Report 1

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March 21, 2024

1 Introduction

This report outlines pricing a call option for a financial asset using a straightforward discrete-time model known as the binomial model. It operates under the assumption that arbitrage opportunities are absent. The chosen asset for analysis is Supermicro Company, a tech company with a current market capitalization of $50.95 billion (as per Yahoo Finance data as of March 16, 2024). The model is applied initially for a three-month maturity period and then extended to six months. The structure of the report is organized as follows: the next sections provide information about Supermicro, a description of the one-period Binomial Model, methodology, and present the outcomes.

2 Hystory

Super Micro Computer, Inc., known as Supermicro, is a leading American IT company headquartered in San Jose, California, with manufacturing operations in Silicon Valley, the Netherlands, and Taiwan. Established on November 1, 1993. Supermicro specializes in high-performance, energy-efficient servers, server management software, and storage systems for various sectors, including enterprise data centers, cloud computing, AI, 5G, and edge computing.

Tracing its roots to a small team led by Charles Liang and his wife Chiu-Chu Liu in 1993, Supermicro grew rapidly. Armed with degrees in Electrical Engineering, Charles Liang had previously held key roles in the tech industry. The company expanded internationally, setting up manufacturing subsidiaries in Taiwan and the Netherlands in 1996 and 1998, respectively. However, legal issues arose, culminating in a 2006 felony charge related to violating the US embargo against selling computer systems to Iran. Supermicro went public in 2007, raising $64 million in its initial public offering. By 2009, it had achieved significant revenue milestones and expanded its European presence. In 2012, it inaugurated its Taiwan Science and Technology Park with substantial construction investment. Supermicro will replace Whirlpool in the SP 500 starting at market open March 18, 2024.

The company faced allegations in 2018 of compromised server hardware, which it vehemently denied, sparking investigations and ongoing scrutiny. Recent developments in 2021 included controversial contracts involving server supply to entities associated with human rights concerns, raising ethical questions about Supermicro's business practices.

Despite challenges, Supermicro continued to innovate its product line. Notable advancements included high-density server platforms, collaboration with AMD for blade server technology, and the introducing of application-optimized server SKUs powered by Intel processors. Corporate expansion saw Supermicro relocate its headquarters to North San Jose, transforming the area into Supermicro Green Computing Park. The company received recognition for contributing to green computing and technological innovation, winning accolades such as Product of the Year at events like the NAB Show.

With its continued growth and commitment to technological advancement, Supermicro remains a key player in the IT industry, navigating challenges while striving for excellence in product development and corporate responsibility.

3 One period Binomial model

The one-period binomial model is a discrete-time model used for pricing options. It assumes that the price of the underlying asset can only move to one of two possible values in the next period. Let S be the current price of the asset, u be the up factor, and d be the down factor. These factors determine how much the asset price will increase or decrease in the next period. In this model, we consider the behavior of a financial market between t=0 to T (maturity time).

The up factor u and down factor d are related to each other through the risk-neutral probability q, which represents the probability of an up move. The down move probability is then $1 - q$.

The relationship between u, d, and σ is expressed as:

$$u = e^{\sigma\sqrt{\Delta t}}$$
$$d = e^{-\sigma\sqrt{\Delta t}}$$

Where σ is the volatility of the asset and Δt is the length of the period.

The price of the call option in the up state (f_u) and the down state (f_d) can be calculated using the following formulas:

$$f_u = \max(Su - K, 0)$$
$$f_d = \max(Sd - K, 0)$$

Where K is the strike price of the option.
The probabilities q and 1-q are are

$$q = \frac{e^{RT} - d}{u - d} \quad 1 - q = \frac{u - e^{RT}}{u - d} \tag{1}$$

Finally, the price of the option (f) can be obtained by taking the expected value of the option payoff in the next period and discounting it back to the present using the risk-free rate:

$$f = e^{-RT}(qf_u + (1 - q)f_d)$$

Where r is the risk-free interest rate.

In summary, the one-period binomial model provides a framework for pricing options by considering the possible future movements of the underlying asset and discounting the expected payoffs to the present time. It's a fundamental tool in options pricing theory, offering insights into the valuation of derivative securities.

4 Methodology and Results

For this study, I conducted research on Yahoo Finance to obtain call option and historical data of the chosen asset, Supermicro.

For the first part of the analysis, I selected an option with a maturity of 3 months and a strike price close to the current value of the stock. I calculated the theoretical price of the option by averaging the Bid and Ask prices.

Next, I computed the daily returns as follows:

$$\text{Return} = \frac{Price_t - Price_{t-1}}{Price_{t-1}}$$

I also calculated the daily volatility σ_{daily} and the yearly one using $\sigma_{yearly} = \sigma_{daily}\sqrt{252}$.

Using the parameters from the binomial model described earlier, including u, d, and the Libor rate corresponding to 3 months, I computed the capitalization factor as:

$$CF = 1 + R \cdot T$$

and not as exponential form as :

$$CF_{exp} = e^{RT} \tag{2}$$

The Libor rates used are

3 months	0.056
6 months	0,057

Table 1: Libor rate R

I found the parameters u and d as $u = e^{\pm\sigma_{yearly}\sqrt{T}}$.
Then, I calculated the risk-neutral probability weight q as in 1 and found the price of the call option. The computed factors for the three month option are summarized in the following table:

Parameter	σ_{daily}	σ_{yearly}	u	d	$s_{compounding}$	$s_{discounting}$
Value	0.6	0.95	1.61	0.62	1.01	0.98

Parameter	q	s_u	s_d	f_u	f_d
Value	0.39	1729.82	663.87	831.84650.81	0

Where in order we have the daily volatility, yearly volatility, the coefficients u (up), d (down), the simple compounding (1+RT) and its inverse, the probability of getting the up state, the down state, the multiplication of u and the stock price and d for the stock price, the option prices in the up state and down state.
I finally computed the price of the option using binomial model and compared with the mid calculated earlier:

price_{theoretical}	207.55
price_{calculated}	254.99
error	0.23

Table 2: Comparison of Option Prices for 3-month Option

The analysis revealed an error of over 22% for the pricing of the three-month option.
I repeated the same analysis for a 6-month option with the following results:

Parameter	σ_{daily}	σ_{yearly}	u	d	$s_{compounding}$	$s_{discounting}$
Value	0.06	0.95	1.78	0.56	1.02	0.98

Parameter	q	s_u	s_d	f_u	f_d
Value	0.38	1901.84	600.68	831.84	0

$price_{theoretical}$	248.80
$price_{calculated}$	308.19
error	0.24

Table 3: Comparison of Option Prices for 6-month Option

Finally, I compared the price found using the binomial model and the theoretical one. The comparison of option prices for the 6-month option showed an even higher error.

5 Conclution

In our study, we examined the process of pricing options using the one-period binomial model. The results showed that the calculation of the price of a Supermicro option with a maturity of 3 months has an error of 23%, while for an option with a maturity of 6 months, the error is 24%.

This indicates that the one-period binomial model can give an indication of the result but has many limitations due to the very simple assumptions on which it is based and cannot be applied in a more complex context. It can certainly help to understand the basic behavior of the market.