Modern portfolio theory of Harry Markowitz

INTRODUCTION TO PORTFOLIO ANALYSIS IN R

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datacamp

Portfolio weights are optimal

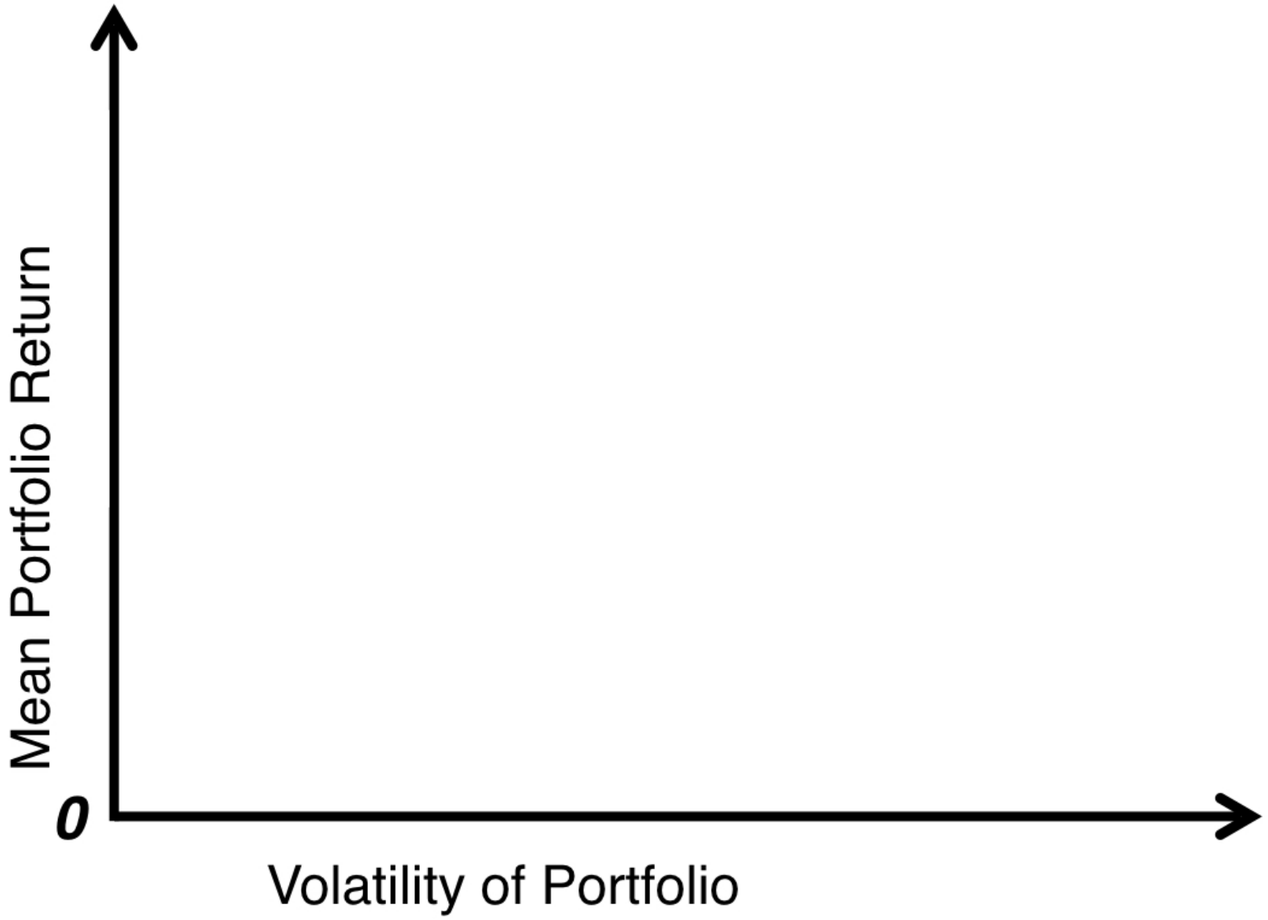
...when they optimize an objective function while satisfying the constraints.

