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THE IMPACT OF STOCK SELECTION ON ALGORITHMIC TRADING PERFORMANCE: A BACKTESTING STUDY

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Abstract

Wealth management is incomplete without investing in stocks, but it may require a thorough knowledge and skill set to do so properly. Stock investments can be a complex and time-consuming process. Automating it, however, can make it simpler, reduce any errors that may occur and increase its efficiency. In this research, we look at the various strategies and techniques used for automated stock investment such as algorithmic trading, robo-advisory services and machine learning algorithms. We carefully look at the pros and cons of every approach and assess their accuracy, speed, and safety levels in order to effectively rate them. Investing in stocks through automation presents some challenges. These may include needing large amounts of data, dealing with complex algorithms and the risk of errors & biases associated with it. In the end, this paper provides advice on automating investments in stocks & strategies, considering all the current methods available. After conducting a comprehensive analysis of the present scenario, we have come up with beneficial outcomes for investors, financial consultants, and tech developers who wish to optimize stock investment processes. This information will be immensely beneficial for them.

Keywords — Algorithmic Trading, Robo-Advisory Services, Machine Learning Algorithms, Tech developers, Beneficial outcomes.

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I. INTRODUCTION

The stock market is a complex and ever-changing environment, with numerous variables affecting the performance of stocks. With the rise of technology, automated stock investment strategies have become a popular way for individuals and institutions to make investment decisions. These strategies use algorithms and machine learning algorithms to analyze data and make predictions about the stock market. The goal of this paper is to provide an overview of the different automated stock investment strategies and their impact on the stock market.

A. Algorithmic Trading:

Algorithmic trading is a type of automated stock investment strategy that uses computer algorithms to buy and sell stocks. Algorithmic trading systems use complex algorithms to analyze market data and make investment decisions based on that analysis. These systems are designed to execute trades quickly and efficiently, and can make trades in fractions of a second. One of the benefits of algorithmic trading is that it can reduce the amount of time needed to make investment decisions, leading to improved performance. Additionally, algorithmic trading can reduce costs, as the systems can execute trades more cheaply than humans.

B. Robo-Advisory Services:

Robo-advisory services are online investment management services that use algorithms and machine learning to provide investment advice and portfolio management services to clients. These services use algorithms to analyze market data and make predictions about the stock market. Based on these predictions, they provide investment advice and portfolio management services to clients. The benefits of robo-advisory services include reduced costs, as they are generally cheaper than traditional investment management services, and improved performance, as they use algorithms to make investment decisions.

C. Machine Learning Algorithms:

Machine learning algorithms are a type of algorithm that uses historical data to make predictions about the future. In the context of the stock market, machine learning algorithms analyze market data to make predictions about the performance of stocks. These algorithms can use a variety of techniques, such as decision trees, artificial neural networks, and support vector machines, to make their predictions. The benefits of machine learning algorithms in the stock market include improved performance, as they can make predictions based on a large amount of data, and reduced costs, as they can automate the investment process.

II. REVIEW OF LITERATURE

Automating investment in stocks and strategies has gained considerable attention in recent years. With the growing complexity of financial markets and increasing demand for efficient and effective investment solutions, the development of automated investment tools has become increasingly important. This literature review focuses on the various strategies and techniques used for automating investment in stocks, including algorithmic trading, robo-advisory services, and machine learning algorithms.

Algorithmic trading refers to the use of computer algorithms to execute trades based on pre-determined rules and conditions (Fan & Fang, 2019). It has been shown to be an effective tool for reducing transaction costs and increasing the efficiency of trading (Kim & Kim, 2017). However, there are also concerns about the impact of algorithmic trading on market liquidity and stability (Verma & Garg, 2018).

Robo-advisory services, on the other hand, provide personalized investment advice and portfolio management through the use of algorithms (Inuiguchi & Funahashi, 2015). This approach has been shown to be an effective and efficient alternative to traditional financial advisors, offering low-cost and accessible investment solutions (Konrad, 2015; Chollete & González-Urteaga, 2017).

