NOMURA QUANT CHALLENGE

Subham Ghosh

Nomura Quant Challenge 2025: Strategy Analysis and Documentation

Executive Summary

This report documents the implementation, analysis, and performance evaluation of five quantitative trading strategies and their ensemble methods.

Methodology and Approach

Individual Strategy Design

Five distinct trading strategies were implemented, each targeting different market inefficiencies:

1. **Strategy 1: Mean Reversion Based on Weekly Returns**
   - Calculates 50-day rolling average of 5-day percent changes
   - Goes long on bottom 6 securities and short on top 6 securities
   - Hypothesis: Assets that have deviated significantly from their historical weekly return patterns will revert to the mean

2. **Strategy 2: Moving Average Crossover**
   - Compares short-term (5-day) and long-term (30-day) moving averages
   - Takes positions based on the percentage difference between these averages
   - Goes long when short-term MA is above long-term MA, short when below
   - Targets trend-following opportunities across securities

3. **Strategy 3: Rate of Change Momentum**
   - Calculates 7-day price rate of change
   - Goes long on securities with lowest ROC and short on securities with highest ROC

- Contrarian approach that assumes short-term price movements will reverse

4. **Strategy 4: Support and Resistance Levels**

- Uses Bollinger Bands with 21-day moving average and 3 standard deviations
- Identifies securities trading near support (buy signal) or resistance (sell signal) levels
- Takes advantage of technical price boundaries in the market

5. **Strategy 5: Stochastic Oscillator**

- Implements %K from standard 14-day lookback stochastic oscillator
- Goes long on securities with lowest %K values (potentially oversold)
- Goes short on securities with highest %K values (potentially overbought)
- Attempts to capture mean-reversion around oversold/overbought conditions

Ensemble Strategy Development

Two different ensemble approaches were developed:

Task 2: Performance-Based Strategy Selection

- Uses rolling 10-day historical returns to select the best-performing strategy
- For the first 10 days, defaults to Strategy 1 as baseline
- Dynamic selection updates daily based on recent performance
- No consideration for transaction costs or strategy volatility

Task 3: Risk-Adjusted Strategy Selection with Transaction Costs

- Uses rolling 10-day volatility (standard deviation) as selection criterion
- Selects strategy with lowest volatility over preceding period
- Incorporates transaction costs (1% of turnover) into return calculations
- Aims to minimize portfolio volatility while controlling transaction costs

Performance Analysis

Task 1: Individual Strategy Evaluation

All strategies exhibited negative returns during the test period:

Strategy	Net Return (%)	Sharpe Ratio
Strategy 1	-44.40	-0.08
Strategy 2	-75.64	-0.17
Strategy 3	-99.97	-0.79
Strategy 4	-99.98	-0.91
Strategy 5	-100.00	-1.00

Strategy 1 demonstrated the least negative performance, suggesting its mean-reverting approach was most suitable for the market conditions present in the dataset. The progressively worse performance across strategies indicates that trend-following and oscillator-based approaches were particularly ill-suited for the specific market dynamics.

Task 2: Performance-Based Strategy Selection

The dynamic strategy selection approach yielded a combined performance of:

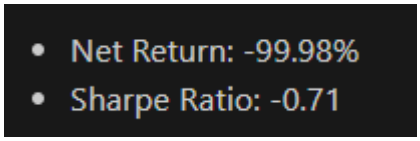
- Net Return: -62.31%
- Sharpe Ratio: -0.13

While still negative, this represents an improvement over four of the five individual strategies. The selection algorithm primarily favoured Strategy 1, which aligns with it having the best individual performance. The visualization of strategy selection over time reveals clusters where specific strategies were consistently chosen, suggesting periods of relative outperformance for different approaches.

The correlation analysis between strategy returns revealed limited diversification benefits, with most strategies exhibiting positive correlation with each other. This explains why the combined strategy could not achieve substantially better results than the individual components.

Task 3: Risk-Adjusted Selection with Transaction Costs

When incorporating transaction costs:



The dramatic deterioration in performance highlights the substantial impact of transaction costs on algorithmic trading strategies. The average daily turnover varied significantly across strategies, with more active approaches incurring higher transaction costs.