Possible Objectives	Possible Constraints
Maximize expected return	Only positive weights
Minimize the variance	Weights sum to 1 (all capital needs to be invested)
Maximize the Sharpe ratio	Portfolio expected return equals a target value

Harry Markowitz

- Nobel Prize Winner
- Recommends finding optimal portfolios by
  - *Objective*: Minimize portfolio variance
  - *Constraints*:
    - Full investment
    - Expected return should be equal to a pre-specified target return

The H. Markowitz approach



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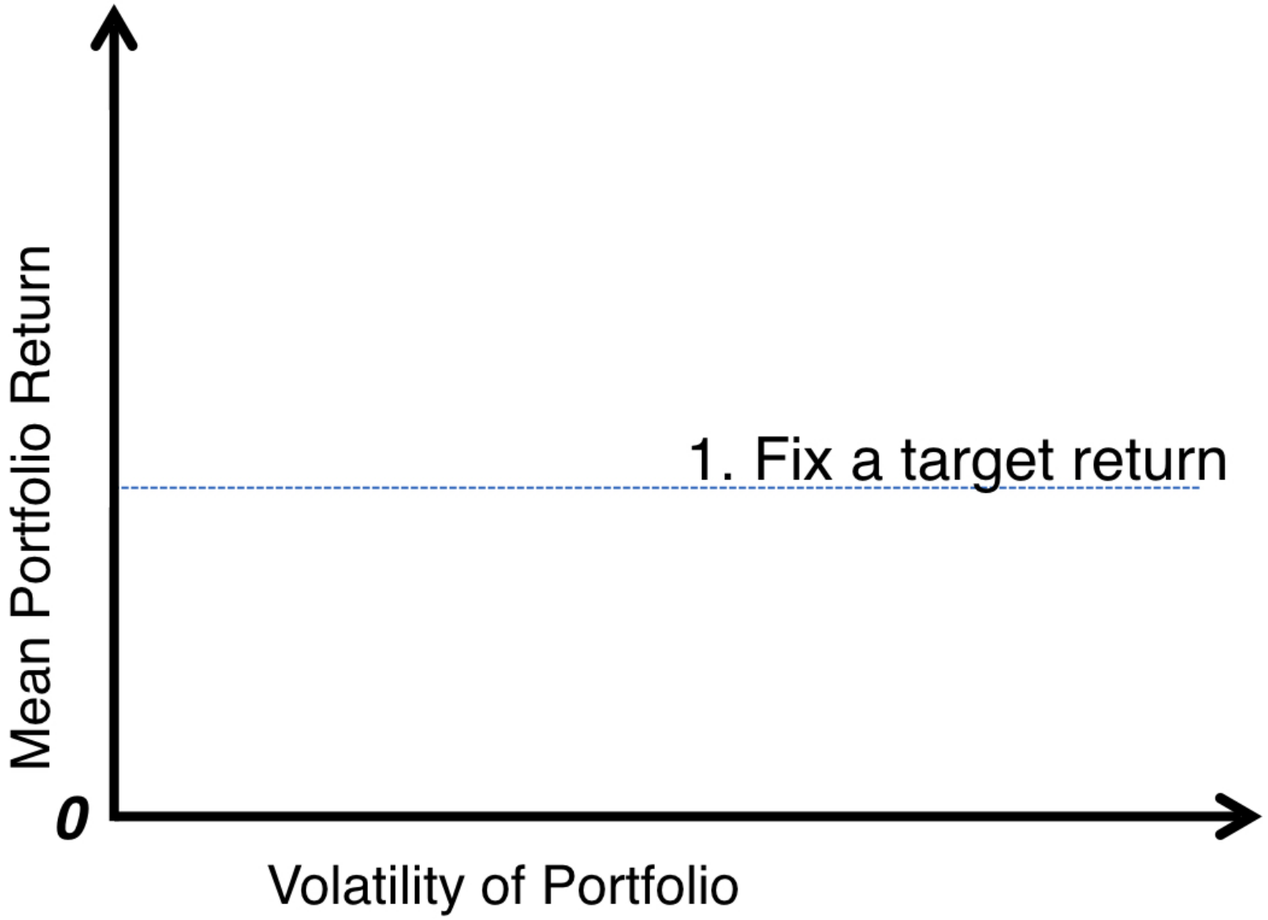

