



# Under the Hood:

## A Deep Dive into Portfolio Optimisation

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# The Research Objective

## Primary Question

Do sophisticated portfolio optimisation models outperform basic models in out-of-sample testing?

If you have £100,000 to invest across stocks, bonds, precious metals and commodities.  
How should it be allocated?

**We're testing this empirically.**

Portfolio optimisation is central to modern finance, investors rely on mathematical models to allocate capital.

However:

- Empirical evidence suggests naive strategies often perform competitively.
- Market conditions shift across regimes.
- Increased model complexity may not always translate into better outcomes.

*This is a live debate in quantitative finance — theory vs. practice.*

# Our Investment Universe

Asset Class	Examples	Count
UK Equities	HSBC, BP, Shell, Tesco, etc...	15
UK Government Bonds	iShares Core UK Gilts ETF	1
Precious Metals	Invesco Physical Gold ETC	1
Commodities	WisdomTree Commodities ETF	1
<b>Total</b>	<b>Multi-Asset Portfolio</b>	<b>18</b>

**Data period:** 2015–2025 (10 years)

- Including major stress regimes
- Daily prices
- Monthly rebalancing

# The Four Strategies We're Testing

- ① **Equal Weight ( $1/N$ )** — Naive baseline
- ② **Mean-Variance Optimisation (MVO)** — Markowitz (1952)
- ③ **Black-Litterman** — Bayesian equilibrium + views
- ④ **Risk Parity** — Equal risk contribution

All tested on identical data with identical methodology

# Strategy 1: Equal Weight

## The Benchmark

Simplest possible: split money equally across all 18 assets

$$w_i = \frac{1}{N}$$

DeMiguel et al (2009): Equal weight often beats sophisticated models due to estimation error in expected returns and covariances.

## Strategy 2: Mean-Variance Optimisation

Markowitz (1952) — Foundation of Modern Portfolio Theory

Maximize return for given risk (or minimize risk for given return)

$$\max_w \frac{w^T \mu - r_f}{\sqrt{w^T \Sigma w}} \quad \text{s.t.} \quad \sum w_i = 1, w_i \geq 0$$

Highly sensitive to  $\mu$  and  $\Sigma$  estimation and can produce extreme, unstable allocations out-of-sample.

## Strategy 3: Black-Litterman Model

### Fischer Black and Robert Litterman (1992) - Global Portfolio Optimisation

Model was created as an enhancement to MVO which overcomes instability by anchoring to market equilibrium.

$$\text{Posterior Returns} = \text{Equilibrium} + \text{Investor Views}$$

- Posterior Returns → A complex, weighted average which generates an estimate of expected returns.
- Equilibrium → A neutral, market capitalisation-weighted returns
- Investor Views → A non-neutral view on asset returns which is weighted by confidence.

## Strategy 4: Risk Parity

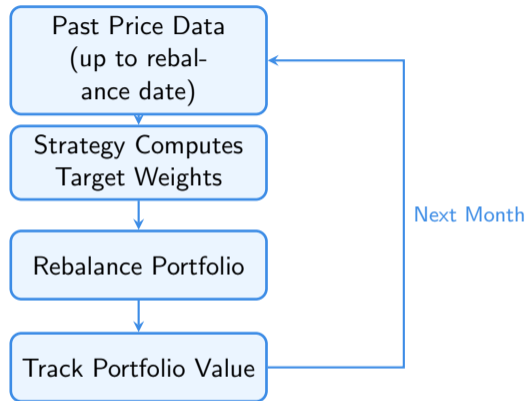
### Equal Risk Contribution, Not Equal Capital

The philosophy of this model is to diversify risk with a structural bias to low-volatility assets.

$$w_i \times \frac{\partial \sigma_p}{\partial w_i} = \frac{\sigma_p}{N}$$

Allocates capital to equalise marginal risk contribution ensuring no single asset or sector is dominant in the portfolio.

# Backtesting Engine



## Critical:

Strictly rolling out-of-sample backtesting with no forward-looking information.

# What We're Measuring

Metric	Definition	Focus
Total Return	Cumulative gain/loss (10 years)	Returns
CAGR	Annualised return	Returns
Volatility	Annualised standard deviation	Risk
Sharpe Ratio	Excess return per unit of risk	Risk Adjusted Performance
Max Drawdown	Largest peak-to-trough decline	
Sortino Ratio	Downside risk-adjusted return	Downside Risk
Turnover	Trading frequency (costs)	Implementation Risk

## **Performance**

- Sharpe ratio, Sortino ratio, Maximum drawdown

## **Regime Robustness**

- Brexit (2016), COVID crash, 2022 equity-bond sell-off

## **Implementation Feasibility**

- Turnover, allocation stability, parameter sensitivity

*Strategies are evaluated on performance, resilience, and implementability.*

# Implementation Status

## Completed:

- Data pipeline (18 assets, 2015-2025)
- Backtesting engine
- Equal weight baseline
- Black-Litterman framework

## → In Progress:

- MVO implementation
- Black-Litterman views
- Risk Parity solver
- Performance analysis

## Coming Soon

- Full backtest results across all 4 strategies
- Regime analysis (bull/bear/crisis)
- Comprehensive research report

## Bridging the gap between theory and practice

Empirical test of whether a theoretical perfect portfolio survives  
real-world estimation errors and regime shifts

*Academic finance says "here's the optimal solution"*  
*We're asking: "does it actually work?"*

## **GitHub Repository**

[github.com/AP-Capital-Research/deep-dive-into-portfolio-optimisation](https://github.com/AP-Capital-Research/deep-dive-into-portfolio-optimisation)

## **Full Research Report**

Expected publication: March 2026

## **Questions or feedback?**

Contact us at [\[rd01004@surrey.ac.uk\]](mailto:rd01004@surrey.ac.uk)

# Thank You

We're excited to share our findings  
with the quant finance community

*Stay tuned for the full results*

