**Statistical Analysis of $TSLA**

**(From IPO to 2/3/2020)**

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Introduction

Since the initial public offering (IPO) of Tesla, Inc. on the NASDAQ on June 29th 2010, $TSLA has not only been a controversial stock but also a major competitor for the legacy automakers in the United States. The opening price of the stock was $19 and as of the final adjusted closing price in the data set used for this analysis, Tesla’s stock price was $780 by the end of the trading day on February 3rd, 2020. For any investor that bought on the that first day and never sold, their investment would have accrued an unrealized gain of 4005% (. In the wake of Tesla’s historic rise, this statistical analysis was performed in an attempt to gain some insight on the viability and risk of $TSLA as well as to explore some potential test cases for investors.

Volatility Inferences

When analyzing the initial price offering of $19 per share and the last closing price of $780 from the dataset, one could infer that Tesla’s stock has been rather volatile with an overall upward trend. This seems to be true but deserves more investigation regarding just how volatile the stock has been. As discovered in Question 1, the average adjusted closing price for $TSLA from the IPO to February 3rd, 2020 was $186 with a standard deviation of $119 and a variance of $14,161. Considering that the standard deviation is roughly 64% of the mean, it is clear that $TSLA’s stock prices have been very spread out and often above the expected value. The variance is also rather high which indicates higher risk but a greater potential for return.

According to Question 2, the probability of Tesla’s adjusted closing price being positive on any given day is 49.7% while the probability of it being negative or unchanged is 50.3%. This data alone implies that Tesla might be more of a stable choice when purchasing stocks considering that it has roughly the same chance of being positive as being negative at the end of any given trading day. However, as explained from the results of Question 1, Tesla’s stock price has actually been very unpredictable.

Three-Day Scenario

To test the likelihood of Tesla generating a positive return over a short amount of time, some questions were answered regarding a period of three consecutive trading days. As seen in the results from Questions 3, 4, and 8, the probability of Tesla’s adjusted closing price being positive at least once over a three-day period is 87.25%. Using the data from these problems, Question 9 investigated what the expected number of positive trading days would be within the same period which came out to be 1.5 days. When looking at these results, an investor may be inclined to believe that buying $TSLA shares at some point within a three-day period would be an obvious choice that has a favorable probability of making profit. However, as many investors learn throughout their experience in the stock market, just because a stock has a good chance of being positive does not make it a good investment. For example, if Tesla shares were purchased and two of the three consecutive trading days returned a positive 1%, there is always a chance that the third day may return a negative 5%. However, if an investor simply looked at the 66% of the time that Tesla shares turned a “profit” in that time period and ignored the 33% of the time that shares fell below the investor’s average cost, they would definitely not be a successful trader. Not to mention, considering Tesla’s volatility, it would not be uncommon to see such an example.

December Performance

Over the decades of stock market data that has been recorded, there are some common trends that stocks tend to follow. For example, “…December has historically been the best month to own stocks. This lines up with a phenomenon known as the ‘Santa Claus Rally’” (Lu, 2022). To explore whether Tesla has performed better or worse during the month of December, Questions 5 and 6 aimed to find an answer to this. It was found that the probability that Tesla’s adjusted closing price will finish positive given that the trading day is in December is 48.3%. This was later proven again in Question 7 using Bayes’ Theorem. While it appears that $TSLA slightly underperforms in the month of December when comparing this result to the overall probability of the adjusted closing price being positive, the difference is not drastic enough to make any major claims.

Buying Regularly

Another test case that was analyzed was that of an investor purchasing shares of Tesla once a month over the course of a year. More specifically, Question 10 investigated the probability of at least six of the twelve days that $TSLA shares were purchased on having a positive adjusted closing price. It was found that there is a 60.5% chance of this occurring. While this is not a guarantee that an investor will be successful using this strategy, it shows that more than half of the days that the shares were purchased on will turn a profit over 60% of the time. This strategy is similar to the famous dollar cost averaging (DCA) approach that was coined by the famous investor Benjamin Graham. Considering the test cases observed up to this point, this has shown to be the most promising for investors that are looking to make successful trades.

Buying During a Short-Term Bull Run

When observing the last ten trading days in the data set (1/21/2020 – 2/3/2020), Tesla’s stock price rocketed from $530 up to $780. Question 12 took this into consideration and aimed to find the probability that an investor will have five positive trading days if they randomly bought the stock on any eight of those ten days. The results showed that this will happen with a probability of 46.7%. While some investors may take these odds, this is not necessarily a good option. As many investors have learned the hard way, it is endlessly impossible to “time” the market consistently and better results are often obtained from purchasing stocks and holding onto them over long periods of time. In this case, it would have been more beneficial for an investor to buy $TSLA at some point towards the beginning of the ten days and simply held onto their shares.

Safe Place for Cash?

Some investors enjoy taking more risk than others because of reasons such as age, amount of buying power, or simply just their personality. Other investors like to take a much safer approach. Considering this disparity, Question 11 explores whether or not buying shares of Tesla would be a good option for an investor who wants to place there money somewhere that will remain relatively unchanged. The probability that Tesla’s adjusted closing price will remain unchanged at the end of just one trading day was found to be 0.2%. Over the course of more trading days, this probability declines drops even lower. While this test case may seem trivial, it was performed to support the earlier claim of Tesla having a high volatility and to highlight other options for investors who prefer lower risk securities. For example, someone who would like to retain the value of their money as it is can simply leave their cash in a checking account (this would technically result in a loss because of inflation). In the case that they would like to gain a steady return on an investment, savings accounts, bonds, or certificates of deposit are much more appropriate methods of investing.