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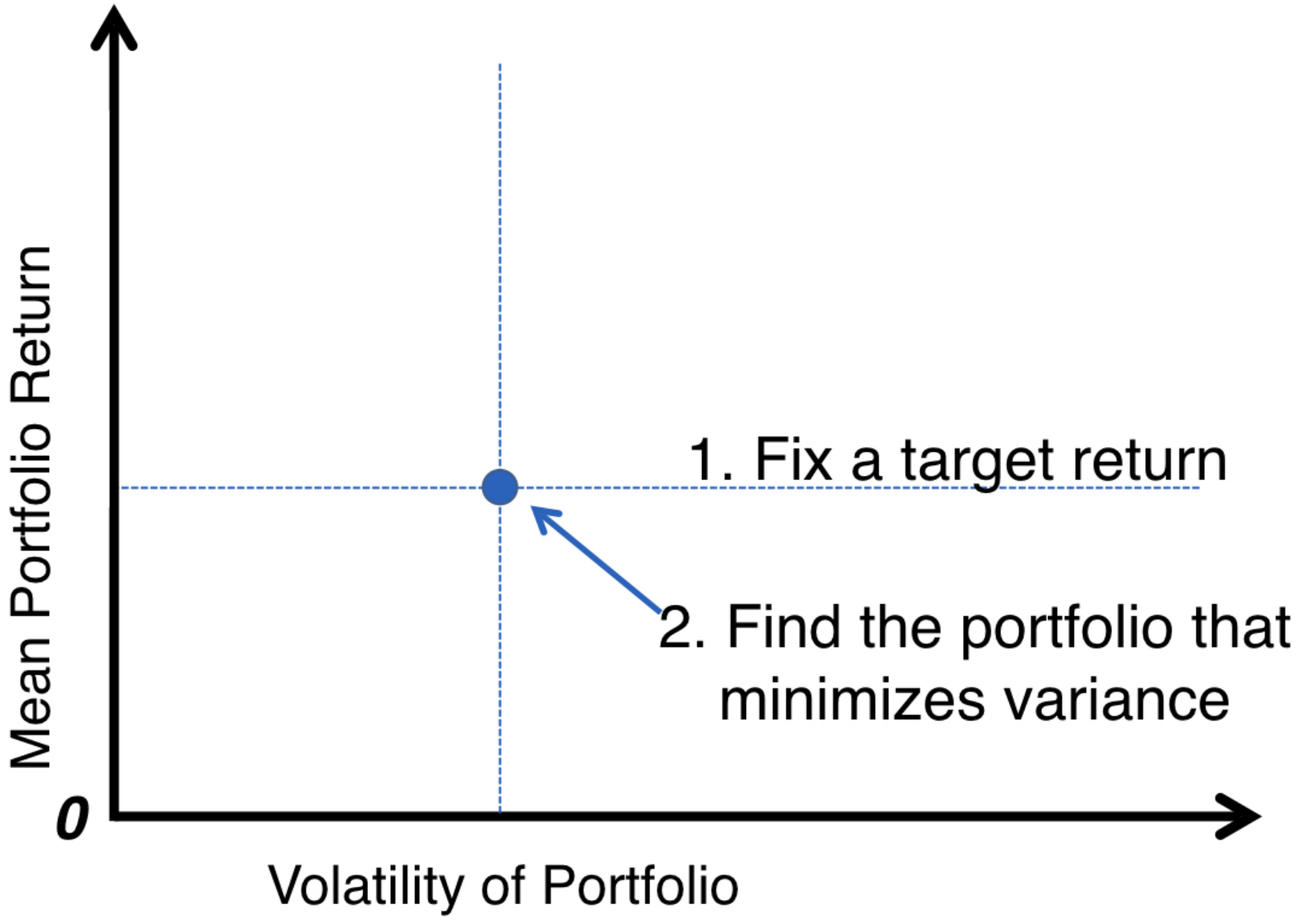

