Analysis of Option Prices Using Black Scholes Model

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Abstract

A mathematical formula used in finance to calculate the theoretical price of an option and ascertain its option premium is known as the Black Scholes option pricing model, which aids option traders in making informed decisions. This article estimates the option premium of various call and put options using the Black Scholes Model. The three distinct option chains chosen for this essay are allMid-Cap companies that are listed on the Indian National Stock Exchange. The companies are Suzlon Energy, Kalyan jewellers India, and Exide Industries Ltd. The analysis demonstrates that theoptions are expensive because the Black Scholes model's computation of the option premium is lower than the actual premium in the market.

Keywords: Option, Black Scholes Option Pricing Model, Call, Put, Option Premium

INTRODUCTION

The Black Scholes equation is found using a mathematical model for finance called Black Scholes' Model, which is used to compute the theoretical price of an option. It is used to determine the option prices for European option, which can only be exercised on their expiration date, in contrast to American options, which offer greater flexibility. The factor taken into account are the underlying price, the strike price, market volatility, the option remaining time until expiration, the expected dividend rate, and the market interest rate. The Black Scholes model, often called Black Scholes Merton, was created by three economists: Fisher Black, Myron Sholes.

The Black Scholes Model makes certain assumptions while calculating the Option prices. These assumptions are-

- The Option is European Option.
- The model assume no dividend is paid during the life of the option.
- Efficient Market (i.e. No prediction of Market movements)

- No Transaction cost involved in buying of the Option
- Returns on the Underlying are normally distributed
- This model assumes that risk free rate of return and the volatility remains constant.

An Option is a derivatives contract that derives its value from an underlying asset. On purchase of an options contract, it gives the owner the right and not the obligation to either buy or sell the underlying assets. A call option gives the option buyer a right to buy and not an obligation to hold the underlying asset, whereas a put option gives the holder of the option a right to sell and not an obligation to sell the underlying asset. Option Traders use Black Scholes option pricing model in order to calculate the theoretical price of the option by calculating the call.

and the put premium and then adding it to the Spot

Price. There are Six factor that affect this model - Spot price, days until expiration, strike price,Volatility Option Premium and Risk free interest rate.

Black Scholes Formula:

$$C = SN(d_1) - N(d_2)Ke^{-rt}$$

C = Call premium
S = Current stock price
t = Time until option exercise
K = Option striking price
r = Risk-free interest rate
N = Cumulative standard normal distribution
e = Exponential term

s = St. Deviation
ln = Natural Log

$$d_1 = \frac{\ln\left(S/K\right) + \left(r + s^2/2\right)t}{s \cdot \sqrt{t}}$$

$$d_2 = d_1 - s \cdot \sqrt{t}$$

This formula takes into account certain important factor as –

1. **Option Premium**- It is an amount given by the Option Buyer to the Option Writer for the undertaking of the obligation to Buy the underlying asset without enjoying the right to reject the same.
2. **Current Stock Price/Underlying Price**- It is the current prevailing stock price of the underlying asset of the Option contract.
3. **Time until expiration** – The time until which the Option contract between the Option Buyer and the Option Writer will expire.
4. **Strike Price** - The price at which an Option trader bets as to whether the o=price of the underlying asset will go up or fall below the strike price.

5. **Risk free interest rate** – It is the interest rate of a risk free instrument in the market that is free from the market risk, In India it is generally the interest on a Treasury bill.

6. **Volatility** – The variation in the trading price in the market over certain period of time. Though the investor could invest in various options, but the assumption is being made that he is interested in options contract of a particular industry or sector.

REVIEW OF LITERATURE

1. **(Sharma & Arora, 2015)** tested the relevance of Black Scholes Model in the Indian Stock market for the Option prices by using the model to calculate the theoretical Option Prices using the equation and then comparing it with the actual values. All the necessary assumptions have been taken into consideration in this research as required by the model foroption price calculation. The research concluded that the Black Scholes model values were not relevant to the market values of the stock option. The findings also showed that there is a need to explore other impacts on the pricing of the stock options than the Black Schole Model.