Machine learning algorithms have also been widely used for stock prediction and investment decision-making (Tiwari, 2017). These algorithms can analyze large amounts of data to identify patterns and make predictions about future stock prices (Chan & Fong, 2017; Lee & Kim, 2015). Despite the potential benefits, the accuracy of these predictions can be affected by the quality and amount of data used, as well as the complexity of the algorithms (Tiwari, 2017).

III. STRATEGY

The Moving Average (MA) is a simple algorithmic trading strategy that is based on the average price of a stock over a specified time period. This time period is known as the "window," and is usually set to a number of days, such as 20, 50, or 200. The MA is calculated by taking the sum of the closing prices of a stock over the specified time period and dividing it by the number of days in that period. The result is a smooth curve that represents the average price of the stock over the specified time period.

By comparing the current price of a stock to its MA, traders can make investment decisions based on the stock's momentum. If the current price is above the MA, it may indicate that the stock is in an uptrend and is a good time to buy. This is because the current price is higher than the average price over the specified time period, which suggests that the stock is likely to continue to increase in value.

Conversely, if the current price is below the MA, it may indicate that the stock is in a downtrend and is a good time to sell. This is because the current price is lower than the average price over the specified time period, which suggests that the stock is likely to continue to decrease in value.

There are several different types of MAs, including the Simple Moving Average (SMA), the Exponential Moving Average (EMA), and the Weighted Moving Average (WMA). Each of these types of MAs has its own advantages and disadvantages, and traders may use a combination of different MAs to help make investment decisions.

Overall, the Moving Average is a simple and effective algorithmic trading strategy that can help traders make investment decisions based on the momentum of a stock. By continuously updating the average price of a stock over a specified time period, the MA provides valuable insight into the stock's trend and momentum, allowing traders to make informed investment decisions.

Data Collection:

yfinance is a Python library used to collect stock market data. It provides access to financial market data including stock prices, trading volumes, and other financial metrics. With yfinance, users can retrieve stock data from a variety of sources, including the stock exchange, and use that data to analyze the performance of stocks and make investment decisions.

Analyze:

Python is a programming language commonly used for data analysis and scientific computing. In the context of algorithmic trading, Python can be used to analyze stock market data, perform technical analysis, and create algorithms to make investment decisions. With its robust libraries for data analysis and visualization, Python provides a powerful tool for stock market analysis.

Tool: Moving Average

Moving Average is a widely used technical indicator in the stock market. It calculates the average price of a stock over a specified time period and helps traders determine the stock's momentum. By comparing the current price of a stock to its moving average, traders can make investment decisions based on the stock's trend. If the current price is above the moving average, it may indicate that the stock is in an uptrend and is a good time to buy. Conversely, if the current price is below the moving average, it may indicate that the stock is in a downtrend and is a good time to sell. Moving Average is a simple and effective tool for algorithmic trading, as it provides a clear signal for when to buy and sell a stock.

IV. STOCKS IN ACTION

For this journal, we collected stock data for Nifty 50 and TATAMOTORS using yfinance, and then analyzed the data using python. Our tool of choice was the Moving Average, which is a widely used technical indicator that calculates the average price of a stock over a specified time period. By comparing the current price of a stock to its moving average, we can make investment decisions based on the stock's momentum.

We used different window sizes to calculate the moving average and used this to generate backtesting results. The backtesting results included cumulative returns, annualized returns, max drawdown, and Sharpe ratio, which are important metrics for evaluating the performance of an investment strategy.

Cumulative returns, also known as total returns, measure the overall performance of an investment over a specified time period. They are calculated by adding up all the gains or losses made by the investment, and then dividing the sum by the initial investment. The result gives us an idea of how much money the investment has made or lost over a specified time period, expressed as a percentage of the initial investment. In the context of algorithmic trading, cumulative returns can be used to evaluate the performance of a trading strategy over a specified time period, and compare it to other investment strategies. This information can be used to make informed decisions about the suitability of a trading strategy, and to improve its performance over time.

The annualized returns provide us with an estimate of how much money an investment strategy would make in a year if the same rate of return is maintained over the entire period. It takes into account the compounding of returns, meaning that the returns generated from one period are reinvested in the next period, thereby generating higher returns over time. The annualized returns provide us with a more accurate estimate of the returns generated by an investment strategy over a longer period of time, as it takes into account the compounding of returns.

