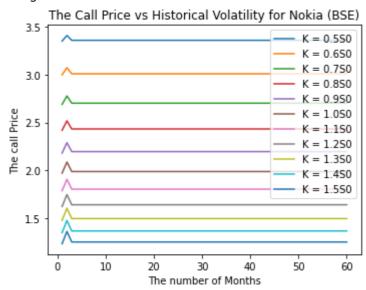


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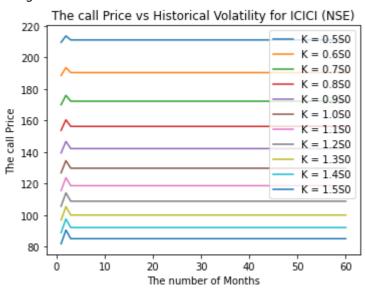




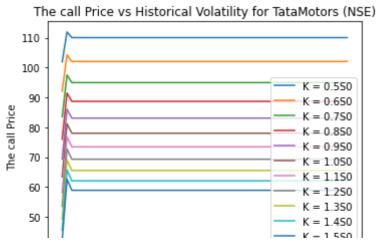
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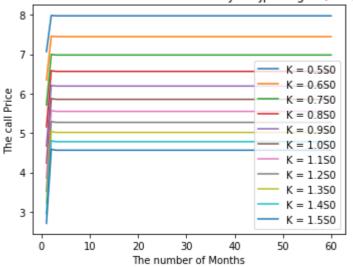
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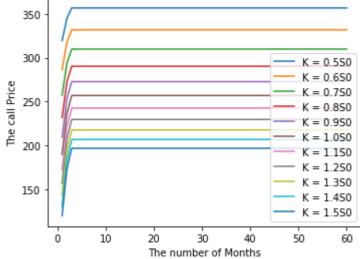
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The call Price vs Historical Volatility for Jp Morgan (NSE)



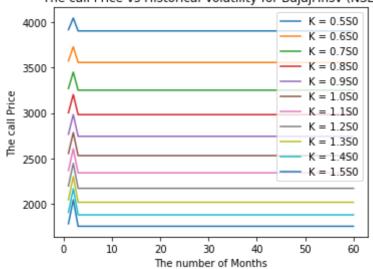
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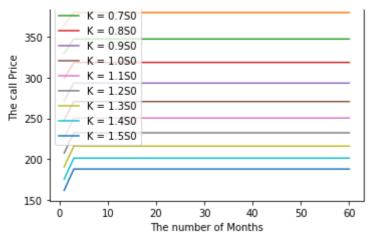
The call Price vs Historical Volatility for BajajFinsv (NSE)



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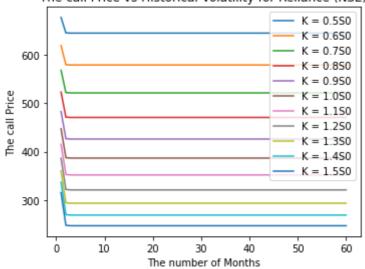
The call Price vs Historical Volatility for Havells (NSE)





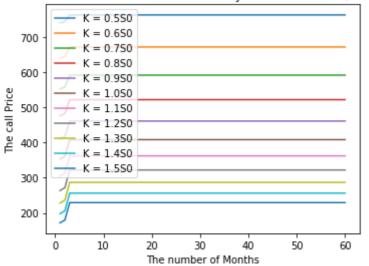
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The call Price vs Historical Volatility for Reliance (NSE)



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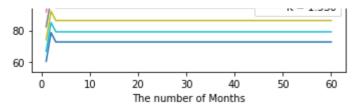
The call Price vs Historical Volatility for Asian Paints (NSE)



