Portfolio Construction

MFIN 602 Term Project

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1.1 Introduction and Background

The objective of our portfolio construction is to develop a diversified investment strategy that balances risk and return. Recognizing the volatile nature of the energy sector, our approach emphasizes risk management while leveraging growth opportunities within this industry.

We began by evaluating a broad set of stocks using valuation and momentum metrics to identify undervalued stocks with strong performance potential. Following this, we implemented optimization techniques to construct a portfolio that minimizes volatility while adhering to return constraints.

This report details our methodology, analysis, and results, including stock selection, weighting strategies, return analysis, and individual stock volatility assessment. Additionally, we incorporated bonds to complement our stock portfolio, further enhancing the risk-adjusted performance of our investment strategy.

1.2 Valuation and Momentum Metrics for Stock Evaluation

We use the following indicators to evaluate the valuation and momentum of each stock:

- **Valuation Metrix:**

  Price-to-Earnings (P/E) Ratio: It indicates how much investors are willing to pay for each dollar of earnings. A lower P/E ratio may indicate that a stock is undervalued.

  EV/EBITDA Ratio: It compares a company's enterprise value to its earnings before interest, taxes, depreciation, and amortization. A lower EV/EBITDA ratio may indicate that a stock is undervalued.

- **Momentum Metrix:**

  RSI (Relative Strength Index): It measures the speed and change of price movements. It ranges from 0 to 100 and is typically used to identify overbought or

oversold conditions in a stock. For this case, we can simplify RSI interpretation to mean that a lower RSI generally signals an undervalued stock, making it a positive indicator for potential investment.

Relative Share Price Momentum: The relative share price momentum measures the price momentum of a stock relative to the overall market. A positive relative share price momentum indicates that a stock is outperforming the market.

We began by collecting four key indicators for the stocks in the stocklist from Bloomberg. Following this, we performed a cleaning process by excluding companies with missing or unavailable ratio values, refining our dataset to a final selection of 31 stocks for analysis. Using Python (Please refer to Appendix A-1 for the code), we computed the average value for each indicator across all stocks and ranked them accordingly. For the first three indicators, the price-to-earnings ratio (P/E), EV/EBITDA, and RSI, stocks with lower average ranks were recognized to perform better, so we ranked them in descending order. Conversely, for the Relative Share Price Momentum indicator, stocks with higher values were considered to be stronger in performance, reflecting stronger momentum. Ultimately, we calculated the total rank for each stock by assigning equally to all indicators and selected the top 10 stocks for the following optimization process.(Please refer to Appendix A-2 for the code)

1.3 Stock Selection and Weighting Methodology

To optimize our selection, we chose to use two methods based on volatility and the Sharpe ratio to identify the best combination and allocation of stocks. Before this optimization, we calculated the correlation matrix of the stocks' returns and visualized it with the heatmap below to check how much room there is to minimize portfolio risk, especially in a scenario where all stocks belong to the energy industry.

The following heatmap illustrates the limited potential for risk reduction through portfolio diversification due to high correlations. However, we can still try to minimize risk by selecting stocks with relatively lower correlations within the group.

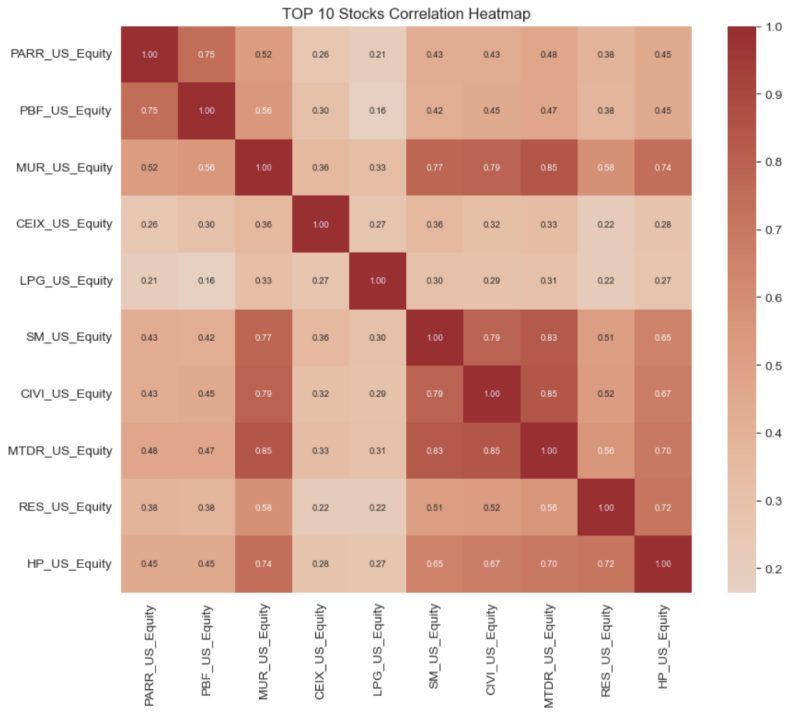

Figure 1: Top 10 Stocks Correlation Heatmap

1.3.1 Minimizing Volatility with Return Constraints

To optimize the portfolio, we implemented a method focused on minimizing volatility while ensuring returns remain non-negative (>=0). This approach emphasizes stability and risk reduction, particularly considering the energy sector's poor performance over the last year.

