

## Introduction

The objective of this report is to provide a comprehensive overview of the financial landscape from October 2014 to October 2024, and to explore various investment strategies during this period.

Firstly, we present a forecasting model which is designed to assist in predicting whether it would be preferable to invest in the stock market or to opt for risk-free assets. The objective of this model is to provide investors with a data-driven approach to decision-making.

We will then provide an overview of portfolio creation, discussing different portfolio strategies, their potential benefits, and inherent limitations.

In conclusion, the report presents the results of seven distinct investment strategies implemented over the period, offering insights into their performance and practical implications for future investment planning.

## Data Selection

To ensure the accuracy and relevance of our analysis for both forecasting and portfolio optimization, we initially used data starting from October 2009. This decision was made to exclude the effects of the 2008 financial crisis, which caused significant market volatility and could distort calculations of expected returns and volatility.

For subsequent periods, we maintained a rolling 5-year time frame. Every 6 months, we updated the dataset by adding the latest 6 months of data and removing the oldest 6 months. This approach allowed us to keep the analysis current while preserving a consistent 5-year horizon for forecasting and portfolio optimization.

## 1. Forecasting Model

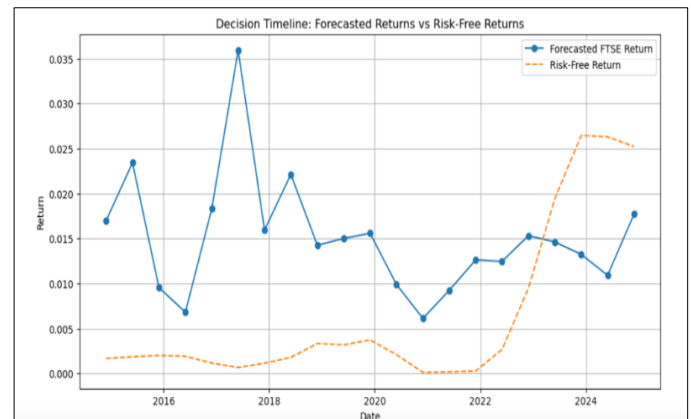
We selected the ARIMA (Autoregressive Integrated Moving Average) model due to its proven ability to effectively capture trends, seasonality, and autocorrelations in financial time-series data. ARIMA is particularly well-suited for datasets like the FTSE 100 returns, which exhibit structured patterns and short-term dependencies.

Specifically, we implemented an ARIMA (1,1,1) configuration, which was chosen to balance simplicity and accuracy. The (1,1,1) order incorporates one autoregressive term, which accounts for relationships with past values, and one moving average term, which addresses short-term shocks in the data. First-order differencing was applied to stabilize the time series and remove trends. This configuration allowed us to produce reliable and interpretable forecasts.

For each forecasted period, the predicted FTSE 100 return was directly compared with the corresponding risk-free rate. If the forecasted return for the FTSE 100 exceeded the risk-free rate, the decision was to invest in the FTSE 100. Otherwise, the recommendation was to allocate funds to the risk-free asset.

Our analysis revealed that for most forecasted periods between 2014 and October 2022, the ARIMA model consistently projected higher returns for the FTSE 100 index compared to risk-free assets, making an equity-heavy strategy favorable during this time. However, a significant shift occurred in November 2022 as risk-free rates climbed sharply from 0.78% in April 2022 to 2.45% in November 2022 and subsequently stabilized around 4.7%.

This substantial increase in risk-free rates reduced the relative attractiveness of FTSE 100 investments, particularly for risk-averse investors who may now find fixed-income options more appealing.

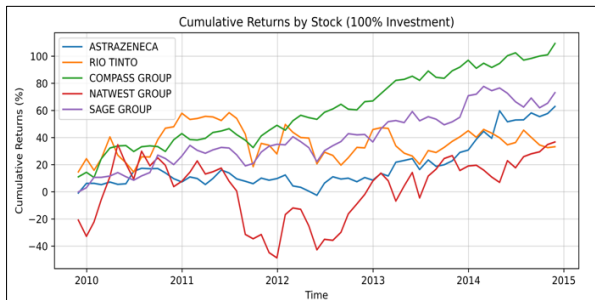


## 2. Selection of 5 UK Companies

To construct a robust portfolio, we employed a systematic process to select five UK companies that would provide a balance of returns and diversification.

