Stochastic Methods for Finance

1st Report

Giovanni Dal Mas

2053346

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1. Goal

The report aims at providing the price of a Call by using the Static Binomial model.
For my project I chose the company Meta Platforms, Inc.

2. Overview and statistics on the company: Meta Platforms, Inc.

Meta Platforms, Inc, (formerly known as Facebook, Inc) is an American multinational technology conglomerate. The company engages in the development of social media applications as well as virtual and augmented reality products allowing users to connect through mobile devices, personal computers and other platforms. The company operates through two segments. The Family of Apps (FOA) segment which includes Facebook, Instagram, Messenger, WhatsApp and other services, and the Reality Labs (RL) segment, which includes augmented and virtual reality related consumer hardware, software and content. The company was founded by Mark Elliot Zuckerberg, Dustin Moskovitz, Chris R. Hughes, Andrew McCollum, and Eduardo P. Saverin on February 4, 2004, and is headquartered in Menlo Park, CA.

Meta is one of the so called 'Big Five', alongside Alphabet (Google), Amazon, Apple and Microsoft, the five largest and most dominant companies in the information technology industry of the United States.

The corporation counts 71.97K employees and 3.29K shareholders. Taking a closer look at the major holders, 0.53% of the shares are held by All Insider, while 79.16% are held by Institutions. Vanguard Group, Inc. (The) with 181,965,468 shares and Blackrock Inc. with 158,101,319 are the top institutional holders.

Meta is the 9th company in the world by market capitalization with $597.66B and it has an Enterprise Value of $546.90B. As regard the income statement the Revenue (ttm) is $117.93B, the Gross Profit (ttm) $95.28B and the Net Income $39.37B.
Analysing the profitability and management effectiveness of the company there is a Profit Margin of 33.38% and a Return on Assets and Return on Equity of 17.97% and 31.10% respectively. The Beta (5Y Monthly) value is 1.39.
Today, March 24, 2022- 6:00 pm Rome GMT+01:00, the price of an option is $219.57.
At the open it was $215.00 and at the previous close the price was $213.46.
The day's range settles between $214.84 and $220.67, while the 52 week's one ranges between $185.82 and $384.33. No information about forward Dividend & Yelds and about Ex-Dividend Date are provided.

3. Maturity T = 3 Months

In the section "Options" of *Yahoo Finance* I select a Call with maturity of approximately 3 months, namely June 17, 2022, and a Strike AtTheMoney (K) of $220.00, the closest to the current value of the stock ($219.57). Then I compute the mean between the Bid Price $16.30 and the Ask Price $16.55, obtaining a Mid-Price of $16.43, the target price for my model.
From the section "Historical Data" I download the last 3 months of daily data, with starting date December 27, 2022, and ending date on March 24, 2022. I then obtain the daily returns through the formula $(S_{t+1}-S_t)/S_t$, where S_{t+1} is the price of the stock today and S_t the price of yesterday. From the returns I compute the daily standard deviation σ_d and multiplying this value for $\sqrt{252}$ (the opening days in the exchange for one year), I obtain σ_y the annual volatility.
The two values are respectively:

$$\sigma_d = 0.04278146 \quad \sigma_y = 0.679134629$$

With the annual volatility I calculate the first two parameters for my Binomial model *u* and *d*, the percentage of increase and decrease of the stock price*:*
u, d = $\exp(\pm\sigma_y * \sqrt{T})$, where T is the maturity, in this case 3 months (3/12 of a year)

$$u = 1.404339821 \qquad d = 0.712078362$$

For the third parameter R, my interest rate, I go to the web site *https://www.global-rates.com/* and look for the correspondent USD LIBOR interest rate for maturity 3 months at date March 23, 2022, which is 0.96571%, therefore:

$$R = 0.0096571$$

Since the USD LIBOR interest rate is linearly compounded and Meta has no dividend involved, the capitalization factor using the simple compounding is 1+RT = 1.002414275 and the simple discounting 1/(1+RT) = 0.99759154.

With these values I can now compute the *risk neutral probability weight:*

$$q = \frac{(1 + RT) - d}{u - d}$$

Having calculated the value of q = 0.419402104, I apply the *risk neutral pricing formula* to obtain the price of a Call .

$$\text{Price}_0(\text{Call}) = (1 + RT)\,(q\,(Su - K)^+ + (1 - q)(Sd - K)^+) = 36.8595$$

Where $Su = S_0 * u$ and $Sd = S_0 * d$, $S_0 = 219.57$ and $K = 220.00$

Comparing the price obtained with the market quote on Yahoo Finance the result is not very coherent. Our target, the *Mid Price* for Strike ATM 220.00, is 16.43 and it is quite far from the price we have estimated (36.86). The percent error, that we can calculate with the following formula, is 124.34 % and it is very high.

$$\delta = \left| \frac{v_A - v_E}{v_E} \right| \cdot 100\%$$

δ = percent error
v_A = actual value observed
v_E = expected value

This result is probably due to the use of a too simple model such as the Static Binomial model.

4. Maturity T = 6 Months

I repeat the same procedure for maturity 6 months, namely September 16, 2022.
In this case the Mid Price is 25.20 (the mean between Bid 25.10 and Ask 25.30), T is 1/2 and the USD LIBOR interest rate for maturity 6 months is 1.38971%.
$S_0 = 219.57$, K= 220.00
These are the values obtained:

$\sigma_d = 0.033312126$
$\sigma_y = 0.528813602$
u= 1.45343204
d= 0.688026665
R= 0.0138971
q= 0.416670558

$\text{Price}_0(\text{Call}) = 37.34485994$

For maturity 6 months the model performed better, computing a price of $37.34 (the Mid Price at Strike ATM 220.00 in the market is 25.20). However, the percent error of 48.19%, is still very high.