AI Method for Portfolio Optimization in Taiwan's Stock Market: Analysing Financial and Economic Data

Final Individual Project Presentation

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Programme of Study: BSc Computer Science

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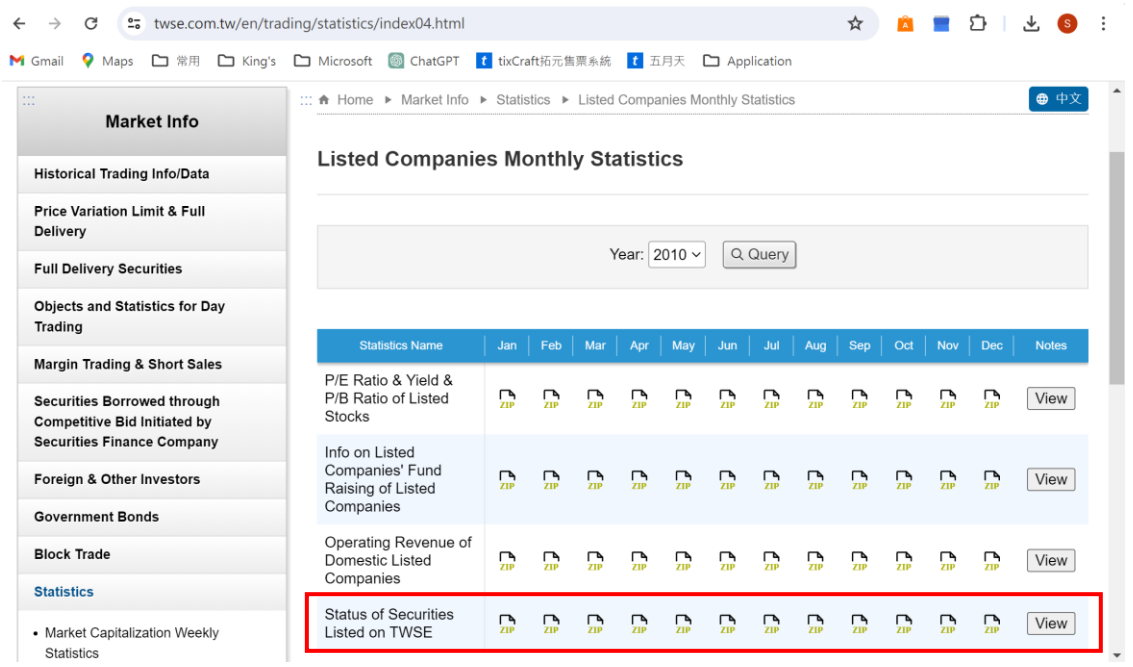
Introduction

- **Objective:** The objective of this project is to optimize portfolio performance in Taiwan's stock market by focusing on stock selection to minimize portfolio risk while ensuring a minimum expected return at least equal to or surpassing the Taiwan 50 Index Return
- **Methodologies:** The project primarily relies on Modern Portfolio Theory (MPT) and Monte Carlo Simulation techniques to achieve the optimization goals.
- **Programming Language used**: Python

Project Process and Stages

- **Data Collection and Preprocessing**: Acquiring and preprocessing historical stock price and essential data mainly based on Taiwan Stock Exchange(TWSE) and Taiwan Open Government Data (OGD)



Project Process and Stages

- **Data Selection:** To filter out stocks with poor performance to ensure selected stocks contribute to portfolio optimization based on stability, liquidity, and positive expected returns over a decade.

  1. Longevity: Select stocks continuously listed on TWSE for the entire ten-year period to ensure market stability.
  2. Liquidity (Average Trading Volume): Evaluate stocks' liquidity based on average trading volume over the ten-year period to ensure adequate market activity.
  3. Expected Return: Compute expected return for each stock based on monthly historical price data.

4. Data Segregation: Segregate and store each stock's information individually in a new DataFrame, facilitating focused analysis.
5. Annualized Expected Return & Volatility: Calculate monthly expected return, annualized expected return, and volatility for each stock to balance risk and rewards.
6. Filtering Based on Liquidity & Expected Returns: Eliminate stocks with low liquidity and negative expected returns, ensuring adequate liquidity and positive returns for portfolio optimization.

- **Tools & Technologies:** Utilized Pandas for data manipulation and NumPy for statistical calculations.