2. **(Nilakantan & Jain, 2014)** Found in their study in the context of Indian Stock market that the Black-Schole model suffers from various deficiencies. They concluded that modified B-S Model is not able to produce efficient results for NIFTY index option in case of At-the-money, Out-of the Money and Deep Out-of-the-Money options. In most of cases call options are under prices by the Black-Schole model. The B&S Model under prices high volatility stock. It pays low reward for the stock that has high volatility.

3. **(Shinde & Takale, 2012)** This paper aim to study the option pricing using Black-Scholes model. It also gives a brief view about the required definitions and different derivations, which are useful for further development and also development of Black-Scholes partial differential equation. It not only explains the concepts in a theoretical manner but also helps us understand by obtaining the solution of Black-Scholes equation and represented it graphically by maple software. The paper use European Option for expiration date and calculates the option prices using Stochastic Differential Equation, Black-Scholes Partial Differential Equation. And it also prove the relevance of the usefulness in financial sector, especially financial engineering. It concludes with the findings that call option prices change by varying parameters.

4. **(Kumar & Agrawal, 2017)** The Black-Scholes Model suffers from a pricing error at the deeper out-of-the money options, which is greater, compared at the near out-of-the- money options and this error increases as the volatility increases. The Black-Scholes model suffers from an error of mispricing options considerably and this error of mispricing increases as themoneyness and volatility increases. The Black-Scholes model over price short-term options and under-price long-term options. The Black-Scholes

model exhibits pricing errors on several parameter. The Black-Scholes model under price in-the money options and overprices out-of-the-money options. The pricing errors are comparatively lesser in the modified BS model compared to the present one. The Black-Scholes model suffers from various deficiencies. It was understood that the modified BS Model would not be able to produce efficient results for NIFTY index option in the case of At-the-money, Out-of the Money and Deep Out-of-the-Money option. The BS Model under prices stocks with high volatility and pays low reward for these stocks.

RESEARCH DESIGN

Statement of Problem -

The pricing of Options in the market is dependent on certain factor such as Spot price, Volatility etc. so it is difficult to estimate the Option price. Black Schole Option pricing model also has makes certain assumptions for the pricing of the option that make It applicable to European Option pricing effectively. In this Paper the Black Schole Model will be used to estimate the option premium in order to calculate the option price to se whether the model is effective or not.

Sources of Data-

The data taken for purpose of research paper is Secondary data. The Stock prices and the Option Chain are collected from the following website:

- http://www.nseindia.com
- http://moneycontrol.comhttp://www.investopedia.com

Hypothesis -

We studied samples of both Call and Put option, where each sample consist of option value of certain different days.

The Black Schole Model has been used for the pricing of the Option.

In order to find the significant difference between the model values and the actual values, wehave formulated certain hypothesis-

Null Hypothesis (HO): There is no significant difference between Black Schole values and theActual market value.

Alternate Hypothesis (H1): There is significant difference between Black Scholes values and theActual market value.

Data Analysis Tools

The tool used for data analysis in this paper is the Black Scholes Option Pricing Model-

$$C = SN(d_1) - N(d_2)Ke^{-rt}$$

This model is used to calculate The Value of A Call (C) using the normal distribution table (N)bytaking the difference between the two parts.

The two parts of the model are –

1. The first part consist of $SN(d_1)$ which is the multiplication of the price by the change in the call premium in relations to change in underlying price. Where d_1 is calculated using:

$$d_1 = \frac{\ln(S/K) + (r + \sigma^2/2)T}{\sigma\sqrt{T}}$$

- In – is the natural log
- S – Is the current stock prices of the underlying asset
- K – It is the Strike prices
- r – represents the Risk free interest rate
- σ - is the standard deviation i.e. is the volatility of the market inserted in the form of decimal in the formula

T – Is the time until option exercise.

2. The second parts is $N(d_2)Ke^{-rt}$ which is nothing but the present value of the exercise price discounted back to today at the risk free rate of returns, sine Black Scholes use the continuous discounting that's why it uses the exponential. Here d_2 is calculated using formula:

$$d_2 = d_1 - \sigma\sqrt{T}.$$

- d_1 – is calculated above.

