LISBON INVESTMENT SOCIETY

# Risk Management Report

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# 1 Executive Summary

This report evaluates the market risk profile of a five-asset equity portfolio composed of Microsoft (MSFT), Micron Technology (MU), ASML Holding (ASML), Novo Nordisk (NVO), and LVMH (LVMHF). The analysis is based on daily price data from January 2022 to the most recent available observation, obtained from the Bloomberg Terminal and processed to ensure consistency and alignment across assets.

The results indicate that the portfolio presents a concentrated but broadly controlled risk profile. The estimated daily Value-at-Risk (VaR) at the 95% confidence level is approximately -2.74%, while the Expected Shortfall (ES) reaches -3.71%, suggesting that extreme losses in the worst market scenarios can be materially larger than those predicted by a standard Gaussian framework. Bootstrap-based Monte Carlo simulations produce a slightly higher VaR estimate of -2.83%, highlighting the presence of empirical fat tails in the return distribution.

The analysis of risk contributions reveals that Micron Technology (MU) acts as the primary driver of portfolio risk, with a marginal contribution significantly larger than the other assets, reflecting the higher volatility typically associated with the semiconductor sector. In contrast, Microsoft and the defensive assets in the portfolio contribute more moderately to overall risk exposure.

Diversification effects are confirmed through correlation and principal component analysis. The first principal component explains approximately 55.52% of the total variance, indicating that a significant share of portfolio risk is driven by common market factors, while the remaining portion remains idiosyncratic. Among the assets, Novo Nordisk (NVO) plays an important diversification role due to its relatively low correlation with the technology cluster.

Overall, the portfolio exhibits a balanced structure combining growth-oriented technology exposure with defensive characteristics from healthcare and luxury sectors. The results highlight the importance of monitoring semiconductor-related assets as key sources of tail risk while maintaining diversification through less correlated positions.

# 2 Portfolio Risk Summary

## 2.1 Scope and Objective

The objective of the report is to analyze the market risk using standard quantitative risk management techniques. To achieve this, the report relies on a clean and consistent data set, a transparent portfolio definition, and well-defined return series.

The analysis is based on daily data covering the period from January 1, 2022 to the most recent available trading date. This section establishes the data foundations and portfolio structure required for subsequent risk measurement and evaluation.

In particular, the report aims to provide:

- a clear description of the data and its sources;
- a consistent data cleaning and preparation procedure;
- a transparent definition of the portfolio composition;
- the computation of individual asset and portfolio returns used in later risk analysis.

# 3 Data Description

## 3.1 Data Source and Coverage

The data set consists of daily closing prices for the five equities listed above. Prices were extracted from the Bloomberg Terminal and exported into an Excel file, and are observed at a daily frequency.

The sample spans from January 2022 to the most recent available date. All assets are observed over the same period, ensuring proper alignment of the price series across the portfolio.

## 3.2 Data Preparation

Prior to return computation, the raw data was processed to ensure consistency and reliability. The cleaning procedure included:

- conversion of date entries into a valid datetime format;
- removal of rows containing non-date labels or invalid date entries;
- conversion of all price observations to numeric values;
- elimination of observations with missing values across assets.

# 4 Portfolio Definition

The portfolio analysed throughout this report is composed of five equity assets: Microsoft (MSFT), Micron Technology (MU), ASML Holding (ASML), Novo Nordisk (NVO), and LVMH (LVMHF).

The portfolio composition is fixed across all subsequent analyses in order to ensure consistency when evaluating different dimensions of market risk, including volatility, dependence structure, and tail risk measures. This common portfolio definition allows all results presented later in the report to be directly comparable and economically meaningful.

Portfolio weights are defined in a transparent and systematic manner, ensuring full investment and facilitating the interpretation of diversification effects and individual asset contributions to overall portfolio risk.