Project Process and Stages

- **Implementation of Modern Portfolio Theory (MPT):** Applying using Covariance Matrix Calculation and Quadratic Programming to minimize risk and maximize portfolio returns relative to the Taiwan 50 Total Return Index.

  1. Annualized Taiwan 50 Return Index Calculation: Compute the target return based on ten-year data for subsequent computations.
  2. Covariance Matrix of Expected Returns: Generate a covariance matrix to manage portfolio risk.

3. Regularization of Covariance Matrix: Apply regularization techniques to ensure positive definiteness of the covariance matrix.
4. Quadratic Programming Optimization Model: Implement MPT using quadratic programming to determine optimal asset weights.
5. Secondary Optimization Model: Refine the portfolio by concentrating on the top 20 stocks with the highest weights to enhance performance and manageability.

- **Tools & Technologies:** Employ Python, NumPy, Pandas, and CVXOPT for data manipulation, statistical calculations, and solving optimization problems.

Project Process and Stages

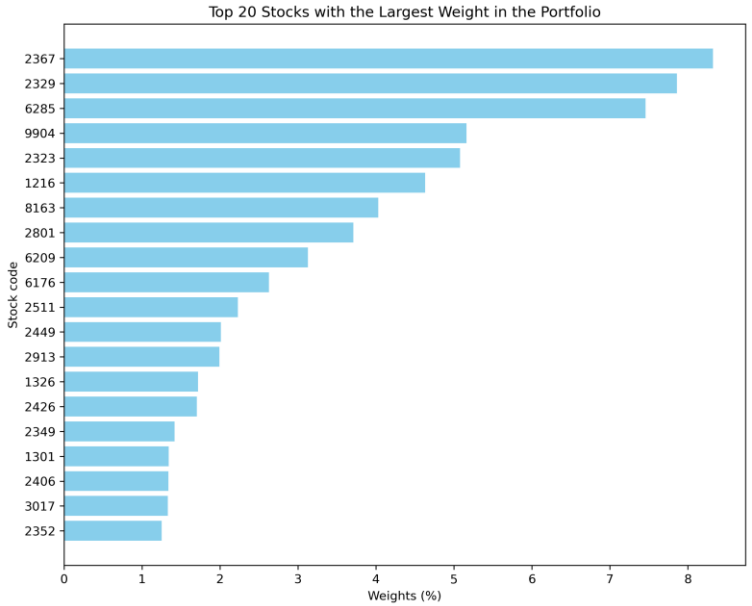
- **Implementation of Monte Carlo Simulation:** Using Monte Carlo simulation to evaluate the risk and variability of the optimized portfolio based on historical data.

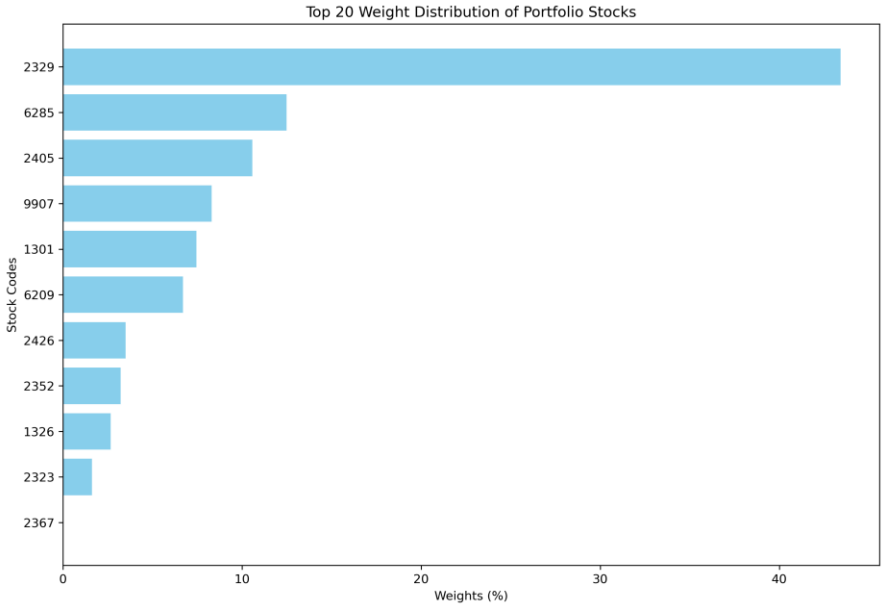
  1. Data Integration: Combine historical stock price data within the optimized portfolio for simulation variations.
  2. Simulation Parameter: Define the number of simulation runs to capture a wide range of potential scenarios.
  3. Risk and Return: Examine the distribution of simulation returns to compute potential risk and expected returns for portfolio assessment.

