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.

Motivation

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
Total	**Multi-Asset Portfolio**	**18**

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 μ and Σ 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 $\rightarrow$ A complex, weighted average which generates an estimate of expected returns.
- Equilibrium $\rightarrow$ A neutral, market capitalisation-weighted returns
- Investor Views $\rightarrow$ A non-neutral view on asset returns which is weighted by confidence.

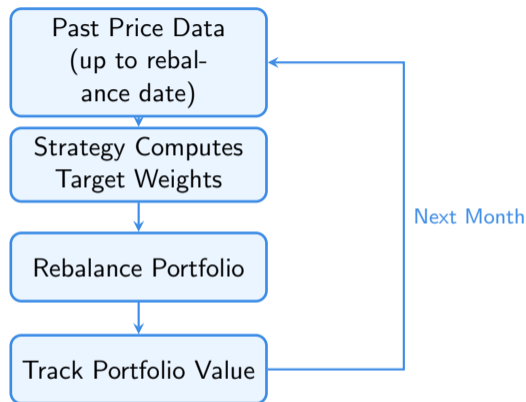# Strategy 4: Risk Parity

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	Tail Risk
Sortino Ratio	Downside risk-adjusted return	Downside Risk
Turnover	Trading frequency (costs)	Implementation Risk

Evaluation Framework

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

$\rightarrow$ **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

Full Research Report

Expected publication: March 2026

Questions or feedback?
Contact us at [email/contact]

Thank You

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

Stay tuned for the full results