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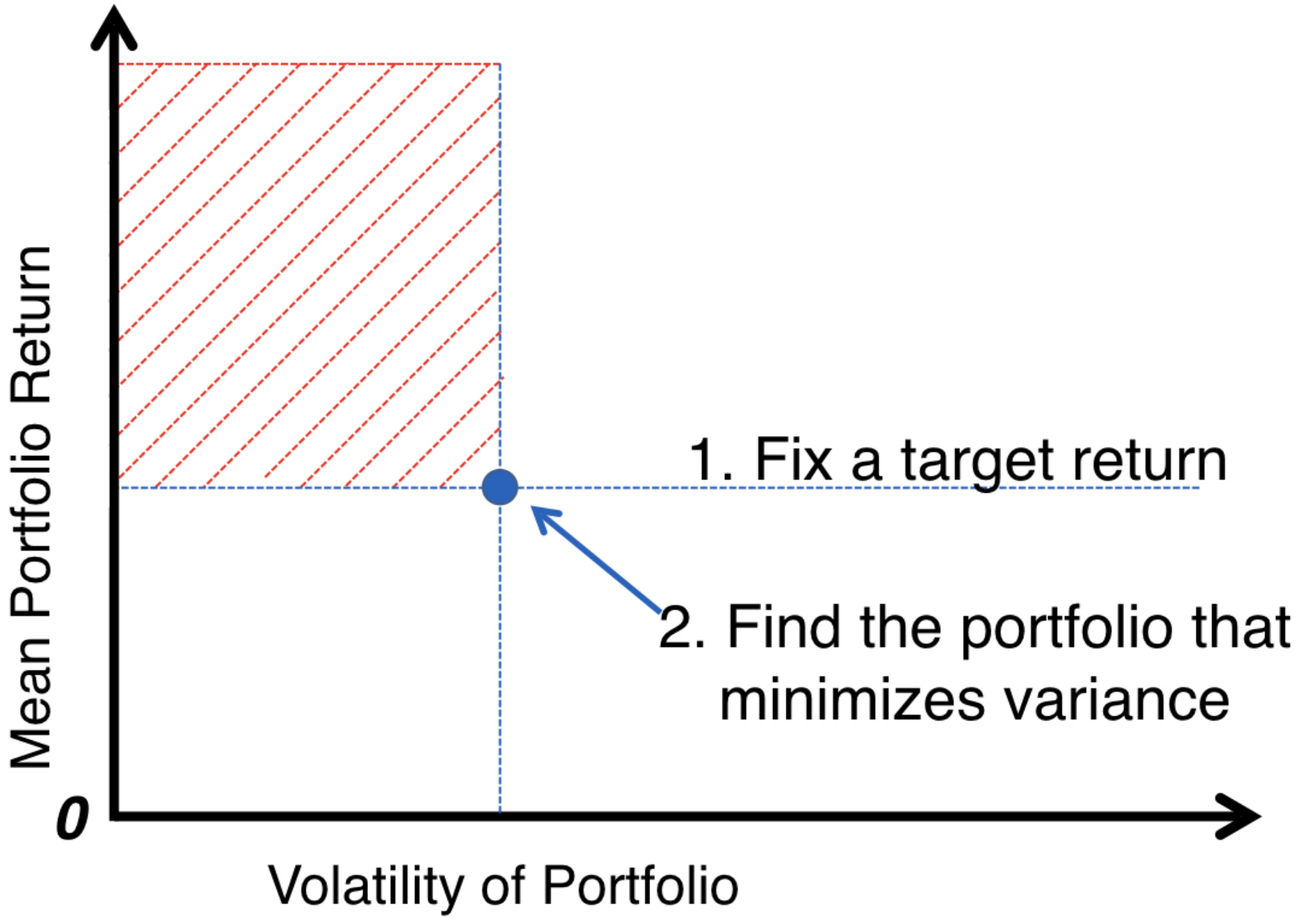