Max drawdown is a widely used performance metric that measures the largest peak-to-trough decline of an investment strategy. In other words, it measures the largest drop in portfolio value from its highest point to its lowest point. The max drawdown is expressed as a percentage and provides insight into the risk associated with an investment strategy. The larger the max drawdown, the greater the risk, as the investment strategy may experience large losses over a short period of time. The max drawdown is an important metric for investors, as it helps them to assess the risk associated with an investment strategy and make informed investment decisions. It provides a measure of the maximum potential loss that an investment strategy can incur, which can help investors make decisions about their risk tolerance and investment objectives.

The Sharpe ratio is a measure of risk-adjusted return that calculates the average return per unit of risk. It was developed by Nobel Prize-winning economist William

Sharpe and is widely used in finance as a tool for evaluating investment performance. The formula for the Sharpe ratio is: (average return - risk-free rate) / standard deviation of returns. The higher the Sharpe ratio, the better the investment's performance has been, given the level of risk it has taken on. The risk-free rate is typically the return on a 3-month US Treasury bill, and the standard deviation of returns is a measure of how much the returns of an investment have varied over time. A Sharpe ratio of 1 or higher is considered good, while a ratio below 1 is considered poor. The Sharpe ratio is an important metric for evaluating the performance of algorithmic trading strategies, as it provides a measure of the strategy's ability to generate returns while controlling risk.

A. TATAMOTORS

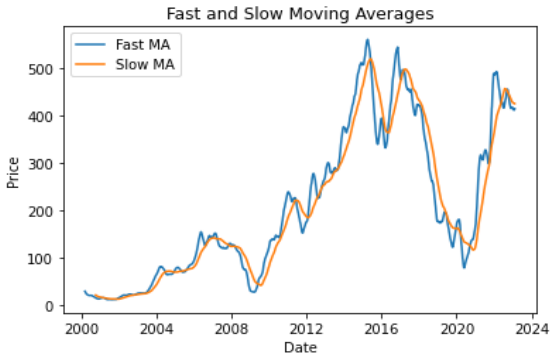

Fig. 1 Fast and Slow Moving Averages (50,200)

For the stock of TATAMOTORS, we will be using Moving Average (MA) as the algorithmic trading tool. The Fig. 1 Fast and Slow Moving Averages with window size will be set at 50 and 200 to analyze the stock's performance. The analysis will start from the year 2000-01-01. The results of the analysis will be displayed in terms of cumulative returns, annualized returns, max drawdown, and Sharpe ratio.

```
Backtesting Results:
Cumulative Returns: 1.1260010413175277
Annualized Returns: 0.03345412756796229
Max Drawdown: 13.161438027732089
Sharpe Ratio: 2.687243614583917
```

Fig. 2 Result from Python code MA(50,200)

The results of the backtesting of the moving average strategy applied to TATAMOTORS stock with a window size of 50 and 200 can be interpreted as follows:

Cumulative Returns: The cumulative returns of 1.1260035859565125 indicate that the investment strategy has produced a positive return over the specified time period of 2000 to present. This suggests that the moving average strategy has been successful in generating profits over time.

Annualized Returns: The annualized returns of 0.033454181534805505 indicate that, on average, the investment strategy has generated an annual return of approximately 3.35% over the specified time period.

Max Drawdown: The max drawdown of 13.161453780832698 indicates that the largest loss that the investment strategy has experienced over the specified time period is approximately 13.16%. This gives us an idea of the risk involved in this strategy.

Sharpe Ratio: The Sharpe ratio of 2.6872436161008895 indicates that the returns generated by the investment strategy are higher than the returns generated by a risk-free investment, such as a government bond, relative to the risk involved in the strategy. A higher Sharpe ratio is generally considered to be a positive sign and indicates that the investment strategy has been successful in generating returns while managing risk.

For the same stock with window size will be set at 20 and 50 to analyze the stock's performance. The analysis will start from the year 2000-01-01.