- **Tools & Technologies:** Utilize Python libraries Pandas and NumPy for data handling and simulation.

Experimental Results

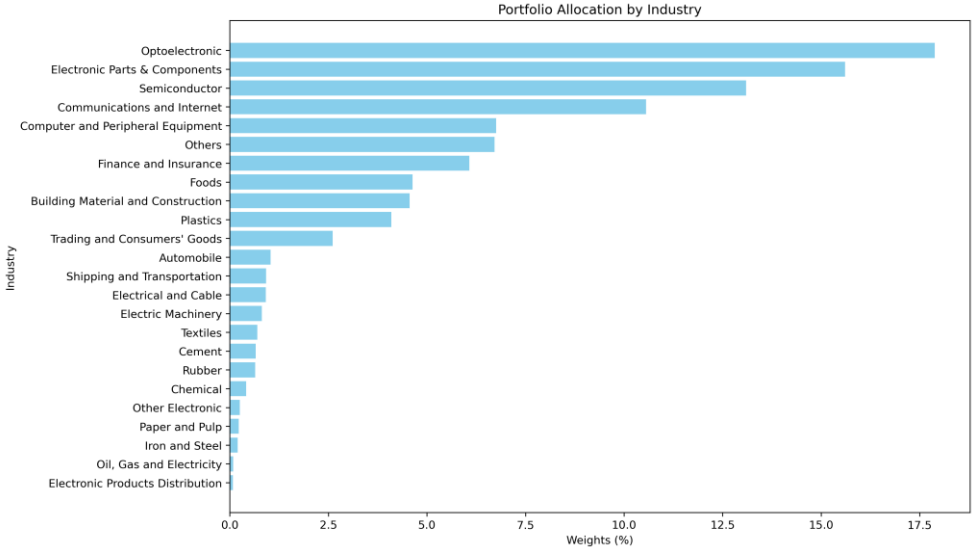
- **Optimized Weights for Selected Stocks:**
  1. Analysed weights for 127 stocks.
  2. Focused evaluation on top 20 stocks.
  3. Core of optimized portfolio, strategic sectors.