σ - is the standard deviation is the volatility of the market inserted in the form of decimal in the formula

- T – Is the time until option exercise

Expected Outcome

The expected outcome of this research is to find the theoretical price of the Options and the intrinsic value using the Black Scholes Model and compare with the Actual price to find out whether this model holds good for the purpose of option pricing or not.

Limitations

The limitation of this paper are –

- This model mainly used for pricing of European Options
- It assume that there is no arbitrage opportunity and the market is 100% efficient
- It assume that market volatility and the risk free rate of return remains constant.
- This Model ignore liquidity and brokerage charges.
- It assume no dividend is paid thus ignoring the impact of it on the valuation.

Data Analysis and Interpretations

Black Scholes Model Calculation

1) Kalyan jewelers –

Kalyan Jewellers was founded by T. S. Kalyanaraman, who opened the first jewellery showroom in 1993 in Kerala, India with an initial capital of ₹75 lakh (US$94,000). The company also has roots in the textile trading, distribution and wholesale business.

Initially, Kalyan Jeweller strengthened their presence in the South Indian states of Kerala, Tamil Nadu, Karnataka, Andhra Pradesh and Telangana. In 2012, they expanded outside South India by opening a showroom in Ahmedabad, Gujarat and signed Amitabh Bachchan as their first National Brand Ambassador.

Calculation of option valuation:

Risk free rate = 11.45%Spot price = Rs 344.30

Expiration date = 18/02/2024Volatility = 22%

a) In the money:

From the above table we assume our strike price as 650. Since the spot price isgreater than the strike price, it would be considered as in the money.

Strike price = 650

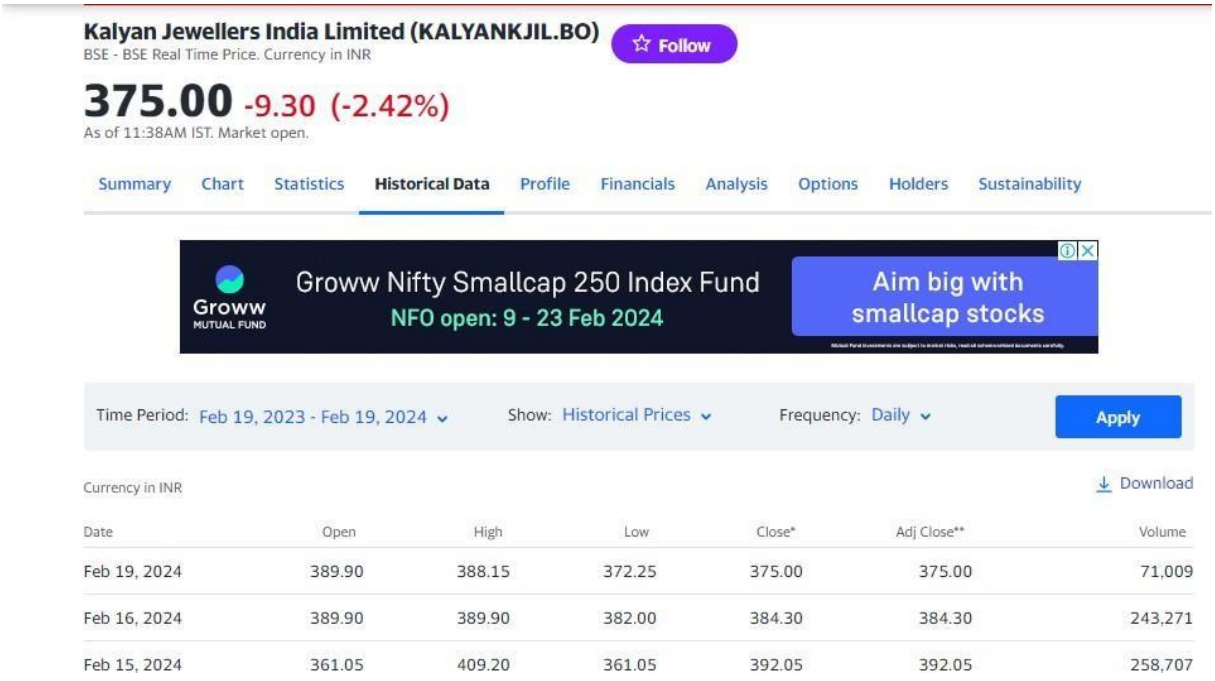
As per the Black Scholes's model

Call option premium = 20.36
The value of call option premium as per Black Scholes model is less than that mentionedin the NSE **26.55**, which mean that the call option is overvalued.