Firstly, the monthly stock returns from October 2009 to October 2014 were analysed to identify long-term trends. Stocks with expected returns below the 5-year average (0.33%) were excluded, resulting in the removal of 10 underperforming options. This ensured that the portfolio was focused on higher-return assets.

From the remaining stocks, we selected those with low correlations (between -0.05 and +0.05) in order to enhance diversification and reduce overall portfolio risk. This balance between higher expected returns and low correlations was crucial for maintaining stability and optimising performance.

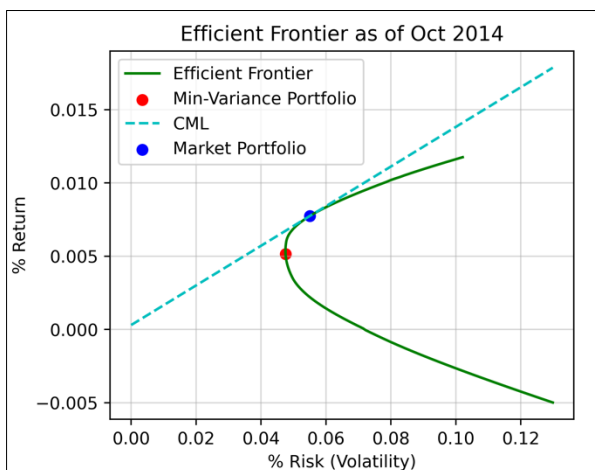


The final selection comprised **AstraZeneca** (0.85%, 4th), **Rio Tinto** (0.64%, 8th), **Compass Group** (0.96%, 3rd), **NatWest Group** (0.61%, 9th), and **Sage Group** (0.84%, 5th).

Some of the top-ranking stocks were deliberately excluded to avoid concentration risk and maintain diversification. The selected companies offered a combination of reliable, steady performers and higher-risk stocks, providing an optimal portfolio balance.

### 3. Portfolios Computations

The portfolio optimisation process focuses on constructing portfolios that effectively balance risk and return. The **efficient frontier** represents the best possible combination of assets for a given level of risk or, conversely, the lowest risk for a given return. It helps investors visualise trade-offs and make informed decisions about their risk tolerance.



To construct the efficient frontier, portfolio weights were constrained to sum to 100%, ensuring a fully invested portfolio, and no negative weights were allowed, meaning short selling was excluded.

This approach ensures realistic and practical allocations.

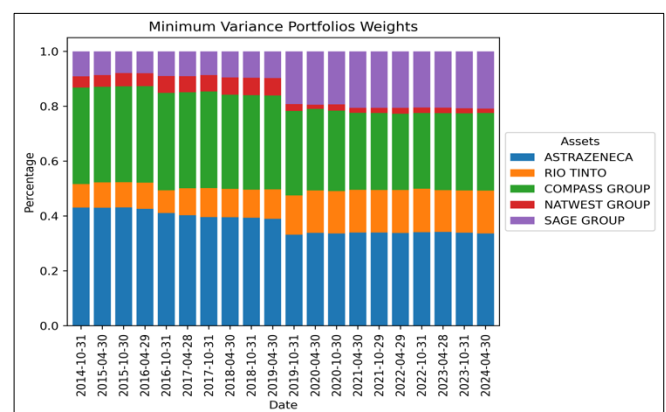
At the extreme left of the frontier is the **minimum variance portfolio**, which has the lowest possible risk of all the portfolios.

This portfolio prioritises stability and diversification, making it a natural choice for risk-averse investors.