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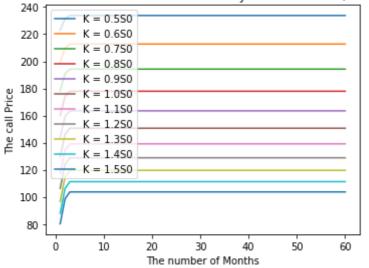
The call Price vs Historical Volatility for Berger Paints (NSE)





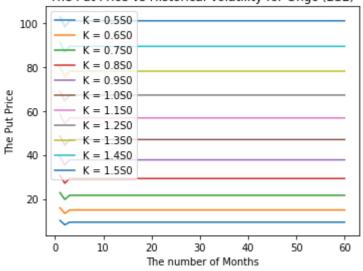
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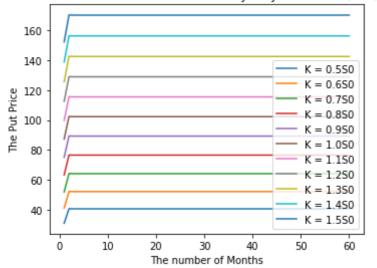
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The Put Price vs Historical Volatility for Ongc (BSE)



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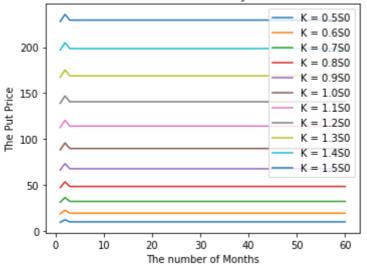
The Put Price vs Historical Volatility for JindalSteels (BSE)



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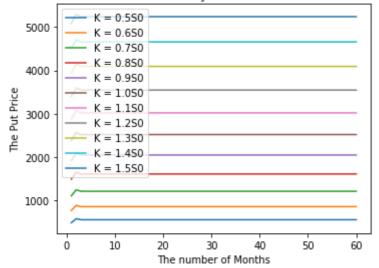
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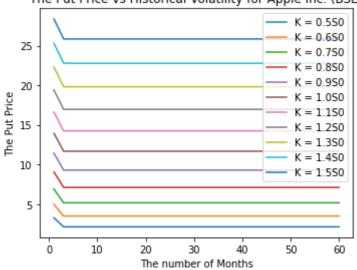
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The Put Price vs Historical Volatility for Maruti Suzuki India Limited (BSE)

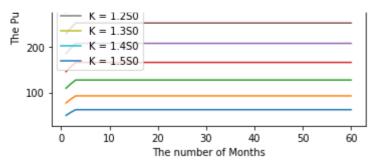


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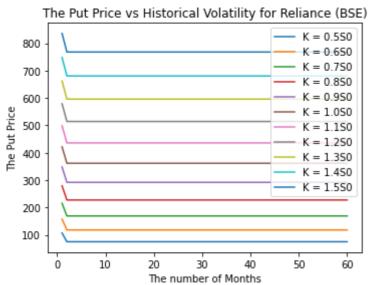
The Put Price vs Historical Volatility for Apple Inc. (BSE)



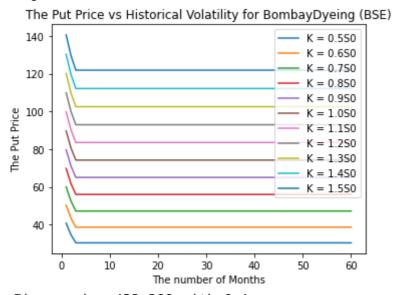
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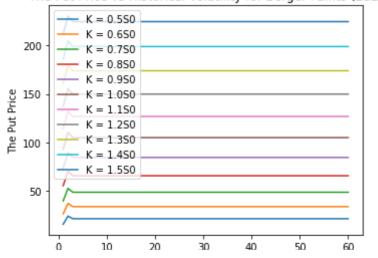


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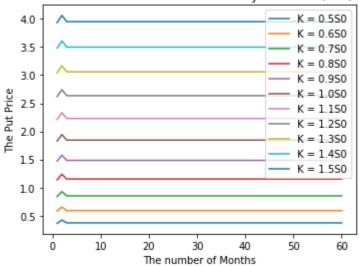




