Portfolio Optimization on NIFTY 50 Stocks

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1 Problem Setup

We study the classical Markowitz mean–variance portfolio optimization problem using historical price data for NIFTY 50 stocks. The objective is to maximize expected portfolio return subject to a fixed risk constraint, long-only weights, and full investment.

2 Data Processing and Estimation

Daily closing price data was cleaned, consolidated, and reshaped into a price matrix. Due to different listing dates, two analysis universes were constructed:

- **Full Universe:** 50 stocks with $\sim$10 years of common history
- **Extended History:** 38 stocks with $\sim$17 years of data

Daily returns were computed and annualized using the standard **252 trading-day convention**. The Global Minimum Variance (GMV) risk floors were:

- Full Universe: $\approx 13.4\%$
- Extended History: $\approx 17.0\%$

3 Optimization Method

The optimization problem is:

$$\max_{w} \ \mu^\top w \quad \text{s.t.} \quad w^\top \Sigma w \le \sigma^2, \ \mathbf{1}^\top w = 1, \ w \ge 0$$

The problem is convex and solved using **Clarabel**, an interior-point conic solver. The model was implemented both via CVXPY and via Clarabel's raw cone interface, where the quadratic risk constraint is expressed as a second-order cone using Cholesky factorization. Both approaches produced identical solutions.

4 Results

Full Universe (50 Stocks)

Target Risk	Exp. Return	# Stocks	Key Holdings
15%	22.04%	12	HINDUNILVR, SHREECEM
20%	29.82%	6	HINDUNILVR, BAJAJFINSV
25%	33.56%	5	BAJAJFINSV, SHREECEM

Higher risk targets lead to increased concentration in high-return stocks.

Extended History (38 Stocks)

Target Risk	Exp. Return	# Stocks	Key Holdings
17%	16.70%	21	HINDUNILVR, BRITANNIA
20%	28.13%	12	SHREECEM, ASIANPAINT
25%	35.08%	7	SHREECEM, BAJFINANCE

The extended-history portfolios are more diversified at lower risk levels but outperform the full-universe portfolios at higher risk, reflecting more conservative risk estimation from longer data.

5 Constraints and Robustness

Introducing a 10% maximum weight cap at 20% risk increased diversification (6 to 12 stocks) while reducing expected return from 29.82% to 25.86%.

Additional experiments varying solver tolerances, scaling, regularization, early stopping, and input noise showed that:

- Optimal portfolios are numerically stable
- Default Clarabel settings are sufficient
- Small perturbations in expected returns do not change portfolio structure

6 Conclusion

This work demonstrates the effectiveness of convex optimization for portfolio construction and highlights the impact of data horizon, constraints, and solver settings. Clarabel provides robust and reliable solutions, and the results illustrate fundamental risk–return and diversification trade-offs in practical portfolio optimization.