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Analysing the stock price of Tata motors and exploring variations in the VWAP value using logistic regression and other statistical measures

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Abstract
Stock market trading is the art of choosing the right stocks based on the analysis of different parameters of the stocks. The risk involved in the price of the stock affects the expected return of the investors. The more the risk, the more the expected return. Before investing your money in a stock, it has become important to analyse the risk or uncertainty of the same stock. The prediction of stock prices is a complex and challenging endeavour due the ever changing nature of the stock market. Various factors can impact the value of a stock. Logistic regression is a valuable tool that allows us to analyse and evaluate stock price trends. In this study, logistic regression will be utilised to explore the correlation between the three month Volume Weighted Average Price (VWAP) of Tata Motors Corporation and the likelihood of its stock either outperforming or underperforming in the market.

Keywords: Tata motors and exploring variations, volume weighted average price, statistical measures

Introduction

The Volume Weighted Average Price (VWAP) serves as a widely recognized indicator in financial markets. It offers a reliable means to assess the average price at which a stock has been traded during a specific time period. By considering both transaction price and volume, VWAP accurately reflects the stock's average trading price. Logistic regression is utilised in this study to analyse statistical measures and comprehend their contribution to specific portfolio objectives. For instance, by employing logistic regression, we can assess how factors like the mean and standard deviation of the stock price, skewness, kurtosis, and JB test results, influence the likelihood of achieving consistent returns or outperforming a benchmark while minimising risk. This analysis provides valuable insights into the drivers of portfolio performance and aids in making well informed investment decisions.

The mean of the stock price provides insight into the average directional movement of a stock's price over a specific period. Skewness, on the other hand, helps investors assess the distribution of price changes and understand the likelihood of extreme events and associated risks. Additionally, kurtosis quantifies the presence of extreme value in price changes, offering crucial information for evaluating risk and potential volatility in stocks. Various statistical measures were explored through examining the daily VWAP values collected for Tata Motors' stock. This data provided insights into the behaviour of the stock's price and potential outcomes. There is a relative scarcity of research on the application of statistical measures to individual stock analysis, as much of the existing literature focuses on broader market analysis or portfolio level assessments. Exploring the implications and usefulness of these measures at the individual stock level could be valuable.

Starting with a discussion of the formulas and statistical concepts, the study examines the tools used for analysis. The findings of this research offer valuable insights into the dynamics of Tata Motors' stock price and highlight the usefulness of understanding these statistical measures in predicting price movements and assessing risk.

Discussion

Firstly, sample mean, which represents the average value of the stock's VWAP over the three-month period is calculated.

Sample mean is used instead of population mean to better understand. The sample mean is computed using the

Formula: $\frac{(Sum\ of\ all\ values)}{(Number\ of\ values-1)}$

The standard deviation (SD) formula is a statistical tool that calculates the square root of the average squared differences between each data point and the mean. By squaring these differences, it makes sure that both positive and negative deviations from the mean are considered.

The formula: $\sqrt{\frac{\Sigma \quad (x-\bar{x})^2}{(n-1)}}$

Where,

- x represents each individual data point in the sample
- x̄ is the sample mean (average)
- Σ denotes the summation, meaning you need to add up the squared differences for each data point
- n is the number of data points in the sample

This formula helps us measure the extent of variation or dispersion within a dataset. To find this in terms of percent change the change in price of VWAP values is taken and the final value is multiplied by 100.

Skewness: We explored the skewness of Tata Motors' stock price changes to understand the asymmetry of the distribution. Skewness is a measure of the lack of symmetry in the data distribution and the equation for skewness is defined as:

Skewness = $\frac{n}{(n-1)(n-2)}\Sigma \quad (\frac{xi-\bar{x}}{s})^3$

- xi = ith Random Variable
- $\bar{x}$ *is the sample mean*
- s is the sample standard deviation

A positive skewness value indicates a longer right tail in the distribution, suggesting a higher probability of occasional large positive price movements. Conversely, a negative skewness value implies a longer left tail and a higher likelihood of large negative price movements.

Kurtosis measures the presence of extreme values or heavy tails in the distribution of Tata Motors' stock price changes. A higher kurtosis value indicates a distribution with heavier tails and more frequent occurrences of extreme price movements. The kurtosis is computed using the following formula:

Kurtosis: $\frac{n(n+1)}{(n-1)(n-2)(n-3)}\Sigma \quad (\frac{xi-\bar{x}}{s})^4 \ \frac{3(n-1)^2}{(n-2)(n-3)}$

- xi = ith Random Variable
- $\bar{x}$ *is the sample mean*
- s is the sample standard deviation

JarqueBera (JB) Test: To further assess the normality assumption in the distribution of Tata Motors' stock price changes, we conducted the JB test. This test is based on the skewness and kurtosis measures and evaluates whether the data follows a normal distribution.

Result

The mean serves as a measure of central tendency, indicating the average value within a dataset. In this scenario, a mean of 480 suggests that, on average, the data points cluster around 480. The percent of standard deviation of 2.416 for the given VWAP data indicates the dispersion of prices around the mean and provides information about the price volatility during the 3 month time frame.

