Mean-Variance Analysis with AI

MGMT 675: Generative AI for Finance

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Goals

- Compute and plot the **tangency portfolio**
- Compute and plot the **global minimum variance portfolio**
- Compute and plot the **efficient frontier** of risky assets
- Compute and plot the **capital allocation line**

Possible Constraints

- No short sales
- Minimum and maximum positions
- Margin requirements (sum of absolute values of longs and shorts ≤ 2)

Solution Methods

- **Solver**
  - Maximize Sharpe ratio (tangency portfolio)
  - Minimize risk subject to achieving a target expected return (efficient frontier)
  - Minimize risk (global minimum variance portfolio)
- **Analytic/algebraic solution**
  - Solution of a system of linear equations (tangency portfolio)
  - Solution of a system of linear equations (global minimum variance portfolio)
  - Combining solutions of two systems of linear equations (efficient frontier)
  - Available only when there are no constraints

Python Solver Options

- scipy.minimize
- cvxopt
- cvxpy

Ask Claude

Discuss methods to find the tangency portfolio when there are no short sales constraints.

Ask Claude

Discuss the advantages and disadvantages of these solver options for mean-variance analysis.

Exercise: Portfolio Cloud

Consider three assets with the following characteristics:

	Asset A	Asset B	Asset C
Expected return	8%	12%	15%
Standard deviation	14%	20%	26%

Correlations: $\rho_{AB} = 0.3$, $\rho_{AC} = 0.1$, $\rho_{BC} = 0.5$

Assume a risk-free rate of 4%. Ask Claude to:

1. Generate 10,000 random portfolios (random weights summing to 1, no short sales) and plot each portfolio's expected return vs. standard deviation.
2. Overlay the efficient frontier and the capital allocation line on the same plot.