Get Rich Quick

For the investors that are focused on earning money quickly, there may be some opportunities through investing in Tesla. For the sake of this test case, it was assumed that an investor would be looking for a short-term return of 10% on their investment. Question 13 explores this idea by determining the probability of having one trading day with a 10% return or greater over the course of one year given that the average number of trading days with at least this high of a return is 1.2 per year for $TSLA. The results demonstrated that there is a 36% chance of this happening. This indicates that there is a 36% chance of this even occurring in one year in which an investor would have to find a way to select that exact trading day to purchase shares of Tesla. While there are other ways of investing to achieve such a goal, this test case showed that it is unlikely for an investor to earn large returns in a short amount of time and the average person should aim to make safer, more consistent investments.

Stock Options

While still considering investors that prefer taking more risk, there is a form of investing known as “stock options” that allow an investor to essentially bet whether a stock will rise or fall within a certain time-period as well as guess what price it might be by a specific date. Question 14 explored the probability that given the expected adjusted closing price of $TSLA being $186 with a standard deviation of $119, the stock price will fall between $400 and $600. The results showed that there is a 68.8% chance of this occurring. For investors that bet on the stock price of Tesla being in that range, they might be inclined to stand by their choice. However, the 68.8% probability indicates the chance that the price of Tesla will fall in that range upon observation of the nearly ten years of data used for this analysis. While investors buying stock options could potentially use calculations like this to make inferences, they would be betting on a future price of Tesla’s stock. As mentioned before, it is nearly impossible to make accurate predictions of stock prices, especially in the short to medium-term future.

Conclusions

After various test cases were explored and empirical data was observed regarding Tesla’s stock price over a nearly ten-year period, there were some valuable lessons learned that have immediate applications to the current stock market. For example, it was obvious that $TSLA’s volatility and risk was high but it was concluded that the potential return for investors was substantial. Some of the takeaways from this study include the fact that trying to predict stock performance is very difficult and that investors typically benefit more from historically valid methods of investing such as dollar cost averaging. Additionally, it was concluded that the opportunity for short-term large returns on investments is unlikely and the average investor who may not be very experienced should not try their luck with timing the market through strategies such as stock options. Following this analysis, it may seem as though buying shares of $TSLA is not a favorable investment. However, for those investors who bought in around the time of the initial public offering, their investments have generated massive returns. Therefore, it seems responsible to buy shares of Tesla using money that one can afford to lose with the plan of holding onto the shares for years.

Research Questions and Solutions

**Question 1:**

What is the expected value, standard deviation, and variance of Tesla’s adjusted closing price from the IPO on June 29th, 2010 to February 3rd, 2020?

* Note: Calculations were completed through Excel since there were over 2400 data points

**Question 2:**

Find the probability that Tesla’s adjusted closing price finishes positive, negative, unchanged, as well as negative or unchanged.

**Question 3**:

Assuming that Tesla’s adjusted closing price finishes either positive or not positive (negative or unchanged), list the discrete sample space for any three trading days.

* Since the possible outcomes for one day is either positive or not positive and there are three trading days, the *mn* rule states there are,
* Let p = positive and n = negative/unchanged

**Question 4**:

Using the discrete sample space for three trading days, find the probability that the adjusted closing price will finished positive at least once out of the three trading days.

* As found earlier,
* Let

**Question 5**:

From the IPO on June 29th, 2010 to February 3rd, 2020, what is the probability that Tesla’s adjusted closing price will finish positive given that the trading day is in December?

* Let
* As found earlier,

**Question 6**:

Are the probabilities of Tesla’s adjusted closing price finishing positive and a trading day being in December independent?

* If , then A and B are independent
* As found earlier,

**Question 7**:

Prove the answer to Question 5 using Bayes’ Rule.

* Bayes’ Rule states that,
* As found earlier,

**Question 8**:

Using the discrete sample space for three trading days, find the probability distribution for Y. Let Y denote the number of days that Tesla’s adjusted closing price was positive.

**Question 9**:

Using the probability distribution from Question 8, find the expected number of days that Tesla’s adjusted closing price was positive.

**Question 10**:

What is the probability that if shares of Tesla are bought once a month for one year that out of the 12 days that the shares were bought on, at least 6 of them will have a positive adjusted closing price?

* Let

**Question 11**:

What is the probability that Tesla’s adjusted closing price will remain unchanged at the end of one trading day?

**Question 12**:

Out of the last 10 trading days (1/21/20 – 2/3/20), there were 7 days where Tesla’s adjusted closing price ended positive. If an investor randomly buys the stock on 8 of the 10 days, what is the probability that they will have 5 positive trading days?

**Question 13**:

If the average number of trading days with at least a 10% rate of return is 1.2 per year for Tesla, what is the probability of having one trading day with a 10% return or greater over the course of one year?

**Question 14**:

Given that the average adjusted closing price for Tesla’s stock is $186 with a standard deviation of $119, what is the probability that the stock price will be between $400 and $600?

Work Cited

Marcus Lu. (2022, May 30). *The best months for stock market gains*. Visual Capitalist. Retrieved May 4, 2023, from https://www.visualcapitalist.com/the-best-months-for-stock-market-gains/