

Monte Carlo Methods in Finance

Julia O’Keeffe, Paul Yaginuma, Graham Lovell, Su Hyun Byeon, & Jacob Zott

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Professor Thomas W. Miller, PhD

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I. Investment Philosophy

In this analysis of Monte Carlo methods in financial trading, we worked with a mean reversion investment philosophy in the energy industry. After analyzing the data using a traditional buy and hold philosophy, the team ran mean reversion to see how the results compared. Mean reversion investment philosophy centers on buying assets when they are oversold (and therefore undervalued) and then selling when they are overbought (and overvalued).

Traditionally, mean reversion is applied in scenarios where a stock undergoes an unexpected but brief change. For example, a company may announce bad news, the stock price will drop below its historical “floor”, people will buy the stock, and eventually the price returns to somewhere in its normal range. Long term, the company sees no major consequences and there is no panic, but investors can buy stock when it is lower than normal. For overvaluing, a company’s stock price may increase past its traditional ceiling (but is expected to return to its normal price) and investors sell at that high before the price returns back to its average.

Mean reversion works best in sideways markets where price fluctuations stay in a range and there’s the assumption that the stock price will return to its long term average range. Trending markets often do not yield successful results for mean reversion strategies, since prices tend to follow the trends rather than reverting to historical averages.

II. Rules

The rules that govern security selection and trading decisions are well-defined using technical indicators: Relative Strength Index (RSI) and Bollinger Bands. The trading rules put in place for the buying signal are when the RSI falls below 20. This indicates that oversold conditions have been met. Additionally, when the stock price falls below the lower Bollinger

Band, this also suggests an undervalued price. For selling rules, the key indicators are when RSI rises above 80 and when the stock price is above the upper Bollinger. These criteria signal when overbought conditions have been met and when there is a potential price decline. Execution timing is based on the next trading day, after a signal is generated.

For the portfolio allocation, the simulation has set the ETF to only invest in long positions. Each stock is equally weighted within the portfolio to begin, and dividends are reinvested to maximize compound growth. The strategy implemented by the team was backtested with 25 years of market data, from 1999 to 2024. In terms of risk management, there was no stop-loss mechanism used; however, mean reversion assumes price recovery over time. Synthetic data was used in a Monte Carlo simulation evaluated performance under a variety of market conditions.

III. Securities Description

The securities we chose to invest in are all large companies within the energy industry. We chose ten companies in total to be part of our energy investment fund and all ten companies currently offer a dividend. The companies we chose to invest in are Exxon Mobil Corp, Williams Companies Inc, ONEOK Inc, Cheniere Energy Inc, Hess Corp, Enterprise Products Partners LP, EOG Resources Inc, Chevron Corp, and ConocoPhillips. According to a list of stocks in the energy sector from Stock Analysis, these ten companies are all in the top 26 of the energy sector by market cap with Chevron and Exxon ranking first and second respectively.

Our selection of funds is evaluated in two scenarios where the first utilizes a buy-and-hold strategy and the second utilizes mean reversion to decide when to sell or buy. In our buy and hold scenario, the team invests \$10,000 in each stock at its opening price on January 4th, 1999, and then calculates returns based on the stock's closing price on December 29th, 2023.

The rules we use for mean reversion are that we will sell a security when its relative strength index over 14 days is above 80 and the price is above the upper Bollinger band. We will buy a security when its relative strength index over 14 days is below 20 and the price is below the lower bollinger band. In this scenario, we start waiting for our buy conditions to be met for each stock on January 4th, 1999, and once the conditions are met, we invest \$10,000 into that stock and we hold our position until the sell conditions are met. Once the sell conditions are met, we sell all of our holdings for that specific stock and wait until the next time our buy conditions are met to reinvest \$10,000 in that company again.

IV. Performance Evaluation

To evaluate the performance of our buy and hold scenario, we calculated the log return on our investments using the opening price on January 4th, 1999, and the closing price on December 29th, 2023. This provides us with a return of about ~2500% from investing \$10,000 in each of our chosen energy stocks while the S&P 500 had a return of about ~500% during this same 25 year period. To evaluate the performance we would've seen from our moving average strategy during those 25 years, we back tested with historical data, which allowed us to calculate the return from our moving average strategy to be about ~270%. Our backtesting shows that buy and hold seems to be the best strategy we evaluated. We utilized Monte Carlo simulation and ran twenty different simulations that create synthetic data with skewed returns where the first open price is equal to the close price from historical data for the prior day. This successfully allowed us to see how our moving average method would perform with varying levels of market volatility.

V. Recommendation

The results from the mean reversion ETF strategy present mixed results when analyzing profitability and risk exposure. The team recommends adding more risk management strategies, such as a defined stop-loss implementation. This would ensure long-term stability for the portfolio. High-momentum trends will not be the focus of this fund, so investors should be aware that this is suitable for range-bound markets. Additional Monte Carlo simulations would yield a more predictable long-term performance benchmark. Expanding from 20 simulations to a significantly higher number would improve the fund's success in the long term. Diversification of the portfolio with more stocks from other industries would ensure better control over the fund's success. Adding similar-performing stocks from industries like commodities and mining or manufacturing would ensure risk management strategies are all covered.

References

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