LISBON INVESTMENT SOCIETY

Risk Management Report

LIS - Lisbon Investment Society

February, 2026

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Portfolio Risk Summary

Scope and Objective

This note summarises the risk profile of a five-stock equity portfolio composed of:

$$\text{MSFT}(\approx 25\%),\ \text{MU}(\approx 12.6\%),\ \text{ASML}(\approx 13.4\%),\ \text{NVO}(\approx 24\%),\ \text{LVMHF}(\approx 25\%),$$

using daily data. This report will give a concise view of:

- optimal portfolio weights that minimise tail risk (99% Expected Shortfall) while preserving diversification);
- short-horizon downside risk of the final portfolio (1-day VaR and ES at 99%, parametric and bootstrap));
- how risk is distributed across positions and how diversification improved relative to the equal-weight baseline (Component ES attribution and Diversification Ratio).
- single-name tail risk of the main risk contributor (NVO)

Executive Summary

This report constructs and evaluates an optimised five-stock equity portfolio. Weights were determined through a combined optimisation that simultaneously minimises 99% Expected Shortfall and maximises the Diversification Ratio, subject to position bounds of 5–25% per asset. The optimisation delivers consistent improvements across all risk dimensions. Annualised portfolio volatility noted a drop of 8%, and historical 99% ES registered a decline of 6.7%. Risk concentration, measured by the spread between the highest and lowest Component ES contributors, **compressed sharply from 16.2 to 5.5 percentage points**, reflecting a near-uniform distribution of tail risk. The Diversification Ratio improved from 1.414 to 1.457, confirming that lower risk and better diversification were achieved simultaneously. At the latest Monte Carlo window, **1-day 99% bootstrap ES stands at 6.54%**, approximately 1.85 percentage points above the parametric estimate of 4.69%, confirming fat-tail dynamics that a Gaussian model would understate. **NVO is the largest single-name tail risk contributor (23.2% of portfolio ES)**, driven by its event-driven tail risk.

1. Correlation and Baseline Risk

The daily log returns reveal that MSFT, MU, and ASML move closely together, while NVO and LVMHF exhibit materially lower correlations with this cluster supporting genuine cross-sector diversification. At equal weights, this structure produces a heavily skewed risk profile:

- MU contributes **29.4%** of portfolio ES despite holding only 20% of capital;
- ASML contributes **26.5%** ; together, the two assets account for **55.9%** of total tail risk;
- MSFT, NVO, and LVMHF contribute just 13.2%, 15.5%, and 15.5% respectively.

The **16.2 percentage point gap** between the highest (MU, 29.4%) and lowest (MSFT, 13.2%) contributors confirms that equal weights are balanced by capital but **deeply unbalanced by risk**, directly motivating the optimisation.

2. Portfolio Optimisation

Method

- Weights are chosen by minimising a combined objective that simultaneously targets low tail risk and high diversification:

$$\min_{\mathbf{w}} \ \mathrm{ES}(\mathbf{w}) - \lambda \cdot \mathrm{DR}(\mathbf{w}), \quad \lambda = 0.05$$

$$\text{subject to} \quad \sum_i w_i = 1, \quad 0.05 \leq w_i \leq 0.25 \quad \forall i$$

- **Expected Shortfall** $\mathrm{ES}(\mathbf{w})$: the average portfolio loss on the worst 1% of trading days, computed directly from ranked empirical returns with no distributional assumption.
- **Diversification Ratio** $\mathrm{DR}(\mathbf{w}) = \dfrac{\sum_i w_i \sigma_i}{\sigma_p}$: the ratio of the weighted-average individual volatilities to actual portfolio volatility. A value above 1 indicates that diversification is reducing portfolio risk below the weighted sum of individual risks.
- A λ **of 0.05** keeps ES minimisation as the primary objective, with DR acting as a tie-breaker that prevents the optimiser from over-concentrating into a single low volatility name. The problem is solved numerically using SLSQP.

Key Findings

MU (−7.4pp) and ASML (−6.6pp) were cut most aggressively their high volatility and mutual correlation made them the dominant tail risk drivers at equal weights. Capital shifted toward MSFT (25.0%), NVO (24.0%), and LVMHF (25.0%). The results across all risk dimensions:

- Annualised volatility: 26.89% → 24.74% (−8.0%);
- Historical 99% ES: 5.67% → 5.29% (−6.7%);
- Largest contributor: MU 29.4% → NVO 23.2%;
- Risk spread (max − min): 16.2pp → 5.5pp;
- Diversification Ratio: 1.414 → 1.457.

Volatility fell more than ES (8.0% vs 6.7%) because deep tail risk is partly driven by NVO's own event-driven risk, which reweighting cannot fully eliminate.

