Asian Options in a Market with High Volatility: Perspective and Evidence from Zoom and Peloton

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Abstract. Contemporarily, uncertainties strongly affect the stock market, especially for the options market that fluctuates dramatically. On this basis, Asian options have become a favorable option for investors due to their low-risk characteristic. In this paper, two recently highly volatile assets, Zoom (ZM) and Peloton (PTON), were selected as investigation targets underlying Asian options. Specifically, both the Black-Scholes method and Monte-Carlo method were applied to price the Asian options for ZM and PTON. Based on calculations with the Black-Scholes formula and simulation with the Monte-Carlo method, we demonstrated that the prices of Asian options are approximately half of the corresponding Vanilla options. Besides, the expected returns are also nearly half of the corresponding Vanilla options. Moreover, according to the comparison between the calculations and simulation, the Black-Scholes formula eventually goes inaccurate while the strike price goes large or less than the original price. However, if the Monte-Carlo method is applied with enough times of simulations, the price of the Asian option will be reflected accurately. Overall, the Asian option is indeed a better choice for prudent investors in a highly volatile market.

Keywords: Asian Options, Black-Scholes, Monte-Carlo Simulation.

1. Introduction

Generally, there are two types of options in terms of executive price, the Asian option and the Vanilla option. An Asian option is a path-dependent option whose payoff relates to the average price of the underlying asset over a certain period [1]. The Vanilla option is a put option that endows the holder a right to purchase or sell an instrument at an agreed price [2]. An Asian option, in contrast to the Vanilla option, provides more protection against risk due to its lower prices and higher stability.

In a highly volatile market, every news can affect the market in the future. For example, a speech about interest rates given by officers in the Federal Reserve can affect the short-term market a lot. However, in the long run, the price of stock mainly depends on itself. Therefore, the investors do not want the volatility to interrupt their predictions on specific stocks, i.e., they want a low volatile option product within this special period.

In 2020, the whole market experienced abnormal volatility under the impact of the COVID-19 pandemic. In this special period of market, Vanilla options are not suitable for pursuing a profit owing to its even higher volatility. Therefore, a lower volatile option is required to replace Vanilla, i.e., Asian options are suitable for this case. In this special period, a few attractive stocks surged at the beginning, and then they fell with different levels of volume. Thus, we decided to pick two of them with high fluctuations to analyze possible profit we can gain from Vanilla options and Asian options on these two assets, Zoom and Peloton.

This paper investigates the Asian options and Vanilla options of the two stocks, which both have been through a highly volatile period due to the COVID-19 pandemic. Zoom's stock soared in the spring of 2020 as millions of people switched to online conferences or courses [3]. However, with the development of vaccines, investors began to realize the lower demand for Zoom calls. Zoom's stock entered an unprecedentedly volatile period and started to back down. Similarly, Peloton's stock is known as one of the top performers in the coronavirus stock market rally, and it has also been through

a tough volatile period [4]. Within this highly fluctuated market, it would be necessary to choose a relatively more stable option to reduce the risks. In this case, the Asian option of the underlying assets is investigated during such a highly volatile period of the market.

The rest part of the paper is organized as follows: Sec. 2 introduces the data collection as well as calculations and simulations methods; Sec. 3 presents the results and discusses the differences between the two options; Sec. 4 gives a brief summary eventually.

2. Data and Methods

2.1 Data Resources

The daily adjusted close prices of the Zoom and Peloton are collected from the website of Yahoo finance [5] and Investing.com [6] database. The time period ranges from April 5, 2020 to April 30, 2020 for Zoom (corresponding to high fluctuation period) while from May 21, 2020 to May 21, 2021 for Peloton. The price evolution for the two companies is illustrated in Figure 1. In the process of data modeling, we granted interest rate data directly from the website of the U.S. Department of the Treasury [7]. Besides, the interest rate is believed to be controlled at a low level for at least 3 years based on current macroeconomics.

Figure 1. The price evolution for Zoom (upper panel) and Peloton (lower panel) during selecting time.

2.2 Black-Scholes Method & Monte-Carlo Method

The option pricing model is constructed mainly following lemmas of the Black-Scholes formula [8]. Subsequently, Monte-Carlo Simulation is carried out to verify the results from lemmas with Peloton stock. First, the formula of the Black-Scholes method is:

$$C = N(d_1)s_t - N(d_2)Ke^{-rt} \tag{1}$$

Here

$$d_1 = \frac{ln\left(\frac{S_t}{K}\right)+\left(r+\frac{\sigma^2}{2}\right)t}{\sigma\sqrt{t}} \tag{2}$$

And

$$d_2 = d_1 - \sigma\sqrt{t} \tag{3}$$

d1 denotes the amount of selling the stock at expiration, and d2 denotes the payment made to purchase the stock when the call option is exercised. C represents call option price. *N* represents CDF of the normal distribution. S_t is short for spot price of an asset. *K* represents the strike price. The minuscule r represents risk-free interest rate. The minuscule *t* represents the time to maturity. σ represents the volatility of the asset.