The visualization of daily turnover and transaction costs showed distinct spikes when switching between strategies with substantially different position compositions. This suggests that strategy continuity is an important consideration when transaction costs are present.

Preventing Overfitting

Several techniques were employed to mitigate overfitting:

1. **Parameter Simplicity:** Each strategy used straightforward parameters with minimal optimization, focusing on standard values common in technical analysis (14-day lookback for stochastics, 21-day for Bollinger Bands).

2. **Cross-Validation:** The model development and testing used separate datasets (train_data.csv vs. cross_val_data.csv) to evaluate out-of-sample performance.

3. **Strategy Diversity:** The five strategies implemented use fundamentally different approaches to market analysis, reducing the risk of overfitting to a particular market pattern.

4. **Dynamic Selection Window:** The 10-day rolling window for strategy selection provides adaptability while being large enough to avoid excessive noise-fitting.

5. **Risk-Based Selection:** In Task 3, the shift from return-based to volatility-based selection criteria provides a more robust metric less susceptible to overfitting.

Key Insights and Conclusions

1. **Adaptive Strategy Selection:** The dynamic approach to strategy selection demonstrates promise, even during challenging market conditions, by adapting to changing environments.

2. **Strategy Correlation:** The correlation analysis revealed limited diversification benefits among the implemented strategies, highlighting the importance of including truly uncorrelated approaches in a portfolio.

3. **Transaction Cost Impact:** The dramatic performance deterioration when incorporating transaction costs demonstrates their critical importance in strategy evaluation and the need for turnover management.

4. **Risk vs. Return Trade off:** The volatility-based selection in Task 3 resulted in lower returns but potentially more stable performance, emphasizing the importance of considering both dimensions.

5. **Adaptive Strategy Selection:** The dynamic approach to strategy selection demonstrates promise, even during challenging market conditions, by adapting to changing environments.

Future Improvements

1. Incorporate fundamental data alongside technical indicators to capture a broader set of market inefficiencies

2. Implement machine learning approaches that can better capture non-linear relationships in the market data

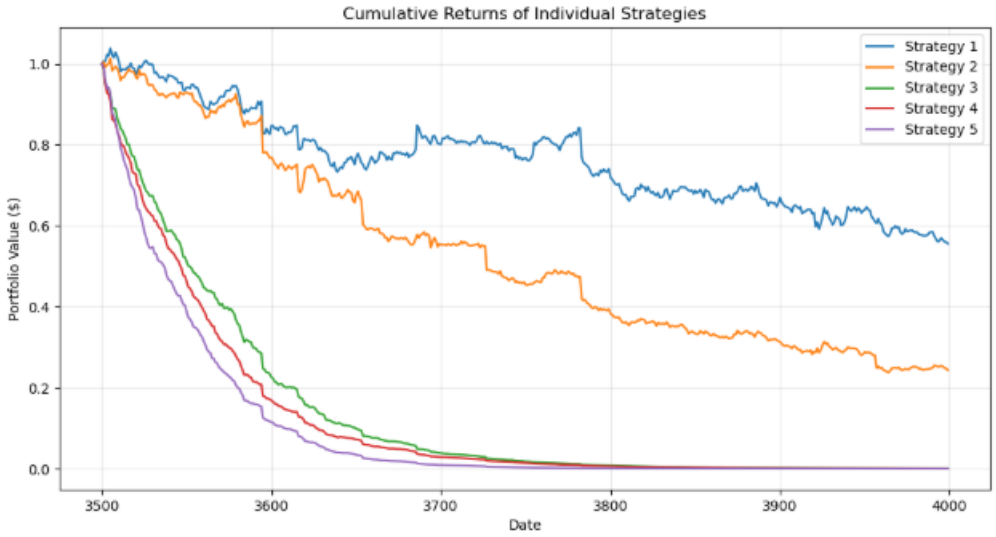
3. Develop more sophisticated transaction cost optimization that considers the tradeoff between strategy switching and turnover