Put option premium = 0.06
The value of put option premium as per Black Scholes model is less than that mentioned inthe NSE i.e **6.00**, which means that the put option is overvalued.

B) Out of Money

From the above table, we will assume our strike price as 700. Since the spot price is less thanthe strike price, it would be considered as out the money.



Date	Open	High	Low	Close*	Adj Close**	Volume
Feb 19, 2024	389.90	388.15	372.25	375.00	375.00	71,009
Feb 16, 2024	389.90	389.90	382.00	384.30	384.30	243,271
Feb 15, 2024	361.05	409.20	361.05	392.05	392.05	258,707

Call option premium = 0.08

The value of call option premium as per Black Scholes model is less than that mentionedin the NSE i.e **7.40**, which means that the call option is overvalued.

Put option premium = 19.75

The value of put option premium as per Black Scholes model is less than that mentioned inthe NSE **34.95**, which means that the put option is overvalued.

2) Excide Industries Ltd.

It is the largest manufacturer of lead-acid storage battery and power storage solutions providerin India. The company has ten international standard factories spread across five states in the country, out of which 8 factories are dedicated to lead-acid batteries and 2 factory manufacture Home UPS System.

Calculation of option valuation:

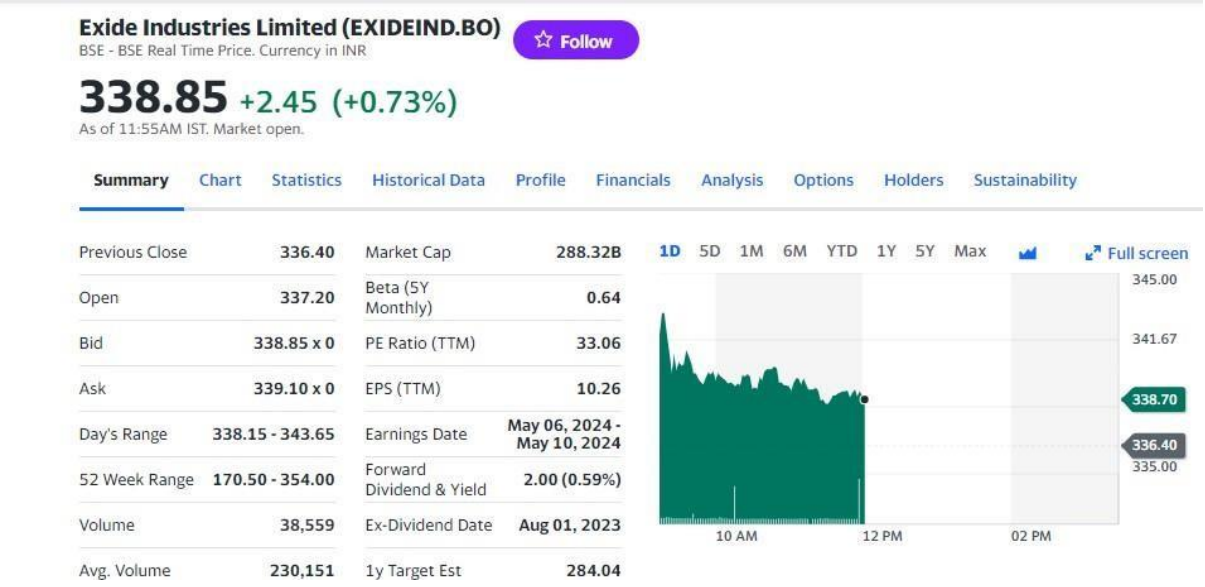
Risk free rate = 6.22%Spot price = Rs 326.50

Expiration date = 18/02/2024Volatility = 0.371%

a) In the money:

From the above table we assume our strike price as 550. Since the spot price isgreater than the strike price, it would be considered as in the money.

