Portfolio Optimizer- Ethan Alan John

What I set out to do

I built a small, investable portfolio of NSE stocks that balances **evidence from markets** with **my own views** without overreacting to either. The tool I used is **Black–Litterman**: it starts from the market's implied expectations and then lets me add modest, transparent tilts where I have conviction. This approach is widely used in practice because it avoids extreme weights and makes views measurable.

Data & setup

- **Market proxy:** NIFTY50 (Yahoo ticker ^NSEI).
- **Assets:** I created a focused set of NSE stocks chosen through fundamental analysis (Hindustan Copper Limited, Fortis Healthcare Limited, Indian Energy Exchange Limited, Waaree Energies Limited).
- **Frequency:** Daily returns, annualized using 252 trading days.
- **Risk-free:** 6.5% (India taken from **Aswath Damodaran's Country Risk Premiums**).
- **Files produced:** daily returns table, annual expected returns, CAPM results, covariance & correlation matrices, inverse covariance, portfolio weights.

Method overview

1. **Build clean returns:** Pull prices, compute daily % changes for each stock and the NIFTY50 index.
2. **Sanity checks:** Spot missing dates, duplicates, and outliers (e.g., >50% daily moves).
3. **Risk model:** Create the **covariance matrix (Σ)** of stock returns, handle singularities with pseudo-inverse if needed.
4. **Market baseline:** Derive **implied returns** that would make the market-cap portfolio optimal under Σ (create a benchmark).
5. **CAPM calibration:** Compute **expected returns using CAPM**, estimating each stock's beta against NIFTY50 and defining the key **Markowitz 'Greek' parameters (α, β, γ, Δ)** used in portfolio construction.
6. **Views:** Apply small, explicit adjustments (e.g., "Stock X +2pp expected return")—this is where my research goes in.

7. **Optimization:** Compute weights from the updated returns and Σ; also show **tangency** and **minimum-variance** portfolios for context.
8. **Evaluate:** Report expected return, volatility, and **Sharpe ratio**, and compare to a simple market-cap portfolio.

Outputs

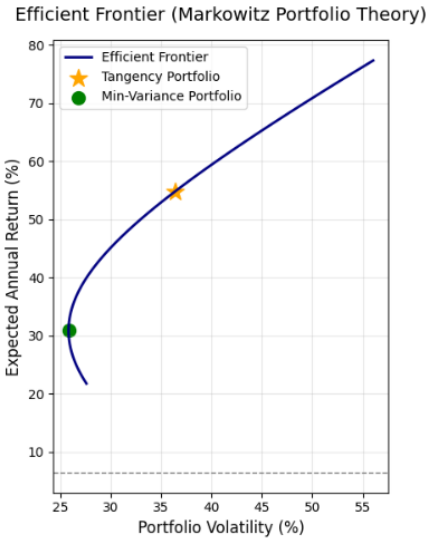
1. Calculated CAPM Expected Returns

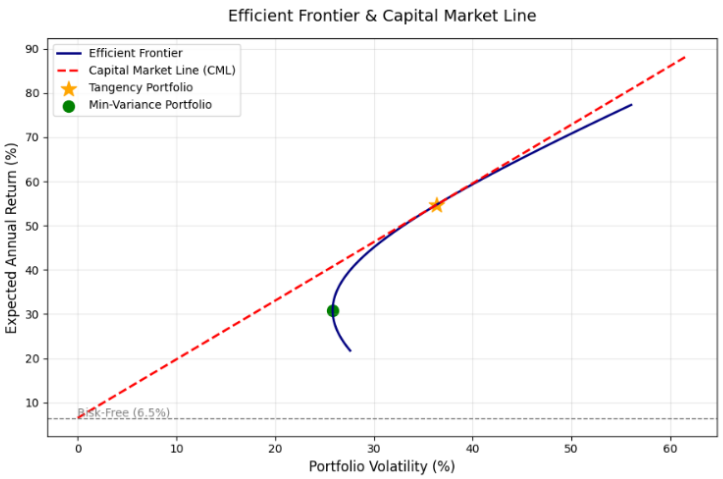
```
✅ CAPM results saved to capm_results.csv
       Symbol      Beta  Expected Annual Return %  CAPM Expected Return %  \
0  WAAREEENER  0.264817                 77.289283                8.185741
1  HINDCOPPER  0.114364                 34.489072                7.228009
2      FORTIS -0.084010                 27.967889                5.965215
3         IEX  0.076546                 21.749459                6.987270
```