4. Add explicit position sizing rules based on volatility to better manage risk

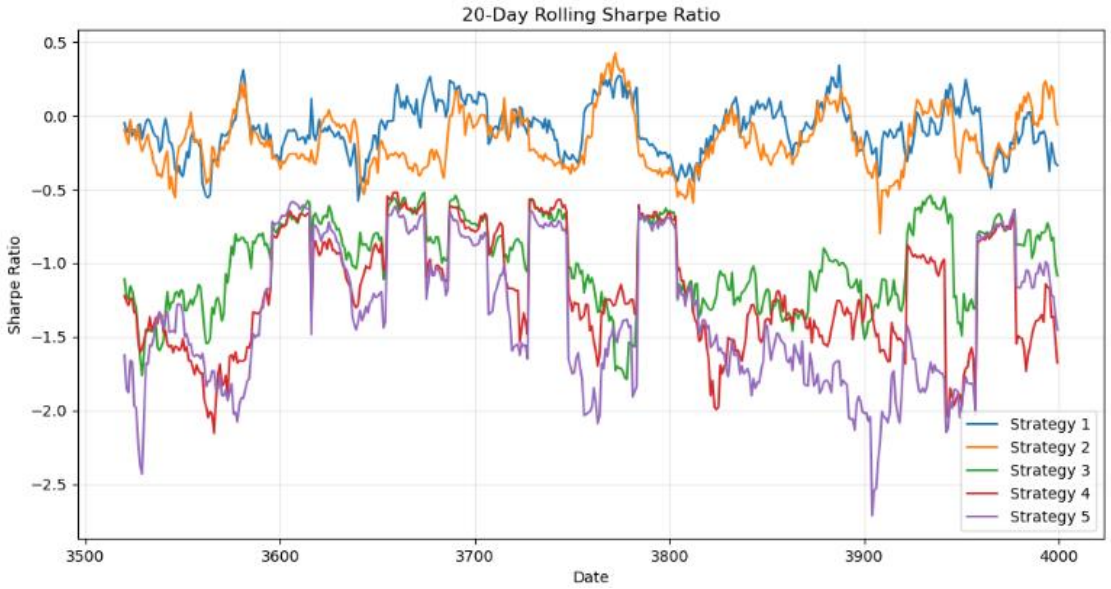
5. Explore alternative ensemble methods like weighted averaging of strategy signals rather than discrete selection

Appendix: Visualization Descriptions

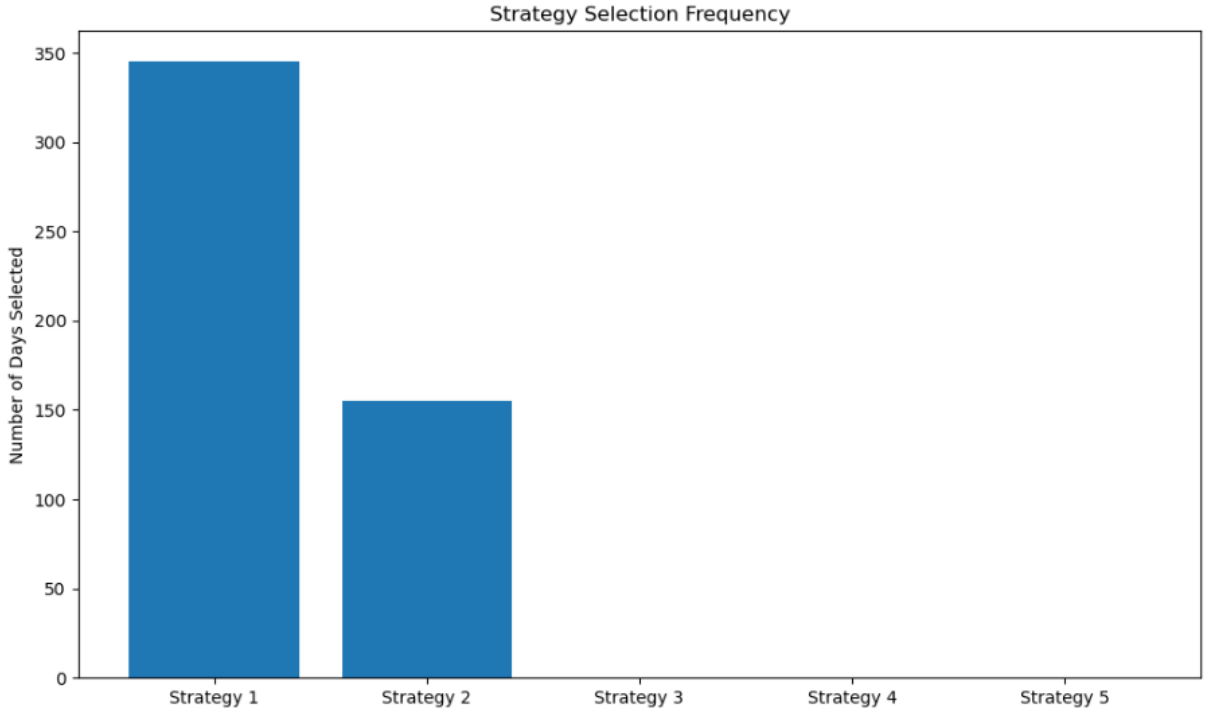
The analysis includes several key visualizations:



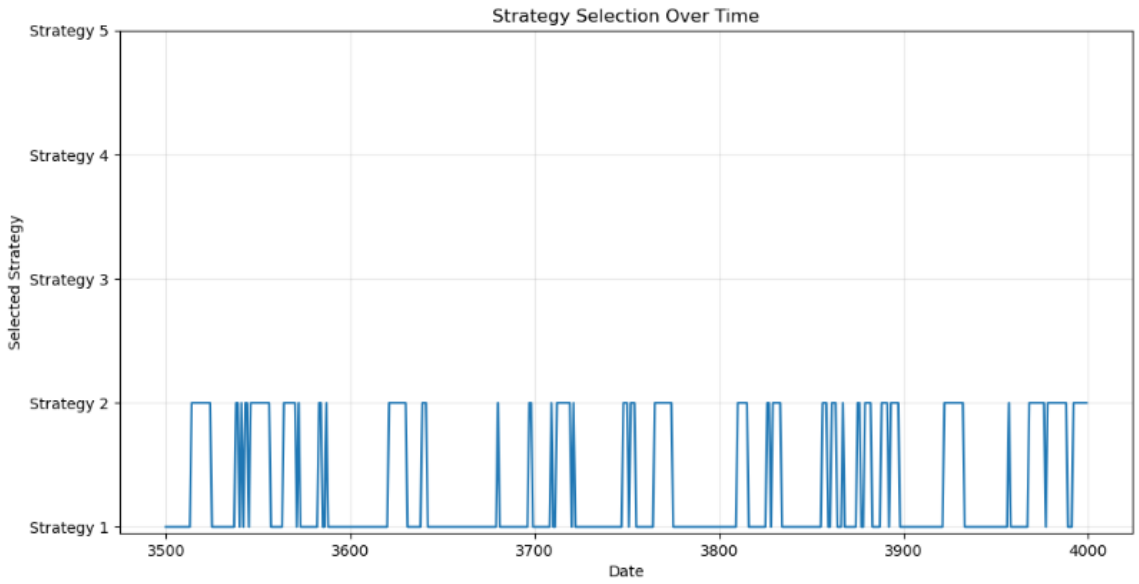
1. **Cumulative Returns Plot**: Shows performance trajectory of all strategies over time



