Project 2: Optimize Something

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1 INTRODUCTION

This project optimizes a portfolio of four assets—IBM, United States Steel (X), SPDR Gold Trust (GLD), and JPMorgan Chase (JPM)—over the period from June 2008 to June 2009. The objective is to determine asset allocations that maximize the Sharpe ratio.

The Sharpe ratio is a standard measure of risk-adjusted return, quantifying how much excess return is earned per unit of risk. Higher Sharpe ratios indicate more favorable trade-offs between return and volatility.

2 OPTIMIZATION METHOD

Portfolio optimization was performed using the `scipy.optimize.minimize` function with the Sequential Least Squares Programming (SLSQP) method. The optimizer maximizes the Sharpe ratio by minimizing its negative value.

Constraints enforce that all allocations sum to 1.0 and that individual allocations lie between 0.0 and 1.0, allowing only long positions. The Sharpe ratio calculation assumes 252 trading days per year, a daily risk-free rate of 0.0, and uses the sample standard deviation of daily returns. The optimization was initialized with a uniform allocation of 0.25 for each asset.

3 RESULTS

Figure 2 compares the normalized daily value of the optimized portfolio with SPY, the S&P 500 index. Both series are normalized to 1.0 at the start of the period on
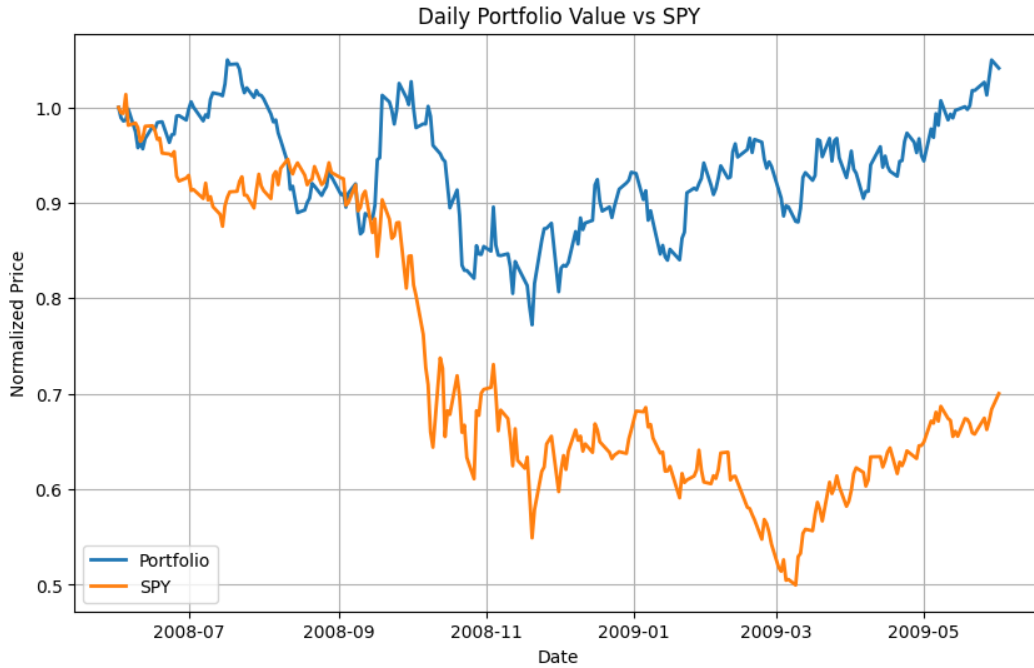
June 1, 2008, and extend through June 1, 2009.

Figure 1: portfolio vs spy

Figure 2: Normalized performance of the optimized portfolio compared to SPY from June 2008 to June 2009.

The optimized portfolio outperforms SPY over the evaluation period. The final portfolio value exceeds that of the market index, indicating superior cumulative performance. Additionally, the portfolio exhibits volatility patterns that differ from the broader market.

4   PORTFOLIO STATISTICS

The optimized asset allocations are as follows: GLD at 76.7%, JPM at 23.3%, and zero allocation to both IBM and X.

Key performance metrics for the optimized portfolio include a cumulative return of 4.10%, an average daily return of 0.000851, a standard deviation of daily returns of 0.020836, and a Sharpe ratio of 0.6483.

5 ANALYSIS

The optimization concentrates the portfolio primarily in gold and JPMorgan Chase, allocating no capital to IBM or United States Steel. During the 2008–2009 period, this combination provided the strongest risk-adjusted performance among the considered assets.

A Sharpe ratio of 0.6483 indicates positive risk-adjusted returns, though the magnitude suggests moderate performance relative to risk. The sustained outperformance relative to SPY throughout most of the period demonstrates how portfolio optimization can identify asset combinations that outperform market benchmarks over specific time horizons.