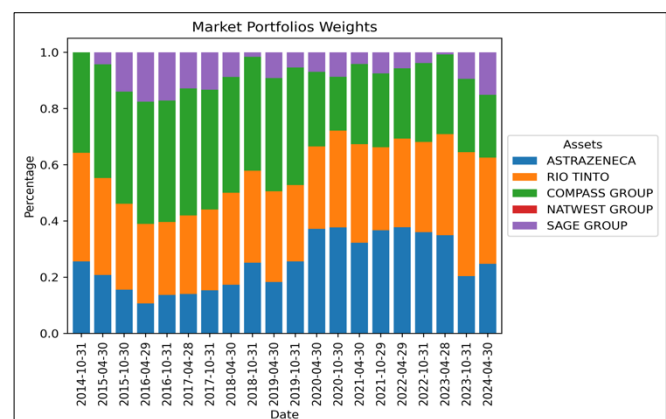
The **Market Portfolio**, on the other hand, is designed to maximize the Sharpe Ratio, which is the highest return per unit of risk. This portfolio lies on the tangent between the efficient frontier and the capital market line (CML).

The two graphs below illustrate the distinct weight dynamics of the minimum-variance portfolio and the market portfolio over the 10-year period of our investment.

The minimum-variance portfolio demonstrates a consistent allocation to AstraZeneca and Compass Group, reflecting their stability and low correlation, which is ideal for minimising risk.



In contrast, the market portfolio demonstrates a dynamic adjustment of weights, with stocks like Rio Tinto gaining prominence during periods of higher expected returns, which demonstrates its focus on maximising risk-adjusted performance in response to market changes.



### 4. Results

The results of the analysis evaluated the performance of seven distinct investment strategies over a 10-year period, from October 2014 to October 2024, starting with an initial capital of £1000.

The strategies were as follows:

1. **Market Portfolio Without Rebalancing:** Invested in the market portfolio using fixed weights (October 2014), with no rebalancing.
2. **Minimum Variance Portfolio Without Rebalancing:** Like the first strategy but using minimum variance portfolio weights. In both cases, annual portfolio returns were calculated as the weighted sum of individual stock returns, compounding iteratively over time.
3. **Market Portfolio with Rebalancing:** Rebalanced portfolio weights every six months to reflect changes in the optimum market portfolio.
4. **Minimum Variance Portfolio with Rebalancing:** Rebalanced portfolio weights every six months for the minimum variance portfolio.
5. **Risk-Free Asset:** Invested entirely in the UK 1-month GILTS, serving as the risk-free asset.
6. **UK Stock Market:** Invested fully in the UK stock market, represented by the FTSE All-Share Index.
7. **Forecasting Model Strategy:** Allocated capital between the UK stock market and the risk-free asset based on the recommendations from a forecasting model.

making it attractive to risk-averse investors, although rebalancing costs remain a challenge.

Without rebalancing, portfolios such as the market and minimum-variance approaches showed decent returns but increased risk over the 10-year period due to weighting drifts. Passive strategies such as the UK Stock Market Index are simple and low cost, but returned only 26%, underperforming active methods. Meanwhile, the risk-free asset, with growth of just 14%, is insufficient for long-term goals. The forecasting model strategy performed moderately well (121%), but the ARIMA model has its limitations - it assumes linear trends and struggles with sudden market shocks or non-linear patterns, reducing its reliability in volatile periods.

Choosing the right strategy depends on an investor's objectives and risk tolerance. Stability seekers may prefer a minimum-variance rebalanced portfolio, while growth-oriented investors can maximise returns with the market portfolio, adjusting the rebalancing frequency to manage costs. Passive index funds remain a low-cost fallback, but regular monitoring and adaptation to changing market conditions are critical to success.

The results of these strategies are detailed below.

Strategies	Terminal Wealth (£)	% Return
Market Portfolio Without Rebalancing	2360.93	136%
Min Variance Portfolio Without Rebalancing	2608.04	161%
Market Portfolio With Rebalancing	3032.13	203%
Min Variance Portfolio With Rebalancing	2536.47	154%
Risk-Free Asset	1135.82	14%
UK Stock Market	1264.99	26%
Forecasting Model Strategy	2208.81	121%

## 5. Conclusions

The results highlight the trade-offs between strategies. The Market Portfolio with Rebalancing delivered the best return (203%), but frequent rebalancing incurs high transaction costs, which can eat into profits, especially for smaller portfolios. The Minimum Variance Portfolio with Rebalancing delivered strong returns (154%) with greater stability,