The number of Months

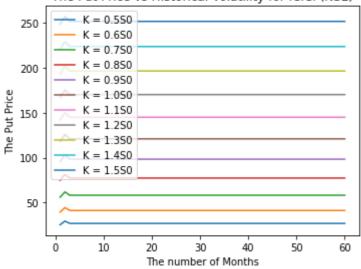
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The Put Price vs Historical Volatility for Nokia (BSE)



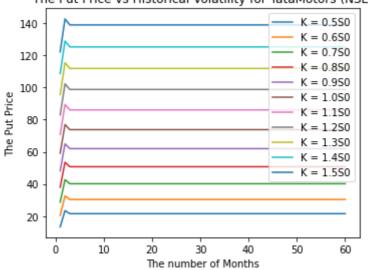
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The Put Price vs Historical Volatility for ICICI (NSE)



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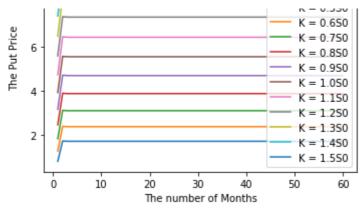
The Put Price vs Historical Volatility for TataMotors (NSE)



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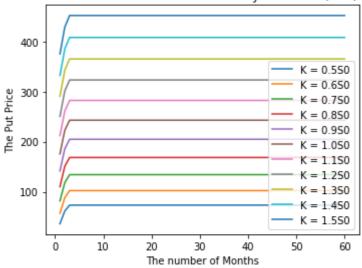
The Put Price vs Historical Volatility for Jp Morgan (NSE)





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The Put Price vs Historical Volatility for Voltas (NSE)



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The Put Price vs Historical Volatility for BajajFinsv (NSE) 5000 K = 0.550K = 0.650K = 0.7504000 K = 0.850K = 0.950The Put Price K = 1.050K = 1.1503000 K = 1.250K = 1.350K = 1.4502000 K = 1.5501000 10 20

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The Put Price vs Historical Volatility for Havells (NSE)

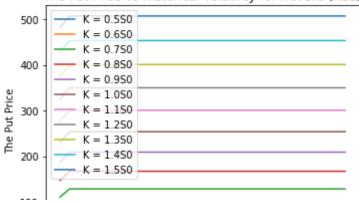
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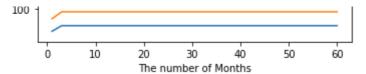
The number of Months

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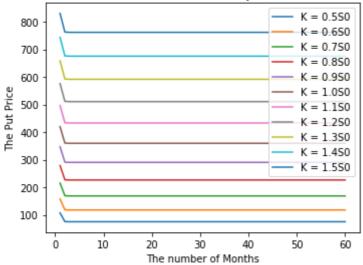
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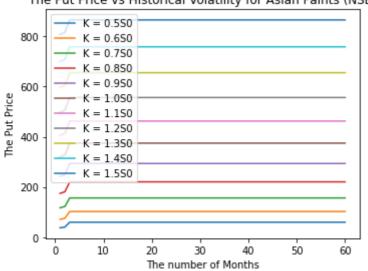
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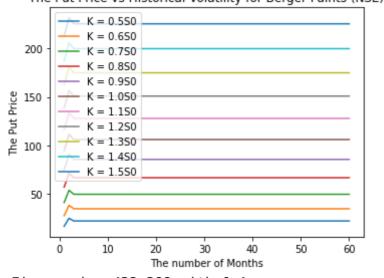
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The Put Price vs Historical Volatility for Asian Paints (NSE)



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The Put Price vs Historical Volatility for Berger Paints (NSE)



<Figure size 432x288 with 0 Axes>

The Put Price vs Historical Volatility for MuthootFin (NSE)

K = 0.550