3. Short-Horizon Risk

Method

- Daily returns are simulated under two models:
  - **Parametric Monte Carlo**: normal distribution fitted to sample mean and variance of the rolling window;
  - **Bootstrap Monte Carlo**: resampling from historical returns to preserve empirical skewness and fat tails.
- For each day, we generate a distribution of 1-day portfolio P&L and compute:
  - 99% **Value at Risk (VaR)**: loss exceeded in 1 out of 100 days;
  - 99% **Expected Shortfall (ES)**: average loss conditional on being in the worst 1% tail.

Key Findings

- The simulated 1-day P&L distribution (Figure 1) is centred close to zero but exhibits a visibly heavy left tail, consistent with the fat-tail dynamics of a technology and healthcare equity portfolio.
- At the 99% level, the latest window yields:
  - Parametric VaR: **4.08%**, Parametric ES: **4.69%**
  - Bootstrap VaR: **5.96%**, Bootstrap ES: **6.54%**.

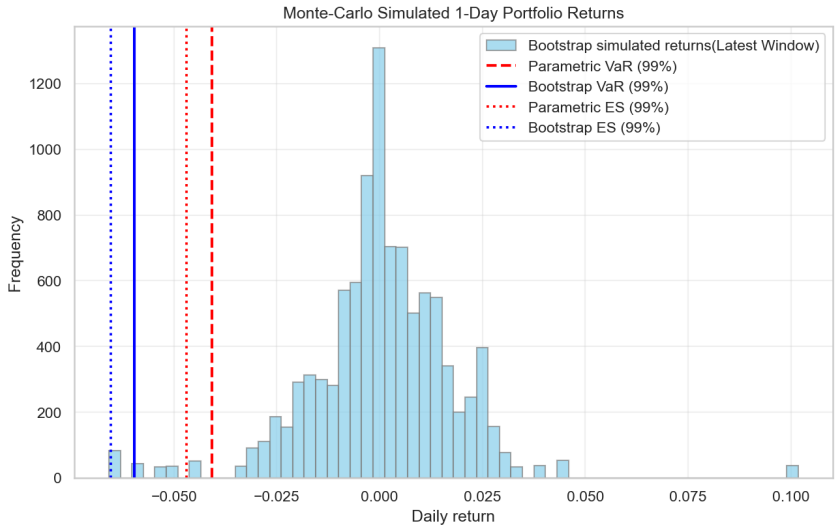


Figure 1: Monte Carlo simulated 1-day portfolio returns with 99% VaR and ES (parametric vs bootstrap)

- **Bootstrap estimates are consistently more conservative**: The gap between bootstrap ES (6.54%) and parametric ES (4.69%) confirms that the empirical distribution has heavier left tails than a normal model implies. A Gaussian assumption would understate tail risk by nearly 40%.
- ES is systematically above VaR at both confidence levels, quantifying the severity of losses once the VaR threshold has been breached.
- Over time (Figure 2), all four series fluctuate with market conditions. Risk was elevated in early 2023, compressed through mid-2024, and has risen again toward 2026 , reflecting the increasing volatility of the semiconductor and healthcare stocks in the portfolio.

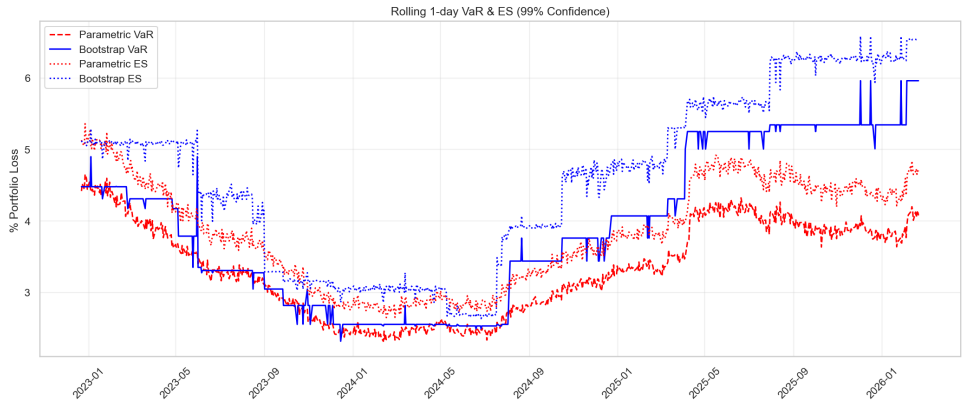


Figure 2: Rolling 1-day VaR and ES (99% confidence) : parametric vs bootstrap.

Bootstrap 99% VaR and ES should serve as the primary reference metrics for daily risk limits. The parametric figures are useful as a quick benchmark, but should not be used alone given that this portfolio exhibits heavier tails than a normal distribution assumes.

4. Single-Name Tail Risk

To complement the portfolio-level metrics, the tail behaviour of NVO US Equity is analysed. The largest Component ES contributor at 23.2% of portfolio tail risk. Its empirical return distribution and historical VaR and ES levels are shown in Figure 3.