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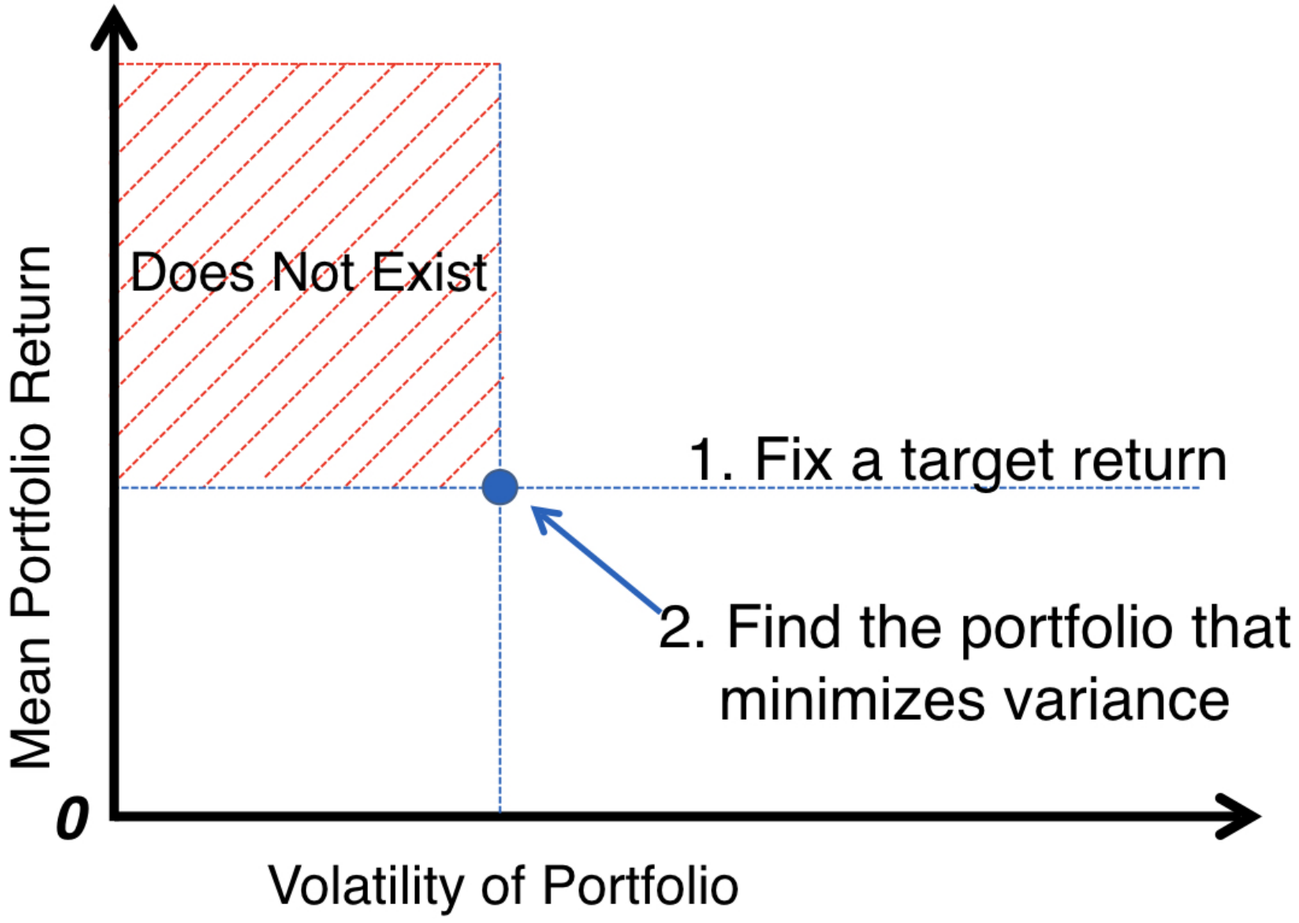

Let's practice!