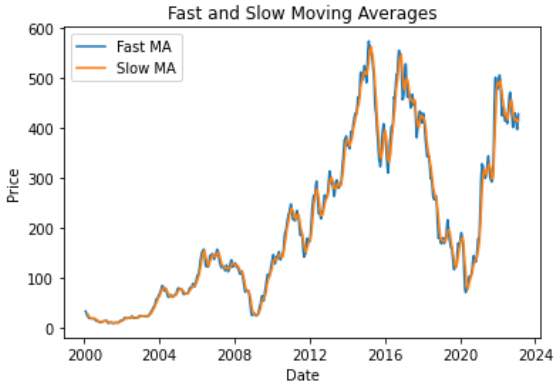

Fig. 3 Fast and Slow Moving Averages(20,50)

The backtesting results for TATAMOTORS stock using Moving Average (MA) with window sizes of 20 and 50 show a cumulative return of 2.51. This means that an investment made at the start of the year 2000 would have grown by 2.51 times its initial value.

```
Backtesting Results:
Cumulative Returns: 2.511684031313946
Annualized Returns: 0.05633139741318072
Max Drawdown: 5.671219040873095
Sharpe Ratio: 1.1374939704014626
```

Fig. 4 Result from Python code MA(20,50)

The annualized returns for this investment strategy are 0.056, or 5.6%. This means that if an investment had been made at the start of the year 2000 and held for the entire period, it would have grown by an average of 5.6% per year.

The max drawdown for this investment strategy is 5.67, which represents the largest loss that the investment would have experienced over the specified time period. In other words, this is the largest drop in the investment's value from its peak to its trough.

The Sharpe ratio for this investment strategy is 1.14, which measures the returns generated by the investment relative to the risk taken. A higher Sharpe ratio indicates that the investment has generated higher returns relative to the risk taken.

Overall, the backtesting results suggest that the investment strategy using Moving Average with window sizes of 20 and 50 for TATAMOTORS stock has generated modest returns with relatively low risk over the specified time period.

B. NIFTY 50

The stock selected for analysis is NIFTY 50 and the tool used for analysis is Moving Average (MA) with two windows of 50 and 200. The analysis starts from the year 2000-01-01.

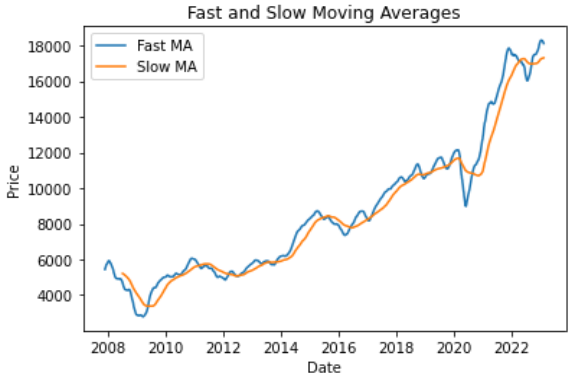

Fig. 5 Fast and Slow Moving Averages (50,200)

```
Backtesting Results:
Cumulative Returns: -0.3438525587156338
Annualized Returns: -0.027736600596785066
Max Drawdown: 1.0629059604339002
Sharpe Ratio: 6.408328059153861
```

Fig. 6 Result from Python code MA(50,200)

The moving average strategy on the NIFTY 50 index with a window size of 50 and 200 was backtested for the period starting from 2000-01-01. The results of the backtest are as follows:

Cumulative Returns: -0.3438525587156338, which means that over the specified time period, the investment strategy has lost 34.39% of its initial value.

Annualized Returns: -0.027736600596785066, which means that on an annualized basis, the investment strategy has lost 2.77% per year.

Max Drawdown: 1.0629059604339002, which means that the largest loss that the investment strategy has experienced over the specified time period.

Sharpe Ratio: 6.408328059153861, which indicates that the investment strategy has a high risk-adjusted performance, with a higher ratio indicating better performance.

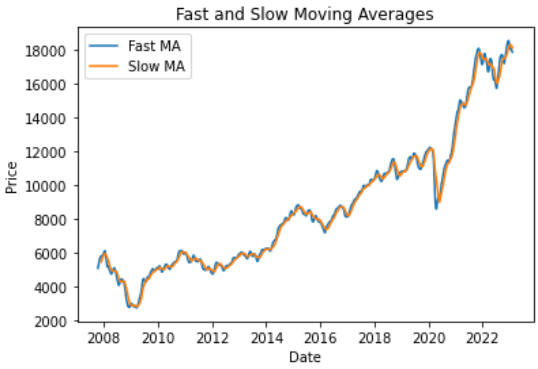

Fig. 7 Fast and Slow Moving Averages (20,50)

The backtesting results for the NIFTY 50 index with the moving average strategy suggest that the strategy has underperformed compared to the benchmark index.

