Evaluating Coca-Cola's Long-Term Investment Performance with Monte Carlo Simulation

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1. Introduction

This research focuses on evaluating a long-term investment strategy using Coca-Cola stock as the primary asset. The goal is to understand how a stable, dividend-paying company performs across different market conditions through data-driven simulation. The study aims to capture both growth potential and downside risks over time by using a Monte Carlo approach. The results will help identify how such a buy and hold strategy can generate consistent returns even during periods of economic uncertainty. The intended users of this research include individual investors, financial analysts, and portfolio managers who seek to apply quantitative tools in assessing investment performance. The final outcome of this research will serve as part of a larger effort to develop an automated framework that uses historical data to estimate future return distributions for long-term portfolio planning.

2. Literature review

Scholars have long examined how market behavior and investor psychology influence asset prices and trading performance. One of the most influential works in this area is by Jegadeesh, N., & Titman, S. (1993), who studied momentum and reversal effects in U.S. stock markets. They discovered that portfolios built by buying stocks with high recent returns and selling those with poor recent returns generated significant positive returns over short and medium horizons. This finding challenged the traditional efficient market hypothesis, which assumes that prices always reflect all available information. Jegadeesh and Titman also observed that the momentum effect tends to weaken or reverse after a year, suggesting that stock prices often move in cycles driven by investor overreaction and correction. Their research became a

cornerstone for modern quantitative investment strategies, influencing both academic studies and institutional portfolio construction.

In contrast to momentum-based strategies, (López de Prado, 2018) focused on the methodological foundation of quantitative finance and addressed the weaknesses of traditional backtesting. He argued that most backtests overfit past data and fail to capture the uncertainty inherent in financial markets. To overcome these limitations, he introduced advanced statistical tools and Monte Carlo simulations that allow analysts to test strategies across thousands of synthetic market scenarios. His work emphasized that financial data often display non-normal distributions, heavy tails, and structural breaks that simple linear models cannot explain. By using stochastic simulations, investors can assess the full range of possible outcomes and better estimate risk-adjusted performance.

Together, these studies demonstrate the evolution of financial research from static, backward-looking models toward probabilistic and simulation-based frameworks. Jegadeesh, N., & Titman, S. (1993) showed that markets contain behavioral inefficiencies that create short-term opportunities, while (López de Prado, 2018) provided a modern approach for evaluating those opportunities under uncertainty. These insights guide the current study's approach to using Monte Carlo simulation as a tool to model Coca-Cola's performance under varying market conditions and to account for randomness in long-term investment evaluation.

3. Research Design and Modeling Method(s)

This study uses historical market data to evaluate the performance of Coca-Cola (KO) through a Monte Carlo simulation framework. The data are obtained from Yahoo Finance using the Python package yfinance, which provides free access to daily adjusted closing prices and

dividends. The selected time period spans from 1999 to 2024 to capture multiple economic cycles, including both bull and bear markets. This range allows the analysis to reflect realistic market volatility and long-term performance trends. The selected time frame also includes major downturns such as the dot-com crash (2001–2002), the subprime mortgage crisis (2007–2008), the European debt crisis (2009–2014), and the COVID-19 pandemic (2019–2021), ensuring that at least one crash period is represented in the data.

Daily log returns are calculated using the natural logarithm of consecutive price ratios, multiplied by 100 for scaling. This method standardizes returns and makes them comparable across time. The log return formula is expressed as $r_t = 100 \times \ln (P_t / P_{t-1})$ where P_t represents the adjusted closing price at time t. Using log returns ensures that compounding effects are properly accounted for when aggregating returns over long periods.

After computing the historical return series, a Monte Carlo simulation is applied to generate a large number of possible future return paths. Each simulated path assumes returns follow a normal distribution characterized by the historical mean and standard deviation. For this analysis, ten thousand random paths are generated to model a 25-year investment horizon. Each path represents a possible evolution of Coca-Cola's stock price, assuming reinvestment of dividends and no transaction costs.

The performance of each simulated scenario is evaluated using statistical metrics such as expected annual return, volatility, and Sharpe ratio. The results are also compared with the historical performance of the S&P 500 index to estimate alpha and beta values, which measure relative performance and systematic risk. To incorporate practical investment conditions, the simulation also considers management and trading fees. Brokerage trading fees are assumed to be negligible under the buy and hold strategy, while annual management fees are modeled

between one and two percent of the total portfolio value. These fees are deducted from simulated returns to estimate net investor performance and provide a more realistic assessment of the investment's profitability.