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The efficient frontier

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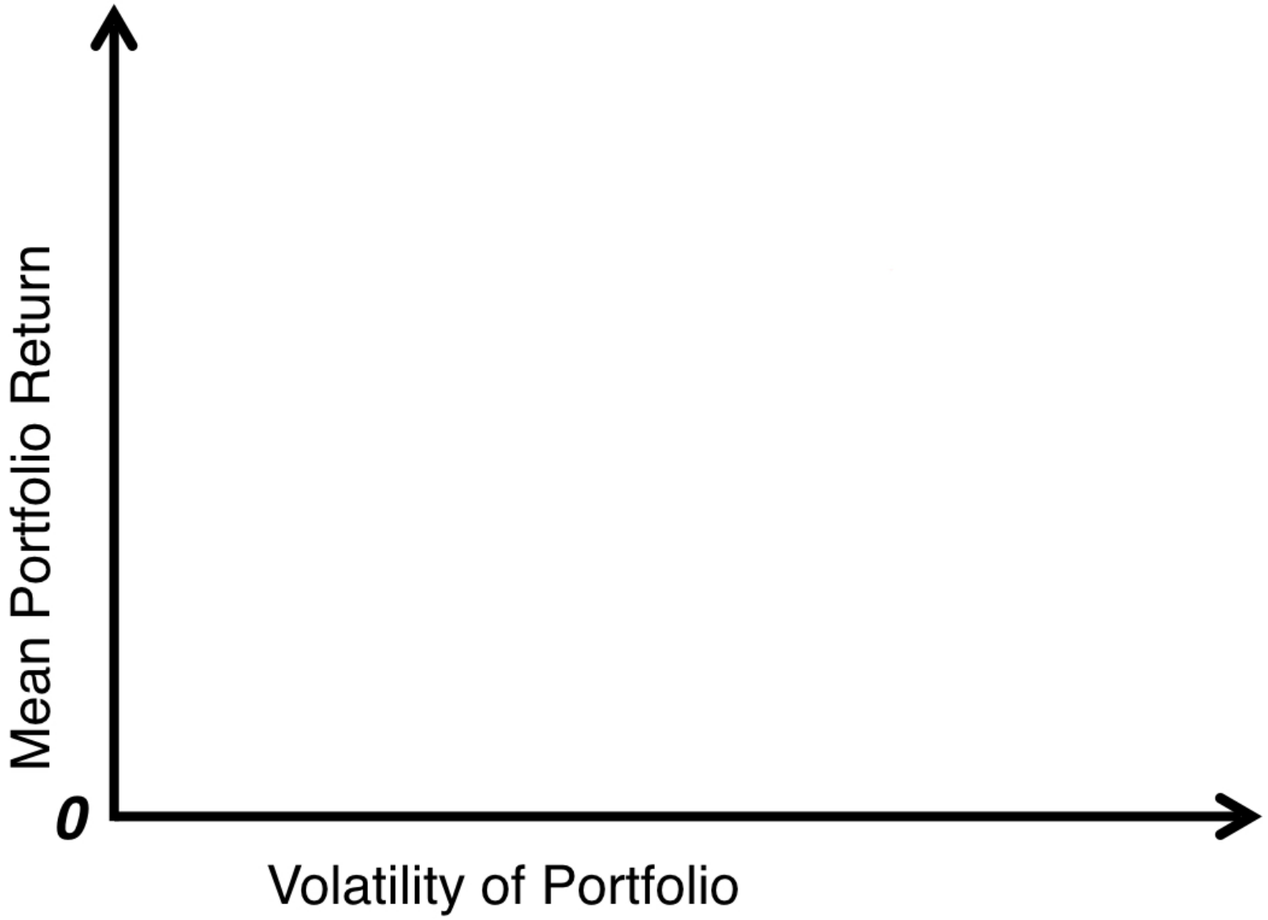
Changing target return