2. Calculated Markowitz's Greeks, Lagrange multipliers, minimum-variance portfolios and tangency portfolios.

```
✅ Alpha (α) Computed Successfully
α (e^T·C^-1·e) = 15.001366

✅ Markowitz scalars
α = 15.001366
β = 4.625514
γ = 2.298590
Δ = 13.086605

✅ Tangency portfolio (risky assets only)
E[R_tan]  = 54.73%
Vol_tan   = 36.35%
Sharpe_tan= 1.327

✅ Minimum-variance portfolio
E[R_mv]   = 30.83%
Vol_mv    = 25.82%
Sharpe_mv = 0.942

Tangency weights (sum≈1):
     Symbol    w_tan
    FORTIS 0.289987
HINDCOPPER 0.097105
       IEX 0.073806
WAAREEENER 0.539103

Min-variance weights (sum≈1):
     Symbol  w_minvar
    FORTIS  0.439438
HINDCOPPER  0.107979
       IEX  0.362985
WAAREEENER  0.089598

λ(R*) = -0.017806,  μ(R*) = 0.273941  (with R* = 54.73%)
```

3. Created visualisations of the efficient frontier.





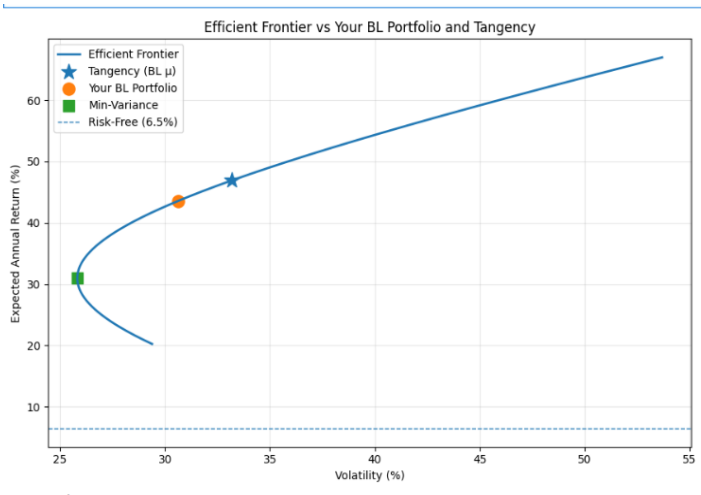
4.Created comparison of CAPM weighted portfolio and Market-Cap Weighted Portfolio.

```
Comparison: Calculated vs Market Cap Weights
    Symbol  Calculated Weight  Market Cap Weight  Difference
    FORTIS           0.289987           0.349988   -0.060001
HINDCOPPER           0.097105           0.141233   -0.044129
       IEX           0.073806           0.052388    0.021418
WAAREEENER           0.539103           0.456390    0.082712
```

5. Introduced my views and readjusted weights.

```
=== Black-Litterman: Non-Interactive Sensitivity (via view deltas) ===
    Symbol  Implied μ (dec)  View Δ (pp)  New μ (dec)  MktCap w  New Weight  Diff (New - Mkt)
    FORTIS         0.290660          2.0     0.310660  0.349988    0.386018          0.036029
HINDCOPPER         0.367664          0.0     0.367664  0.141233    0.140273         -0.000961
       IEX         0.172431          3.0     0.202431  0.052388    0.113840          0.061451
WAAREEENER         0.769659        -10.0     0.669659  0.456390    0.359870         -0.096520

Portfolio (with new μ):  E[R]=43.55%,  Vol=30.62%,  Sharpe (Rf=6.5%): 1.210
```

6. Plotted my BL efficient frontier.




```
=== Comparison ===
Tangency (BL μ):   ER=46.90%,  Vol=33.17%,  Sharpe=1.218
Your BL portfolio: ER=43.55%,  Vol=30.62%,  Sharpe=1.210
Min-Variance:      ER=30.97%,  Vol=25.82%
```

7. Used current market prices and took total funds to be 100000 rupees and created stock allocations.

```
=== Investment Allocation for ₹100,000 ===
    Symbol  Weight  Price (₹)  Amount (₹)  Shares (rounded)
    FORTIS    0.39    1097.90    38601.75                35
HINDCOPPER    0.14     346.30    14027.27                41
       IEX    0.11     139.14    11383.97                82
WAAREEENER    0.36    3514.30    35987.00                10

Total Invested ≈ ₹99,177
```

Takeaways

1. Implemented a professional BL workflow on Indian equities with real data

2. Integrated finance theory with coding practice by combining CAPM, Markowitz mean–variance optimization, and Black–Litterman.

3. Demonstrated quantitative reasoning through computing and interpreting Markowitz's key Greek parameters (α, β, γ, Δ) and Lagrange multipliers to understand how portfolio weights evolve mathematically.

4. Showed practical investment sense by translating theoretical weights into actual rupee allocations based on ₹100,000 invested capital and current stock prices.

Scope for Improvement

1. **Expand asset universe:** Include more sectors and stocks to make the portfolio more diversified and realistic.
2. **Add real-world constraints:** Incorporate factors like transaction costs and liquidity to make the model investable.
3. **Enhance view modeling:** Introduce confidence levels matrix in the Black–Litterman framework instead of fixed percentage adjustments.