This approach follows the recommendation by (López de Prado, 2018) to use stochastic simulation instead of static backtesting, as it captures uncertainty and reflects a broader range of market conditions. The Monte Carlo method provides an intuitive yet powerful framework for visualizing the variability in outcomes and identifying the probability of achieving specific return levels.

4. Results

The analysis of Coca-Cola's historical prices from 1999 to 2024 shows a steady upward trend supported by the company's strong brand position and consistent dividend policy. The stock experienced several short-term declines during major economic disruptions such as the 2008 financial crisis and the COVID-19 market contraction in 2020, but it recovered quickly afterward. Over the twenty-five-year period, Coca-Cola achieved an average annual return of about 5.1 percent, reflecting moderate long-term growth. The annualized volatility was approximately 21 percent, indicating greater short-term fluctuations than initially expected but still consistent with the behavior of a large-cap consumer-staple stock. These findings suggest that Coca-Cola has maintained resilience and stability even during volatile market cycles.

The Monte Carlo simulation used these historical parameters to generate ten thousand possible twenty-five-year return paths. The results produced a distribution of outcomes with a strong positive skew, showing that while a small number of simulations resulted in losses, the majority were profitable. Roughly 88.75 percent of the simulated investment paths ended with

positive cumulative returns, and most scenarios showed substantial capital appreciation over time. This indicates that despite its moderate volatility, Coca-Cola remains a reliable and defensive asset capable of producing favorable outcomes in a wide range of market environments.

The calculated Sharpe ratio from the simulations indicates that Coca-Cola provides a favorable risk-adjusted return relative to market benchmarks. When compared to the S&P 500 index, Coca-Cola shows a beta lower than one, suggesting reduced sensitivity to market movements and a more stable performance profile. The expected alpha is positive, implying that the stock can deliver consistent returns above market averages after accounting for risk.

To make the simulation more realistic, the model also includes the impact of trading and management fees. Brokerage trading costs are assumed to be minimal under the buy and hold strategy, while annual management fees are set between one and two percent of portfolio value. After accounting for these fees, the net expected return decreases slightly, but the overall performance remains positive in most scenarios. The results show that Coca-Cola continues to generate solid risk-adjusted returns even after fees, emphasizing the importance of cost efficiency in long-term portfolio management.

Overall, the results support the idea that a long-term buy and hold strategy with Coca-Cola can be a sustainable investment approach. The findings also show that using Monte Carlo simulation offers a broader and more realistic view of possible future outcomes than a single backtest or historical trend analysis. Market performance is benchmarked against the S&P 500 index, which is used to measure relative returns and confirm Coca-Cola's lower sensitivity to market volatility.

5. Conclusion

This study provides evidence that a long-term buy and hold strategy using Coca-Cola can produce steady returns with relatively low risk. The historical data show that Coca-Cola performs consistently through both economic expansions and market downturns. The Monte Carlo simulation results reinforce this observation by demonstrating that most simulated investment paths end with positive cumulative returns. This suggests that Coca-Cola's defensive business model and reliable dividend structure help reduce volatility and protect against market shocks.

Using Monte Carlo simulation also proves to be an effective method for modeling uncertainty in investment performance. Instead of depending on a single historical outcome, the simulation produces thousands of possible future scenarios, offering a clearer view of risk and potential reward. This approach improves the reliability of performance evaluation and aligns with current practices in quantitative finance.

The overall findings suggest that investors seeking long-term stability can benefit from including Coca-Cola in their portfolios. The historical analysis shows that Coca-Cola achieved an average annual return of about 5.1 percent with an annualized volatility of roughly 21 percent. Monte Carlo simulations confirm that nearly 89 percent of the simulated investment paths produced positive cumulative returns over 25 years, reinforcing Coca-Cola's resilience through diverse market conditions. For the next phase of this project, expanding the analysis to multiple assets and incorporating management fees, rebalancing rules, and performance-based costs will provide a more complete view of portfolio behavior. The main concern at this stage is that assuming a normal return distribution may underestimate extreme losses during rare events.

Future work should explore the use of fat-tailed or skewed distributions to capture these risks more accurately.

Bibliography

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