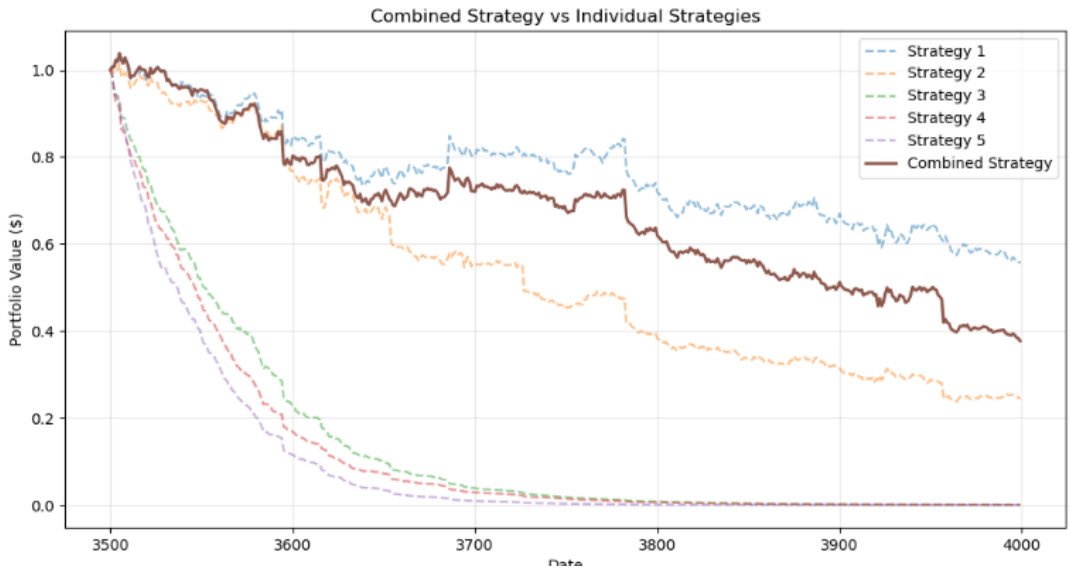
2. **Rolling Sharpe Ratio**: Displays risk-adjusted performance in moving windows



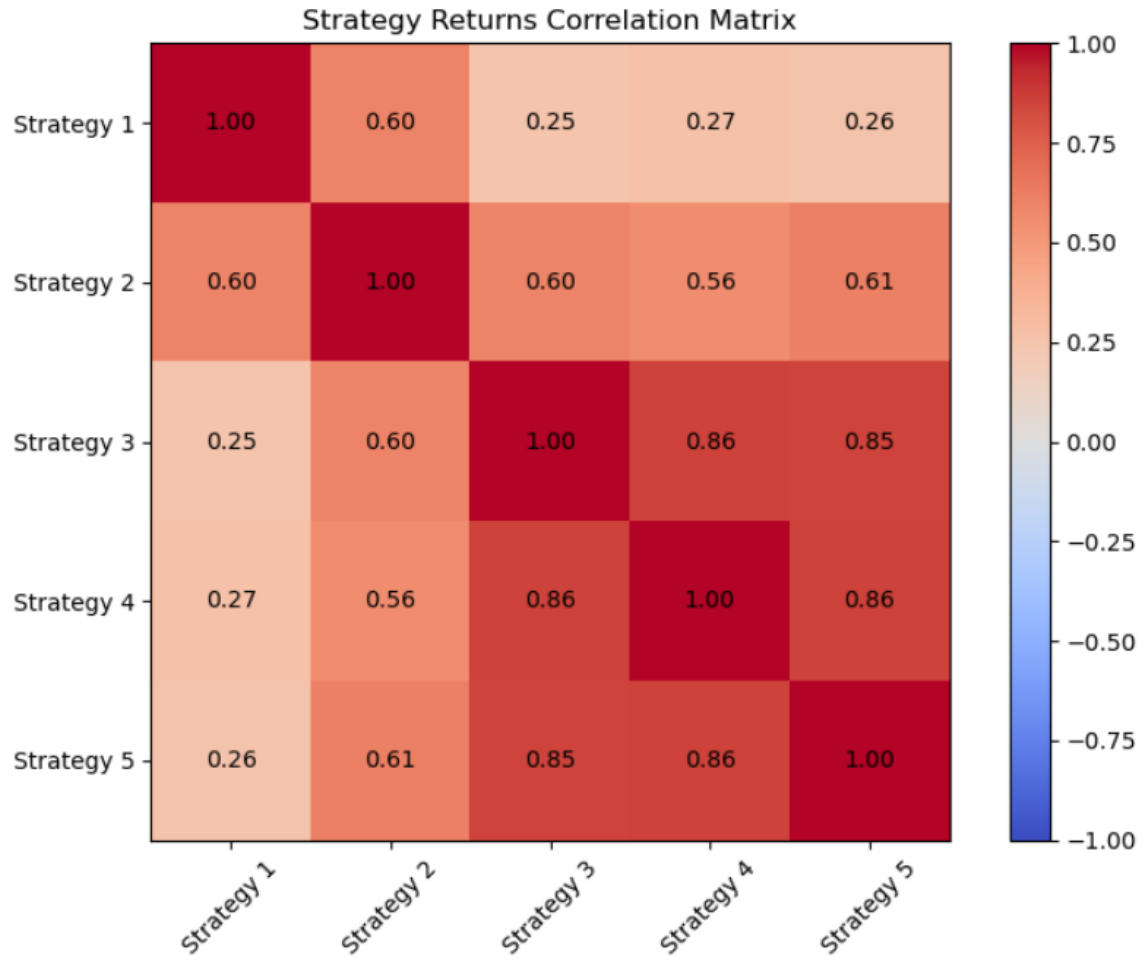
3. **Strategy Selection Frequency**: Bar chart of how often each strategy was selected