Table 1. The indicative price obtained from Monte-Carlo simulations ran 1million times

	Price	Indicative Price
Vanilla Call	\$7.89	\$7.86 -- \$7.92
Asian Call	\$4.50	\$4.49 -- \$4.52
Vanilla Put	\$7.89	\$7.87 -- \$7.91
Asian Put	\$4.50	\$4.49 -- \$4.51

Since the Monte-Carlo Simulation never provides the exact outcome, more calculations are required to reduce the standard error i.e., improve the accuracy of our results [9]. An analysis table from Excel is used to simulate the payoff of the Asian option and Vanilla option. The final prices of the Asian option and Vanilla option are determined by the average of the simulation of Asian payoff and Vanilla payoff. The simulations of random prediction of the stock price and option prices are running 10000 times. With this number of approaches, the maximum error is controlled under \$0.5. Besides, it is estimated that the error will be controlled within \$0.05 with 1 million times simulations (as listed in Table 1).

3. Results and Discussion

3.1 Analysis for Zoom

Based on Black-Scholes, the prices for Asian and Vanilla options are similar for the Zoom Peloton stock (as shown in Table 2). Subsequently, the Monte-Carlo's method is used to simulate the price of Asian options. For the Zoom stock, the price of using Asian call option is 4.69 dollars whereas the price of Vanilla call option is 9.37 dollars.) Furthermore, the price of using Asian put option is 4.23 dollars in contrast to 8.58 dollars using the Vanilla put option. Moreover, the maximum loss (depicted in Fig. 2) of investing in the Zoom stock using Asian option is shown in the histogram. The histogram is right-skewed, and there's a peak at the range of 3.717 to 5.157.

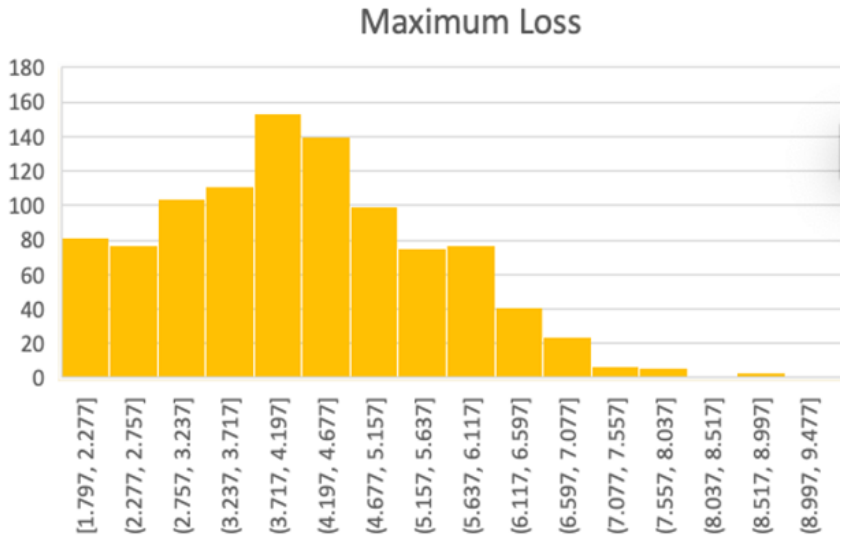

Figure 2. Maximum Loss of Investing in Zoom Using Asian Option.

Table 2. Price of Vanilla option and Asian option based on BS model and MC simulations for Zoom and Peloton

	Zoom		Peloton	
	Black-Scholes Model	*Monte Carlo*	*Black-Scholes Model*	*Monte Carlo*
Asian Call Option	$ 4.53	$ 4.69	$ 4.69	$ 4.50
Vanilla Call Option	$ 7.21	$ 9.37	$ 7.90	$ 7.89
Asian Put Option	$ 4.22	$ 4.23	$ 4.63	$ 4.50
Vanilla Put Option	$ 7.80	$ 8.58	$ 7.90	$ 7.89

3.2 Analysis for Peloton

As summarized in Table 2, the price of using Asian call option is 4.46 dollars compared to 7.82 dollars using the Vanilla call option for the Peloton stock. In addition, the price of using Asian put option is 4.44 dollars in contrast to 7.69 dollars using the Vanilla put option. The average return of the Asain call option is approximately 4.42 dollars, whereas the average return of the Vanilla call option is approximately 7.61 dollars. In addition, the average return of the Asain put option is approximately 4.39 dollars, whereas the average return of the Vanilla put option is approximately 7.80 dollars. To summarize, the price of Asian options of both stocks is about half of their Vanilla options, and the returns are about half of the Vanilla ones.