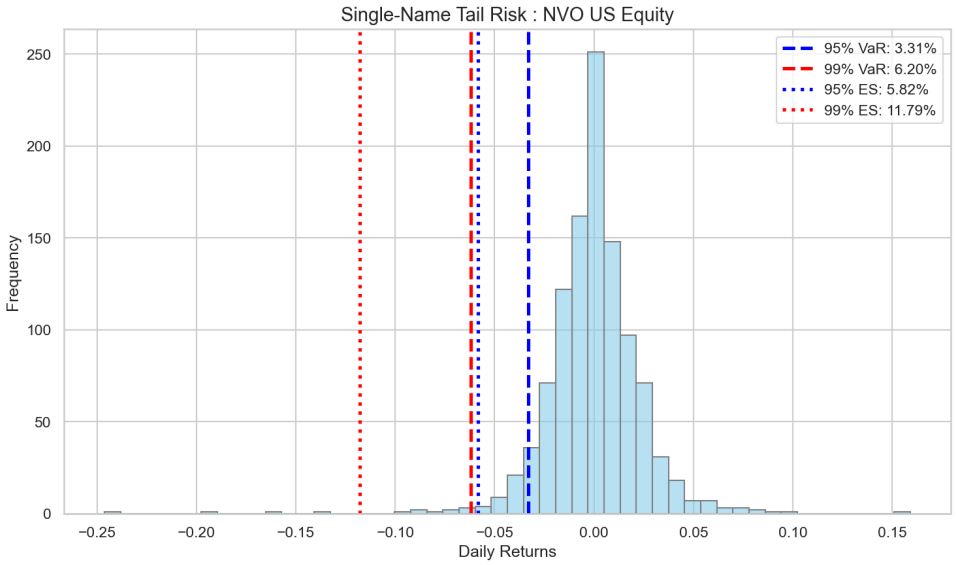


Figure 3: Historical daily returns for NVO US Equity with 95% and 99% VaR and ES levels marked.

From this distribution:

- 95% 1-day historical VaR is **3.31%**, with ES of **5.82%**
- 99% 1-day historical VaR is **6.20%**, with ES of **11.79%**

Two features stand out. First, the ES/VaR ratio is high, showing that losses beyond the threshold tend to be significantly larger, not just near the limit. Second, moving from 95% to 99% confidence, ES **nearly doubles** (5.82% to 11.79%) while VaR increases to 6.20% ,as we look deeper into the tail, the worse the losses get, consistent with a stock prone to large single-day moves.

NVO's **99% ES of 11.79%** explains why it remains the **largest Component ES contributor at 23.2%**, even at a below equal-weight position. Position sizing alone cannot eliminate event-driven tail risk, so actively monitoring NVO's event calendar is still necessary alongside the quantitative risk framework.

5. Conclusions

- **Optimal Allocation**: Final weights of MSFT 25.0%, MU 12.6%, ASML 13.4%, NVO 24.0%, and LVMHF 25.0% reflect the optimiser's reducing to MU and ASML the two assets that contributed most to tail risk, and shifting capital toward assets from different sectors that diversify the portfolio more effectively.
- **Risk Reduction**: Optimisation improved all risk metrics simultaneously annualised volatility fell 8.0%, daily ES fell 6.7%, and the risk spread compressed by 10.7pp. Lower risk and better diversification were achieved without sacrificing one for the other.
- **Model Choice**: Bootstrap ES (6.54%) should serve as the primary daily risk limit. The parametric figure (4.69%) understates true tail exposure confirming fat-tail dynamics that a Gaussian model cannot capture.
- **Concentration Risk**: Despite optimisation, NVO remains the top risk contributor at 23.2% of portfolio ES. This is an irreducible idiosyncratic exposure that must be managed through monitoring rather than position sizing alone.
- **Diversification**: A DR of 1.457 implies a 31.4% reduction in volatility versus holding the five assets independently, up from 29.3% at equal weights. NVO and LVMHF provide genuine cross-sector diversification.
- **Monitoring**:
  - Track bootstrap VaR/ES and their day-on-day changes as part of the daily risk dashboard;
  - Monitor the Diversification Ratio and key pairwise correlations (MSFT–MU, MSFT–ASML, NVO–LVMHF) monthly;
  - Review portfolio weights if DR falls persistently below 1.40 or bootstrap ES exceeds 7.5%;
  - Flag NVO's event calendar for large single-day losses

In summary, the portfolio achieves a **well-balanced profile of growth exposure, tail risk control, and genuine diversification**. Risk is driven by a small number of identifiable factors, the co-movement of technology assets and NVO's event-driven tail risk and can be monitored effectively using the proposed Monte Carlo and Component ES framework.