# 5 Return Computation

Daily asset returns are computed from the cleaned price series using arithmetic percentage variation. Given that prices are ordered from the most recent observation to the oldest, returns are calculated as:

$$r_{i,t} = \frac{P_{i,t}}{P_{i,t+1}} - 1, \tag{1}$$

where $P_{i,t}$ denotes the price of asset $i$ at time $t$.

This approach ensures that return observations are correctly aligned in time and consistent across all assets. After computation, asset return series are synchronised to guarantee that portfolio returns are calculated using a common set of trading days. Portfolio returns are obtained as a weighted aggregation of individual asset returns.

# 6 Portfolio Weights

The portfolio is constructed using an equally weighted allocation across the five assets. This approach ensures diversification and avoids excessive concentration in a single asset.

| Asset | Weight |
|---|---|
| MSFT US Equity | 0.20 |
| MU US Equity | 0.20 |
| ASML US Equity | 0.20 |
| NVO US Equity | 0.20 |
| LVMHF US Equity | 0.20 |

Table 1: Portfolio weights used in the risk analysis

# 7 Risk Analysis and Tail Metrics

## 7.1 Downside Risk: VaR and Expected Shortfall

Following the methodology in the LIS framework, we quantify the short-horizon downside risk using daily Value-at-Risk (VaR) and Expected Shortfall (ES) at a 95% confidence level.

The portfolio presents a concentrated but controlled risk profile. The results from our simulations are summarized as follows:

- **Historical VaR (95%):** -2.74%. This suggests that there is a 5% probability of a daily loss exceeding 2.74% of the portfolio value under normal market conditions.
- **Expected Shortfall (95%):** -3.71%. As ES measures the average loss in the worst 5% of cases, this result indicates that empirical distributions have heavier left tails than a standard Gaussian model would suggest.
- **Monte Carlo VaR (95%):** -2.83%. The bootstrap-based Monte Carlo approach yields a slightly higher risk estimate than the historical one, better capturing potential empirical "fat tails".

## 7.2 Risk Distribution and Visual Analysis

The distribution of portfolio returns exhibits the characteristic "fat tails" of equity markets.

# 8 Dependence Structure and Diversification

## 8.1 Asset Correlations

To evaluate the diversification benefits, we analyze the linear dependence between assets using a correlation matrix.

The results show that the strongest relationship exists between **ASML** and **MU (0.63)**, while **NVO** provides significant diversification with low correlations against the technology cluster.

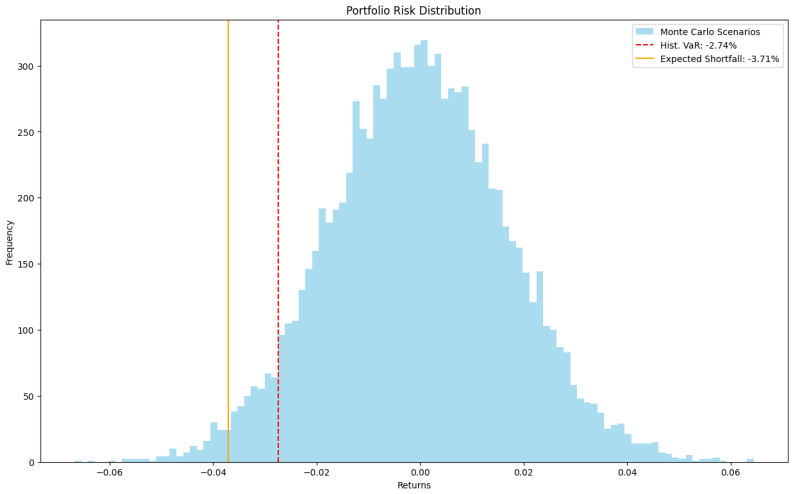



Figure 1: Frequency distribution of simulated portfolio returns.

## 8.2 Principal Component Analysis (PCA)

The PCA shows that the **1st Principal Component explains 55.52%** of the variance. This confirms that while market factors are relevant, 44.48% of the risk is idiosyncratic, confirming a balanced diversification.