Strike price = 550



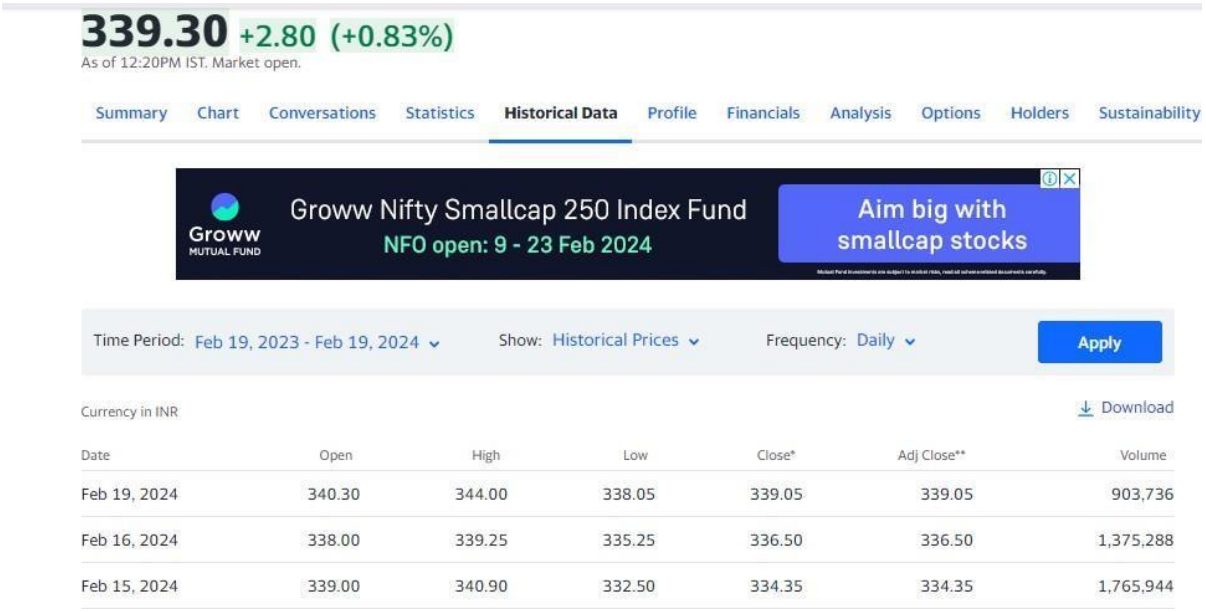
As per the Black Scholes's model

Call option premium = 30.36
The value of call options premium as per Black Scholes's model is less than thatmentioned in the NSE **35.55**, which mean that the call option is overvalued.

Put option premium = 0.04
The value of put option premium as Black Scholes's model is less than that mentioned inthe NSE **4.00**, which means that the put option is overvalued.

B) Out of Money

From the above table, we assume our strike price as 00. Since the spot price is less than thestrike price, it would be considered as the money.



339.30 +2.80 (+0.83%)
As of 12:20PM IST. Market open.

Summary Chart Conversations Statistics **Historical Data** Profile Financials Analysis Options Holders Sustainability

Time Period: Feb 19, 2023 - Feb 19, 2024 Show: Historical Prices Frequency: Daily Apply

Currency in INR Download

Date	Open	High	Low	Close*	Adj Close**	Volume
Feb 19, 2024	340.30	344.00	338.05	339.05	339.05	903,736
Feb 16, 2024	338.00	339.25	335.25	336.50	336.50	1,375,288
Feb 15, 2024	339.00	340.90	332.50	334.35	334.35	1,765,944

Call option premium = 0.07

The value of call option premium as per Black Scholes's model is less than that mentionedin the NSE **6.40**, which means that the call option is overvalued.

Put option premium = 16.75

The value of put option premium as per Black Scholes's model is less than that mentioned inthe NSE **33.95**, which means that the put option is overvalued.

3) Suzlon Industries

Suzlon Provides Renewable Energy Solutions Worldwide

Founded in 1995, Suzlon is one of the leading global renewable energy solution providers. Over the past two decades, Suzlon installed over ~20.5 GW of wind energy in 17 countries across six continents.

