Portfolio Optimization Presentation

Master's Degree in Financial Risk and Data Analysis, course of Artificial Intelligence in Banking and Finance

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Table of Contents

Portfolio Optimization

1 Introduction

Portfolio optimization is all about building the right investment mix, distributing the capital across different assets. There are various ways to optimize a portfolio, but most approaches follow these steps:

- Know Your Goals: Figure out your risk tolerance, investment horizon, and financial aspirations.
- Pick Your Investments: Choose the assets (stocks, bonds, or other investment options).
- Analyze Performance: Research past data and use models to estimate how much each asset is likely to return and how risky it is.
- Building the Mix: Use optimization techniques to determine the best way to spread your capital across the chosen assets.

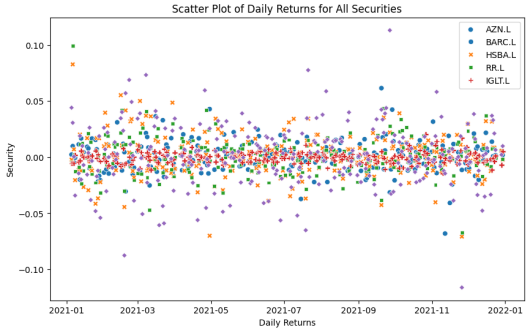
Table of Contents

2 Our scenario and the application in Python

Analyzing UK Assets Post-Brexit

2 Our scenario and the application in Python

Our aim is to use Python to analyse and optimise a portfolio consisting of five selected UK assets chosen to represent sector diversification and reflect the unique dynamics of the UK financial market post-Brexit.



Assets and Bonds

2 Our scenario and the application in Python

The assets taken into consideration are:

- AstraZeneca: one of the world's most renowned pharmaceutical companies.
- Barclays: one of the UK's leading financial institutions.
- HSBC: one of the world's largest banks with a strong presence in the UK.
- RollsRoyce: a British icon in the aerospace and defence industry.
- Gilts: British government bonds.

Scenario

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The exit of the United Kingdom from the European Union, known as Brexit, was motivated by:

- Concerns over national sovereignty;
- Immigration control;
- Economic independence.

In 2021, the financial sector had to adapt to new regulations and rules on cross-border trade and capital management. In order to mitigate risks and maximise returns, investors had to consider:

- Fluctuations in exchange rates;
- Stability of stock markets;
- New trading dynamics in portfolio diversification;
- Data analysis and the artificial intelligence.

Description of the code

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- Download historical data from YahooFinance;
- Obtain the Daily Closing Prices;
- Create a correlation matrix, a pairplot and a scatterplot of daily returns with the

  `seaborn`

  library.

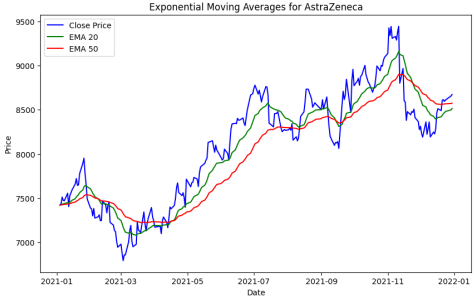

Figure: An example of plot for AstraZeneca

Optimization of the Sharpe Ratio

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- Obtain the optimal weights creating 100.000 casual portfolios, with all different weights combinations.
- Calculate and memorize the Sharpe Ratio of each portfolio.
- Extract the portfolio with the highest Sharpe Ratio and the one with the lowest volatility (minimum variance).

Optimization with the SLSPQ method

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- Minimize the negatives of the Sharpe Ratios, with the constraint that the sum of the weights is equal to 1.
- Find the portfolio with the minimum variance, minimizing the function that calculates the volatility of a portfolio.

Python Code

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For the first optimization method...

```
# Indentify the portfolio with the highest Sharpe Ratio
max_sharpe_port = results_frame.iloc[results_frame['sharpe'
    ].idxmax()]
# Identify the portfolio with smallest standard deviation
min_vol_port = results_frame.iloc[results_frame['stdev'].
    idxmin()]
```

For the second optimization method...

```
optimal_port_sharpe = max_sharpe_ratio(mean_returns, cov, rf
    )
```

Table of Contents

Results from Python: 1st method

3 Results and interpretation

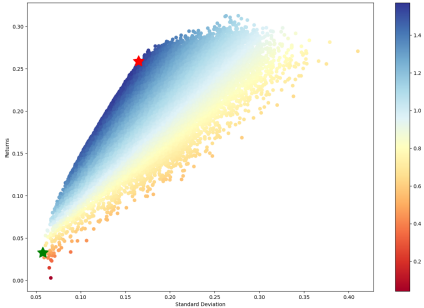

Figure: Sharpe Ratio scatterplot

Simulating random portfolios allowed us to evaluate a wide range of asset combinations and identify those offering the best return/risk ratios. Portfolio optimization allowed us to identify the portfolio with the highest Sharpe Ratio and the portfolio with the lowest standard deviation.

Results from Python: 2nd method

3 Results and interpretation

```
print(pd.DataFrame([round(x,2) for x in optimal_port_sharpe['x']],index=tickers).T)

   HSBA.L  AZN.L  BARC.L  RR.L  IGLT.L
0    0.09   0.52    0.38   0.0     0.0

print(pd.DataFrame([round(x,2) for x in min_port_variance['x']],index=tickers).T)

   HSBA.L  AZN.L  BARC.L  RR.L  IGLT.L
0    0.04   0.07    0.11   0.0    0.78
```

Figure: Results from the second optimization

Sharpe Ratio Maximization: Using the Sequential Least Squares Programming (SLSQP) optimisation algorithm, the optimal portfolio is identified by considering the average asset returns, their covariance and risk-free return.

Variance Minimization: Using the same SLSQP optimisation algorithm, the optimal portfolio is identified by taking into account only the covariance of the assets, without considering risk-free returns.