3.3 Explanation

According to the results, it is suggested that investors ought to choose the Asian option to reduce the volatility inherent in the two fluctuated stocks. Zoom's stock soared in the spring of 2020 as millions of people switched to online meetings and courses [10]. However, with the development of vaccines, investors began to realize the lower demand for Zoom calls. Zoom's stock entered an unprecedentedly volatile period and started to back down. Peloton also experienced a large soar because of the home-training trend caused by the COVID-19 pandemic. Nevertheless, it suffered a severe public relations crisis: its products caused several deaths and severe injuries. These accidents lead to a large stock price shrink, which means the volatility of this stock was large in the recent year. Therefore, our research on this stock gives a key takeout that the Asian option is very suitable to use under these circumstances. Firstly, it is shown in both cases that the price of Asian options is lower than the price of Vanilla options. This case indicates that investors could purchase the Asian options at a cheaper price, i.e., lose less money if anything happened. Although investors would receive less profits by choosing the Asian options, it's better to earn less money than taking high risks and losing

all the money in this highly volatile market. Furthermore, based on the maximum loss graph, one can infer that there's a high chance that investors would lose less money if choosing the Asian options. In addition, Figure 2 also indicates that choosing the Asian option is less risky because the maximum loss mainly concentrates on the left side of the graph. Under different strike prices, options also have different prices. Therefore, with the Monte-Carlo method, we simulated the price of these 4 options under 10000-time attempts, and the price changes are reflected in Figure 3.

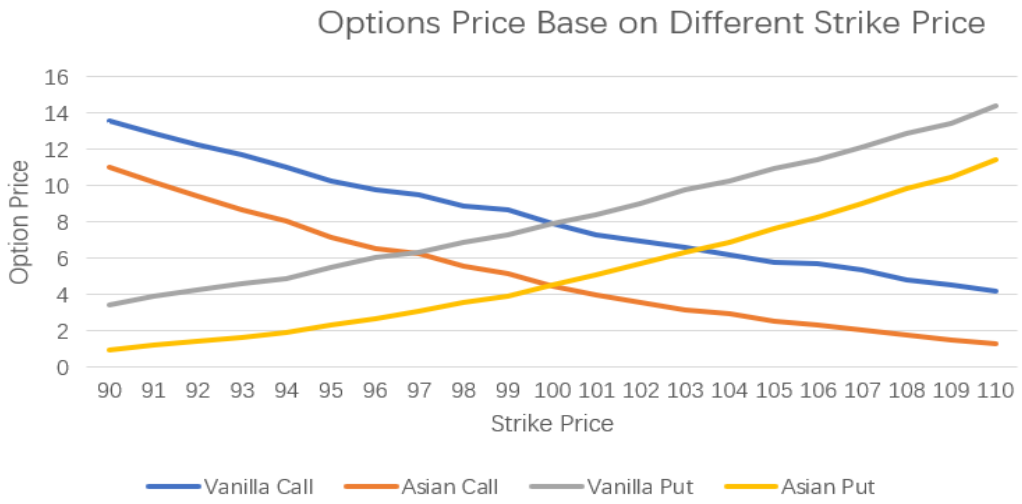

Figure 3. Option price as a function of strike price for Peloton.

3.4 Drawbacks and Limitations:

Despite Asian option possess advantages on lower risks, it also has some drawbacks on pricing. Specifically, one vital disadvantage of the Asian option is that the difficulty in computing price, i.e., it would be harder for investors to manipulate an average price over a period than single prices.

Moreover, the pricing and simulation models in this paper face some limitations. For both methods, a fixed sigma (standard deviation) is used of a stock based on historical data to price Asian options. Nevertheless, in the real world, the sigma changes with the stock price changes, macro economical events, etc. Thus, the fixed sigma makes the simulation inaccurate for the long term, i.e., it is necessary to change the sigma while the market goes on.

4. Conclusion

In summary, we apply both the Black-Scholes method and the Monte-Carlo method to price the Asian options and Vanilla options. Based on the analysis, the Asian options and Vanilla options' prices are evaluated for two high volatile stocks, Zoom and Peloton. We first apply the Black-Scholes method to Zoom's stock as well as Peloton's stock. According to the results, the prices are similar in both Asian options and Vanilla options, which indicates that the Black-Scholes method is not completely accurate to evaluate path-dependent options as it would cause numerical instability during calculation. The Monte-Carlo Method reflects that Asian options do have lower volatility with a lower expected return. Besides, it is a good choice for investors to avoid high-level risks under a highly volatile market. However, in specific cases, we use the pricing model differently. For example, the volatility is related to the whole market environment and the operation status of the company itself. As for the two cases mentioned above, although coronavirus has similar impacts on Zoom's stock and Peloton's stock, the two corporates take different financial actions in response to the effects. Therefore, in the specific case, one ought to estimate the duration and extent of a special event or market trend that will affect the company's stock price. Overall, this exotic pricing model will give the investors a lower-risk choice in a volatile market. These results offer a guideline for investors who plan on purchasing the Zoom or Peleton stocks.

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