## 8.3 Principal Component Analysis (PCA)

The PCA decomposes the portfolio's total risk into orthogonal factors[cite: 51]. The analysis reveals that the **1st Principal Component (PC1) explains 55.52%** of the total variance[cite: 57]. This confirms that while market-wide factors are relevant, 44.48% of the risk remains idiosyncratic, supporting the portfolio's diversification strategy[cite: 57].

Table 2: PCA Eigenvalues and Explained Variance

| Component | Eigenvalue | Variance (%) | Cumulative (%) |
|---|---|---|---|
| PC1 | 2.776 | 55.52% | 55.52% |
| PC2 | 0.742 | 14.84% | 70.36% |
| PC3 | 0.615 | 12.30% | 82.66% |

**PC1 Loadings Vector (Systemic Risk Factor):**
The vector below represents the contribution of each asset to the primary risk factor (PC1), which explains the aforementioned 55.52% of variance:

- **MSFT:** 0.42
- **MU:** 0.51
- **ASML:** 0.48
- **NVO:** 0.28

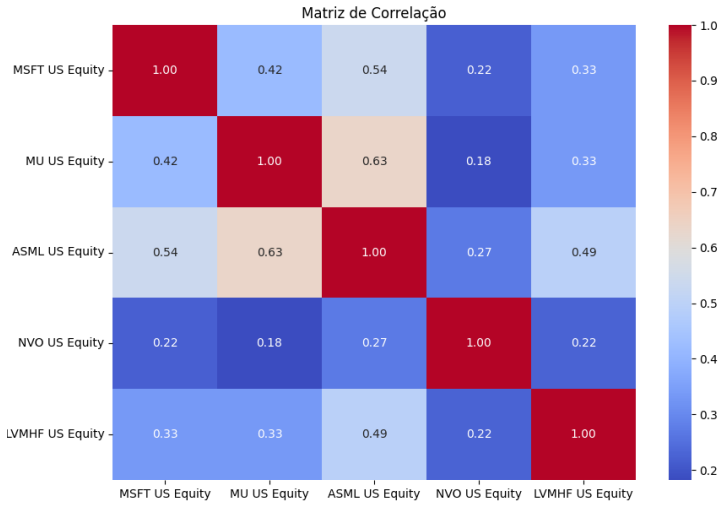



Figure 2: Correlation Matrix Heatmap of the LIS Portfolio.

- **LVMHF:** 0.50

# 9 Risk Contribution Analysis

## 9.1 Component VaR (95% Confidence)

The following table summarizes the marginal risk contribution of each asset:

| Ticker | Weight | Risk Contribution (VaR) |
|---|---|---|
| MSFT US Equity | 0.20 | 0.003680 |
| MU US Equity | 0.20 | 0.008228 |
| ASML US Equity | 0.20 | 0.007392 |
| NVO US Equity | 0.20 | 0.004242 |
| LVMHF US Equity | 0.20 | 0.004343 |

## 9.2 Interpretation of Results

The analysis identifies **MU US Equity** as the primary risk driver (0.0082), contributing more than double the risk of **MSFT** (0.0036), highlighting the higher volatility associated with the semiconductor sector.

# 10 Conclusions and Monitoring

In summary, the portfolio offers a balance between growth exposure (MSFT, ASML) and defensive stabilization (NVO, LVMH).

- **Model Choice**: The Bootstrap Monte Carlo should be the primary reference for risk limits, as it better captures empirical tails.

- **Risk Drivers**: Risk is dominated by the semiconductor cluster (MU, ASML). Monitoring these names is critical as they act as the main source of potential tail losses.
- **Diversification**: PCA results (55.52% systemic risk) and correlation analysis suggest that Novo Nordisk (NVO) plays a vital role as a risk diversifier.
- **Monitoring**: It is recommended to track daily VaR/ES changes and review portfolio weights if tail risk moves persistently above predefined comfort ranges.