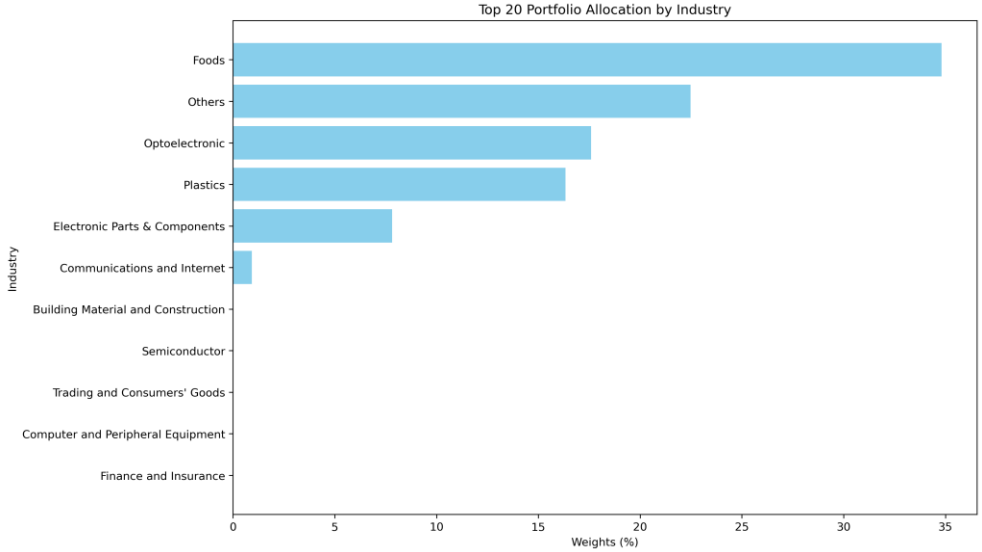




Experimental Results

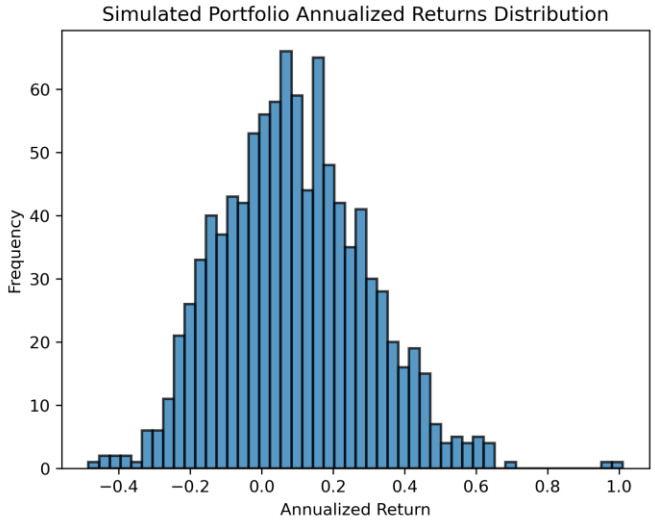
- **Portfolio Allocation by Industry:**
  1. Balanced distribution among top 20 stocks.
  2. Mitigates over-reliance on individual stocks.
  3. Strategic allocation in specific sectors for outperformance.

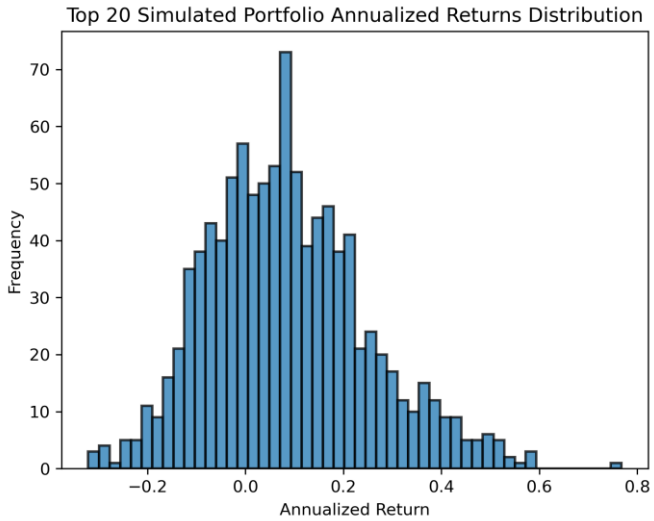




Experimental Results

- **Simulated Portfolio Annualized Returns Distribution:**
  1. Portfolio of 127 stocks: 9.11% return, SD 0.20.
  2. Top 20 stock portfolio: 8.5% return, SD 0.16.
  3. Lower risk, slightly lower return in focused portfolio.





Evaluation

- **Challenges and Limitations:**
  1. Attempted to include sentiment analysis of financial news.
  2. Regional restrictions and data availability limited analysis.
  3. Impact on understanding market dynamics and portfolio risk.

- **Data Limitations:**
  1. Data sourced mainly from Taiwan Stock Exchange (2010-2020).
  2. Excludes COVID-19 pandemic impacts on markets.
  3. Findings may lack representation under extreme conditions.

- **Human Errors in Data Processing:**
  1. Manual data checks may lead to inaccuracies.
  2. Potential for misjudgements in data consistency.

Conclusion

- **Portfolio Optimization Success:**
  1. Demonstrated risk diversification strategy.
  2. Ensured minimum expected return aligned with Taiwan 50 Index.
  3. Concentrated investment in top 20 stocks reduced risk.
- **Tailored Investment Philosophy:**
  1. Significant allocations to 'Optoelectronics' and 'Food' sectors.
  2. Reflects confidence in sector performance and market outlook.

Conclusion

- **Adaptability in Portfolio Management:**
  1. Balance between diversification and concentration strategies.
  2. Additional diversification beyond a threshold may not yield significant risk reduction.
  3. Concentrated investments in well-performing stocks can enhance performance with conservative risk management.

Future Work

- **Comprehensive Market Indicators:**
  1. Incorporate broader range of market indicators (e.g., GDP, unemployment rates, financial news).
  2. Provides detailed analysis of stock market and economic conditions.

- **Expansion of Data Scope:**
  1. Include data during COVID-19 pandemic for comprehensive view of portfolio optimization under extreme market conditions.
  2. Enhances relevance and applicability of research findings.

- **Comparative Analysis with Economic Sectors:**
  1. Analyse performance comparison between portfolio and specific economic sectors.
  2. Understand impact of economic developments on stock selection and portfolio optimization.