The Suzlon Group comprises of Suzlon Energy Limited and its various subsidiaries. The Group's vision for growth is driven by the concept of sustainable development. In recent years, Suzlon has developed strong competencies in solar power too and plans to offer Wind-Solar hybrid solutions. Its global wind installations alone help in reducing more than 52.51 million ton of CO_2 emissions every year.

The Suzlon Group's manufacturing footprint is spread across India and covers 14 facilities. Suzlon's success is due to it dynamic workforce of over 6,300 employees, who are respected and empowered as the Group most valued asset.

In India, Suzlon is a market leader with 111 wind farm and an installed capacity of over 14,490 MW. It has developed some of Asia's largest operational onshore wind farms in nine states including Gujarat, Rajasthan, Maharashtra and Tamil Nadu. The Group's diverse client portfolio include power utilities and electricity producers in both the private and public sectors.

The Suzlon Group aims to make renewable energy both simple and cost effective for customer. In fact, Suzlon pioneered the Concept to Commissioning' model in wind energy, enabling it to meet the breadth and depth of customer requirements across the renewable energyvalue chain.

Calculation of option valuation:

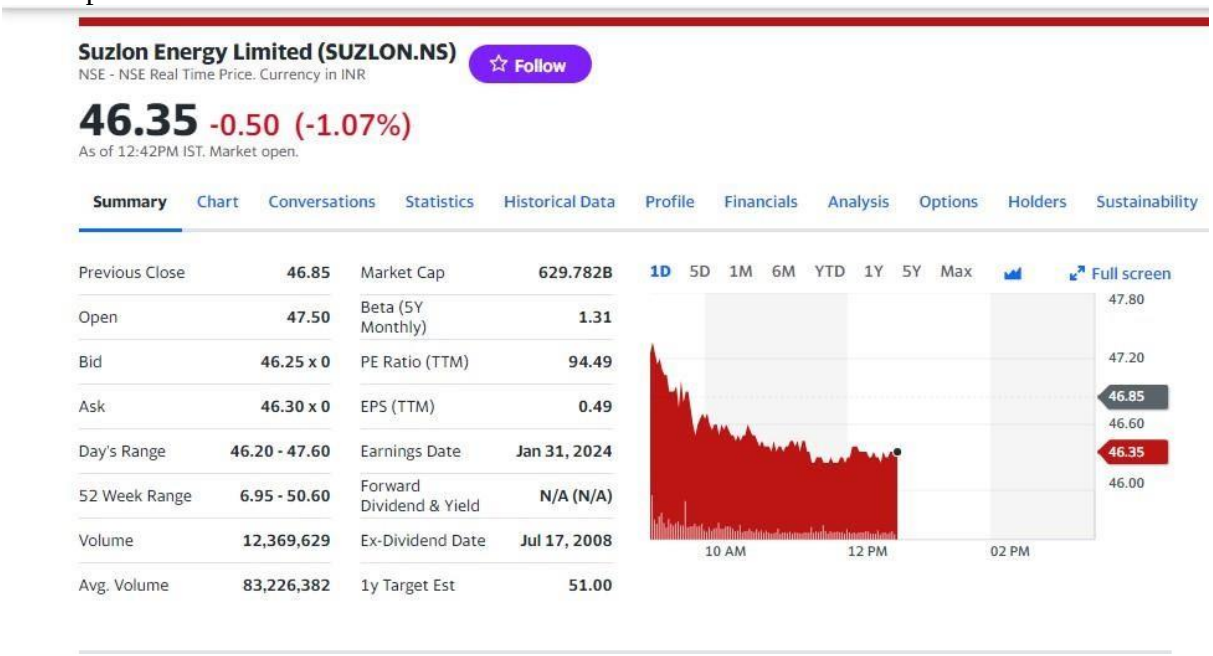
Risk free rate = 7.22%Spot price = Rs 46.35

Expiration date = 19/02/2024Volatility = 1.48%

a) In the money:

From the above table we will assume our strike price as 560. Since the spot price isgreaterthan the strike price, it would be considered as in the money.