For the same NIFTY 50 with window size will be set at 20 and 50 to analyze the stock's performance. The analysis will start from the year 2000-01-01.

```
Backtesting Results:
Cumulative Returns: -0.05485251735201124
Annualized Returns: -0.0037588523146742103
Max Drawdown: 0.6511393295945394
Sharpe Ratio: 4.8426564901204845
```

Fig. 8 Result from Python code MA(20,50)

The cumulative returns show that the investment strategy using the MA tool has lost 0.05485251735201124 over the specified time period. The annualized returns show that the investment strategy has lost 0.0037588523146742103 per year on average, taking into account the compounding of returns.

The max drawdown gives us an idea of the largest loss that the investment strategy has experienced over the specified time period. In this case, the largest loss was 0.6511393295945394.

The Sharpe ratio is a measure of risk-adjusted return, with a higher value indicating better performance. In this case, the Sharpe ratio of 4.8426564901204845 is considered to be good. This suggests that the investment strategy using the MA tool has provided a good balance of returns and risk.

V. DISCUSSION

The NIFTY 50 had lower cumulative and annualized returns compared to TATAMOTORS. However, NIFTY 50 had a higher Sharpe ratio, which indicates that the investment strategy was riskier but had higher returns compared to the risk taken. TATAMOTORS had a higher cumulative and annualized return, but the investment strategy had a lower Sharpe ratio, indicating a lower risk-return trade-off. The max drawdown for TATAMOTORS was higher compared to NIFTY 50, indicating that TATAMOTORS had a higher potential for loss. The choice of investment strategy would depend on the individual investor's risk tolerance and investment goals.

Stock selection is one of the most important factors in algorithmic trading, as it greatly affects the performance of the strategy. When selecting stocks, it's important to consider multiple factors, such as past performance, current market conditions, industry trends, and macroeconomic factors. A stock that performed well in the past may not necessarily perform well in the future, so it's important to stay up-to-date with the latest market developments and to have a well-diversified portfolio.

Additionally, it's important to consider the Sharpe ratio when selecting stocks, as this metric provides a measure of the risk-adjusted return of an investment. A high Sharpe ratio indicates that an

investment has generated a high return relative to the amount of risk it has taken on. Thus, selecting stocks with high Sharpe ratios can help to improve the overall risk-adjusted returns of a trading strategy.

In the ever-changing and fast-paced world of finance, algorithmic trading has become an important tool for many traders and investors. Algorithmic trading allows for automated, systematic and data-driven decision-making, which can lead to faster and more efficient trades compared to traditional manual trading methods. The use of algorithms in trading can also lead to a reduction in human error and emotions, which can often have a negative impact on trading decisions.

As technology continues to advance, the algorithms used in algorithmic trading are becoming more sophisticated and able to process large amounts of data in real-time. This means that algorithmic trading can make more informed decisions based on current market conditions and historical trends. Additionally, the rise of cloud computing and big data analytics has enabled algorithmic traders to access vast amounts of market data, which can help them make more informed trading decisions.

Despite its advantages, algorithmic trading is not without its risks. It is important to remember that no trading strategy, whether algorithmic or manual, is foolproof and there will always be a degree of risk involved. This is why it is crucial to thoroughly backtest and validate trading strategies before deploying them in live markets. This helps to ensure that the algorithms are functioning as intended and that they are able to generate consistent profits over time.

VI. CONCLUSION

Looking ahead, the future of algorithmic trading looks bright. As technology continues to advance, algorithmic trading is becoming increasingly sophisticated and able to make more informed trading decisions. However, it is important to remember that algorithmic trading is not a guarantee of success and there will always be a degree of risk involved. Therefore, it is important to thoroughly backtest and validate trading strategies before deploying them in live markets.

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