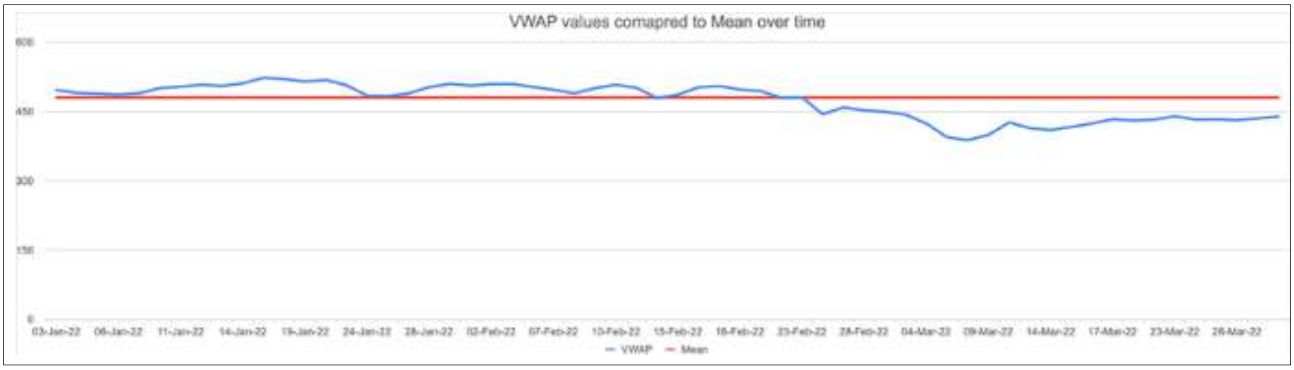

Fig 1: A line chart comparing VWAP values to Mean over time. The x-axis represents dates from January 3rd, 2022 to March 28th, 2022, and the y-axis represents VWAP and Mean values

The dataset's tails are relatively lighter compared to a normal distribution, indicated by a kurtosis of 1. This lower probability of extreme values in the tails means that outliers or significantly distant observations from the mean are less likely to occur. The dataset also exhibits a relatively more peaked distribution. For example, the stock prices of Tata Motors over a 3month period demonstrate a kurtosis of 1, suggesting that the prices are stable with a reduced likelihood of extremely high or low returns close to the mean. The impact of the skewness measure on extreme price events was found to be significant. In this case, a skewness of 0.6 was observed, indicating an asymmetry in the distribution. Specifically, the left tail of the distribution is longer or more pronounced than the right tail. This slight left skewed distribution suggests that there is a tendency for the dataset to have lower values compared to higher values.

The JarqueBera test examines whether a dataset follows a normal distribution by considering its skewness and kurtosis. The null hypothesis of the JB test assumes normal distribution, while the alternative hypothesis suggests otherwise. The JB test results indicated that the distribution of stock prices' VWAP values deviated from normality. A significant p-value suggested that there were departures from the assumption of a normally distributed variable.

Conclusion

Suggested by a kurtosis of 1, the stock prices of a company over three months showed a distribution with lighter tails and fewer outliers than a normal distribution. The market could view a company with this kurtosis as more stable, indicating a decreased risk of sudden and extreme price movements. This positive perception implies a relatively predictable and less volatile investment option. Due to varying risk preferences, different investors actively seek investments with greater potential for returns, even if they come with higher volatility. Thus, an investor's interpretation of kurtosis should be in line with their own risk tolerance and investment goals. Although, it is important to understand that a kurtosis of 1 doesn't automatically mean it's a great investment opportunity. Considering other factors before thorough analysis is important.

Secondly, the skewness measure demonstrated a significant impact on the likelihood of extreme price events. This measure determines the distribution's asymmetry. The left tail of the distribution is longer or more pronounced when the skewness value is negative. A slightly left skewed distribution, indicated by a skewness of 0.6, implies that the dataset tends to have lower values than higher values. As a result, the probability of low returns is greater than that of high returns.

When the standard deviation is smaller, it suggests that the data points are closer to the mean. This indicates less variability and a denser spread of values. On the other hand, when there is a higher standard deviation, price volatility and risk increase. This signifies greater variability and dispersion in the data. Consequently, with a lower standard deviation, the risk decreases. A standard deviation of change in price of 2.416 shows moderate volatility and price movements in the stock price.

Furthermore, the JB test results provided evidence of departures from normality in the distribution of stock prices' VWAP values. A significant p-value indicated deviations from the assumption of a normally distributed variable. It is integral to understand that a p-value of 0.04, while indicating statistical significance, does not ensure profitability or successful trading strategies. It simply implies that the stock prices display some deviation from an efficient market, which could potentially result in exploitable opportunities. This finding could catch the eye of market participants such as traders, institutional investors, and analysts. It suggests that the stock prices of the analysed company have characteristics that stray from the idea of an efficient market, with a p-value of 0.04 from a market perspective. Over a period of three months, the analysis of stock prices for a company reveals a significant p-value of 0.04. This holds importance not only for the wider market, but also for the average investor. Therefore, based on the p-value of 0.04, we can infer that the dataset is statistically significantly different from a normal distribution. It suggests that the data deviates from a perfect bell shaped curve and has some no-normal characteristics.

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