Strike price = 560



As per the Black Scholes's model

Call option premium = 20.36

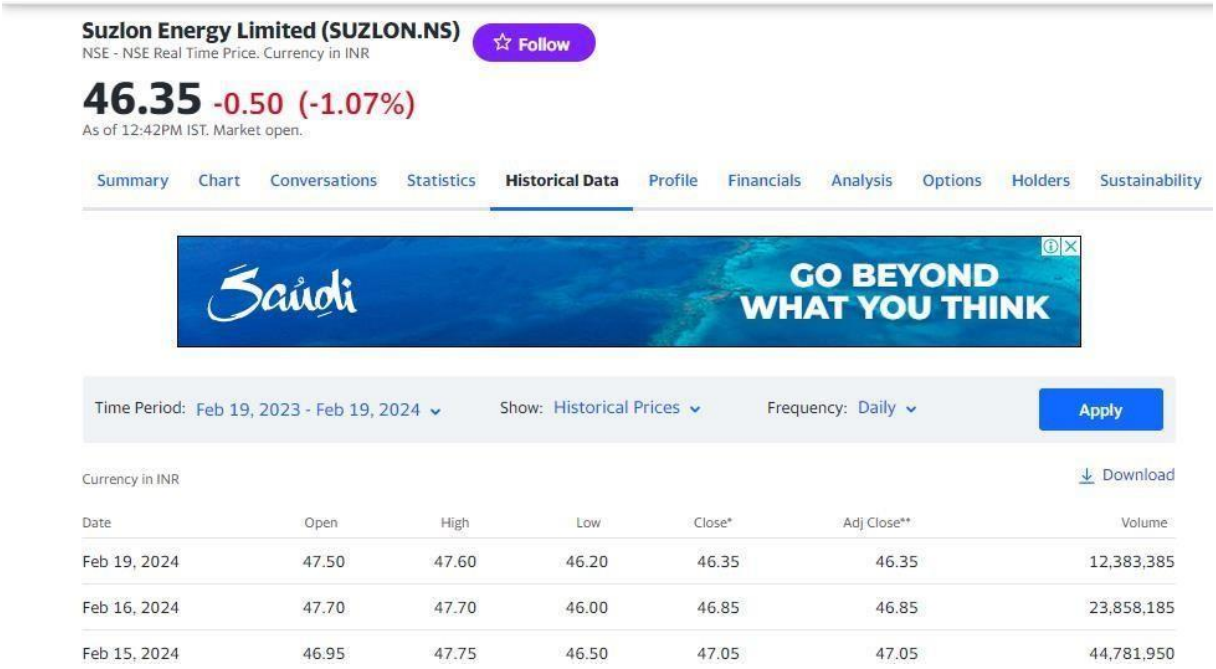
The value of call option premium as per Black Scholes's model is less than that mentionedin the NSE **25.55**, which means that the call option is overvalued.

Put option premium = 0.02

The value of put option premium as per Black Scholes's model is less than that mentionedin the NSE **2.00**, which means that the put option is overvalued.

B) Out of Money

From the above table, we assume our strike price as 00. Since the spot price is less than thestrike price, it would be considered as out the money.



Date	Open	High	Low	Close*	Adj Close**	Volume
Feb 19, 2024	47.50	47.60	46.20	46.35	46.35	12,383,385
Feb 16, 2024	47.70	47.70	46.00	46.85	46.85	23,858,185
Feb 15, 2024	46.95	47.75	46.50	47.05	47.05	44,781,950

Call option premium = 0.08

The value of call option premium as per Black Scholes's model is less than that mentionedin the NSE **3.40**, which means that the call option is overvalued.

Put option premium = 15.75

The value of put option premium as per Black Scholes's model is less than that mentioned intheNSE **31.95**, which means that the put option is overvalued.

CONCLUSION

The Black Scholes's Model allow the investor to make a smart decision by finding out whether the options have been overvalued or undervalued depending on which, the appropriate decision can be made. It is finally concluded that the Null Hypothesis (Ho) is accepted as there is significant difference between Black Scholes Option Prices and the Actual Option price.

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