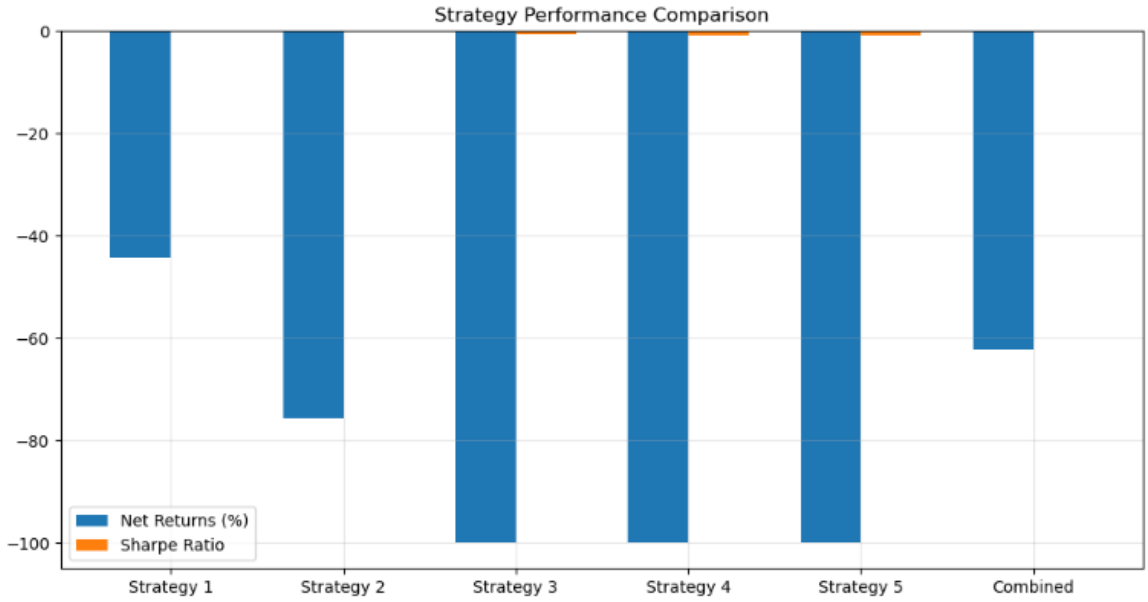
4. **Strategy Selection Timeline**: Time series of which strategy was active each day