Using a loop, we generated all possible combinations of 5 to 10 stocks from the top 10 list. For each combination, we calculated key metrics like expected returns, the covariance matrix, and the correlation matrix. (Please refer to Appendix A-3 for the code)

We applied the scipy.optimize.minimize function to minimize portfolio volatility, using the Sequential Least Squares Programming (SLSQP) method, which is designed to handle constrained optimization problems. The constraints included:

- Sum of weights equals 1.
- Each weight lies between 0.1 and 0.5 to ensure diversification. This avoids extreme scenarios, such as one stock being weighted at 100% while others are at 0%, ensuring a balanced and diversified portfolio.

- Portfolio return>= 0. This constraint arises from the energy sector's recent poor performance, requiring us to ensure that our portfolio avoids incurring any losses.

1.3.2 Sharpe Ratio Optimization

We also tested a method that maximizes the Sharpe Ratio since a higher Sharpe Ratio indicates better risk-adjusted performance. (Please refer to Appendix A-4 for the code) The overall implementation is the same as the previous approach. The only thing which is important to note is that since scipy.optimize primarily provides tools for minimization, we converted the maximization problem into a minimization one by taking the negative value of the Sharpe Ratio.

1.3.3 Why We Chose Minimizing Volatility

After comparing the two methods, we determined that minimizing volatility with a return constraint was a better choice for our portfolio due to the following reasons:

- The energy sector and our portfolio stocks had poor returns last year due to the shift towards ESG, making the Sharpe Ratio less effective: balancing the return and risk is not enough for our case. Additionally, the portfolio's returns under this approach are worse than those achieved with the first method.

- Based on our valuation and momentum metrics ranking, the portfolio stocks are undervalued with significant growth potential. We believe our portfolio would benefit from future appreciation while managing current risks.

Ultimately, we produced the following optimal allocation in Table 1.

1.3.4 Analysis of the Portfolio Daily Returns and 20-Day Rolling Volatility

We visualized our portfolio's daily returns and 20-Day Rolling Volatility as follows to conduct further analysis:

Protection Against Major Losses:

Bloomberg Ticker	Company Name	Weight
CEIX US Equity	CONSOL Energy Inc.	0.27
HP US Equity	Helmerich & Payne, Inc.	0.12
LPG US Equity	Dorian LPG Ltd.	0.22
MTDR US Equity	Matador Resources Company	0.13
MUR US Equity	Murphy Oil Corporation	0.14
SM US Equity	SM Energy Company	0.12

Table 1: Portfolio Allocation of Selected Stocks

- By minimizing volatility, the portfolio ensures that even during turbulent market conditions, investors are less likely to experience severe losses, which is more attractive for risk-averse investors.

Small Volatility Range:

- Our portfolio's volatility fluctuates within a very limited range, indicating our effective risk management.

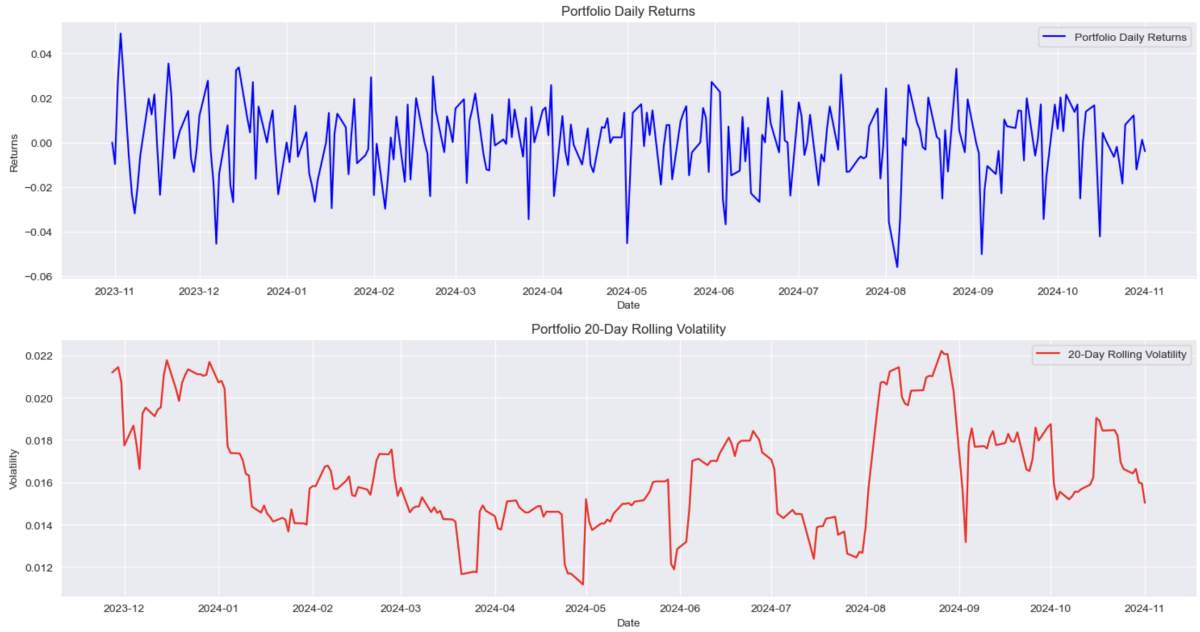

Figure 2: Portfolio Daily Returns and 20-Day Rolling Volatility