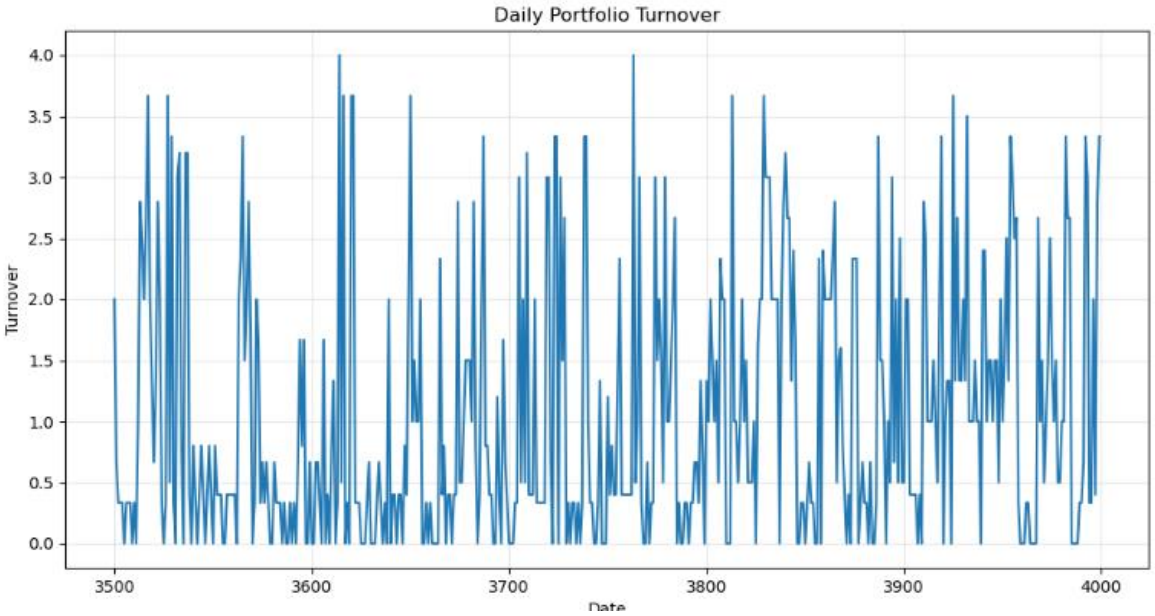
5. **Combined vs. Individual Performance**: Comparison of ensemble versus standalone strategies



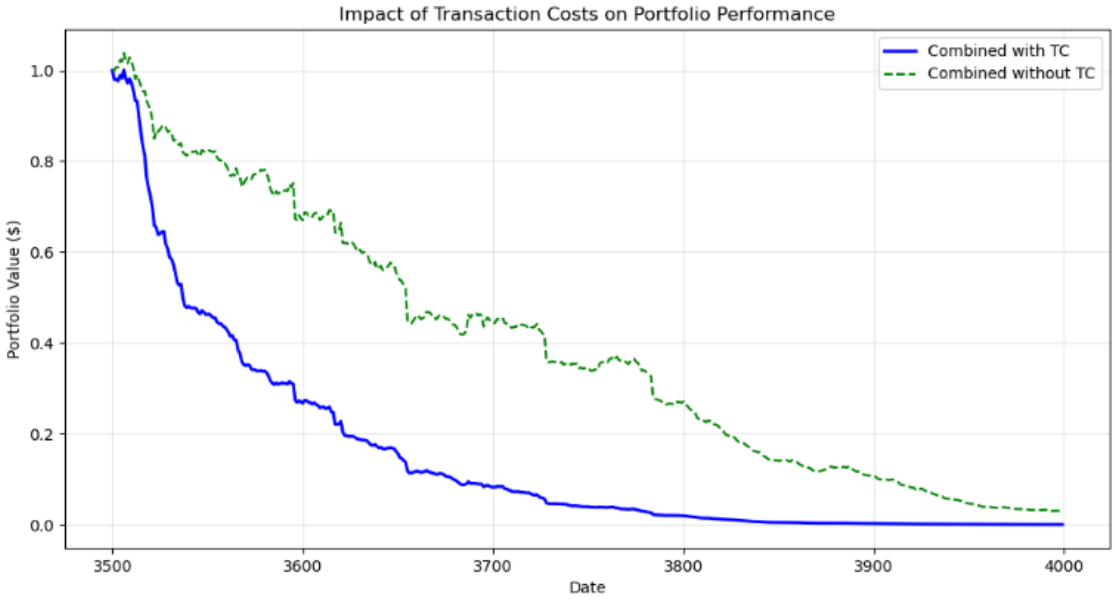
6. **Strategy Correlation Heatmap**: Visual representation of return correlations



7. **Performance Comparison**: Bar chart comparing net returns and Sharpe ratios



8. **Daily Turnover**: Time series of portfolio turnover



9. **Transaction Cost Impact**: Comparison of performance with and without costs

These visualizations provide intuitive understanding of strategy behaviour and performance characteristics throughout the test period.