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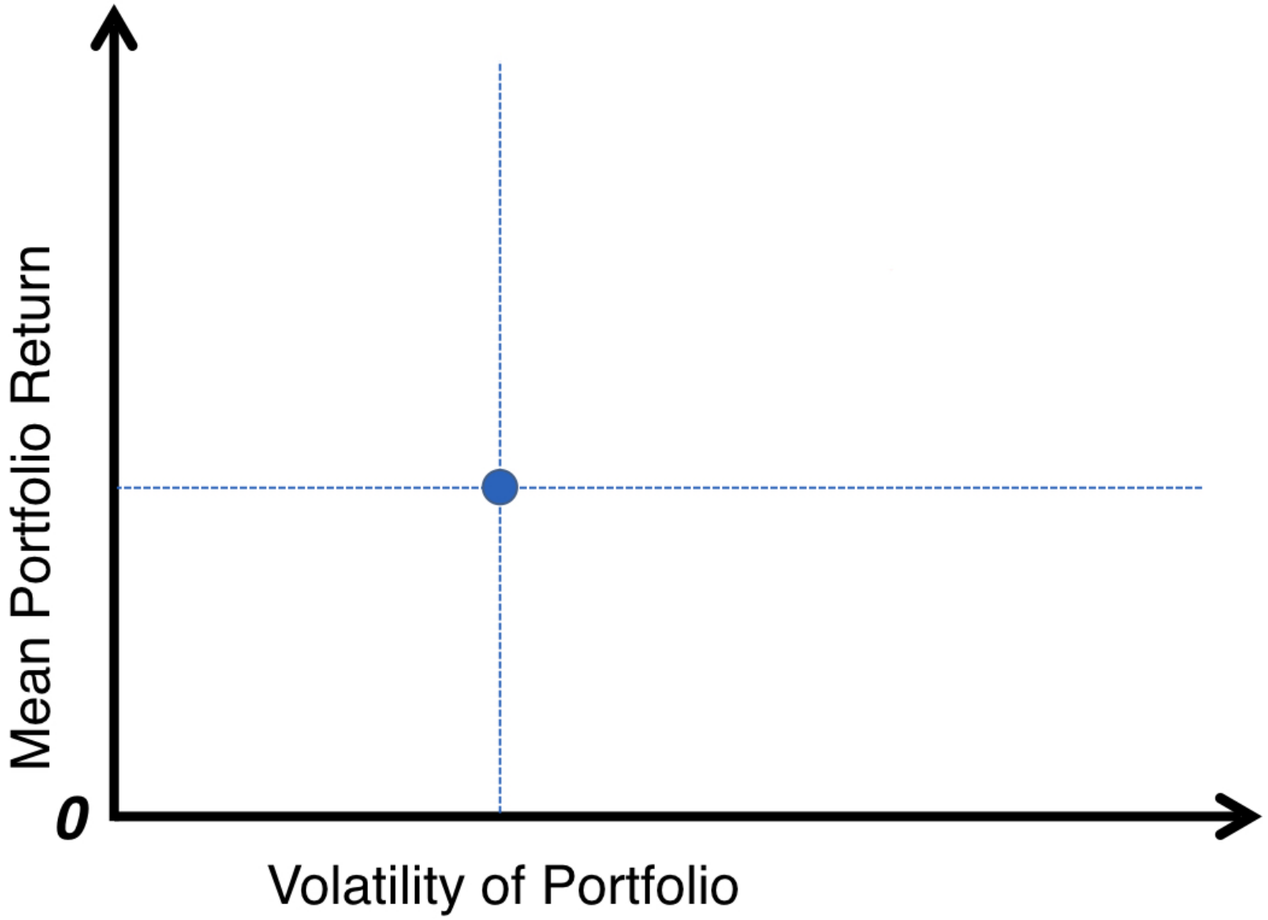

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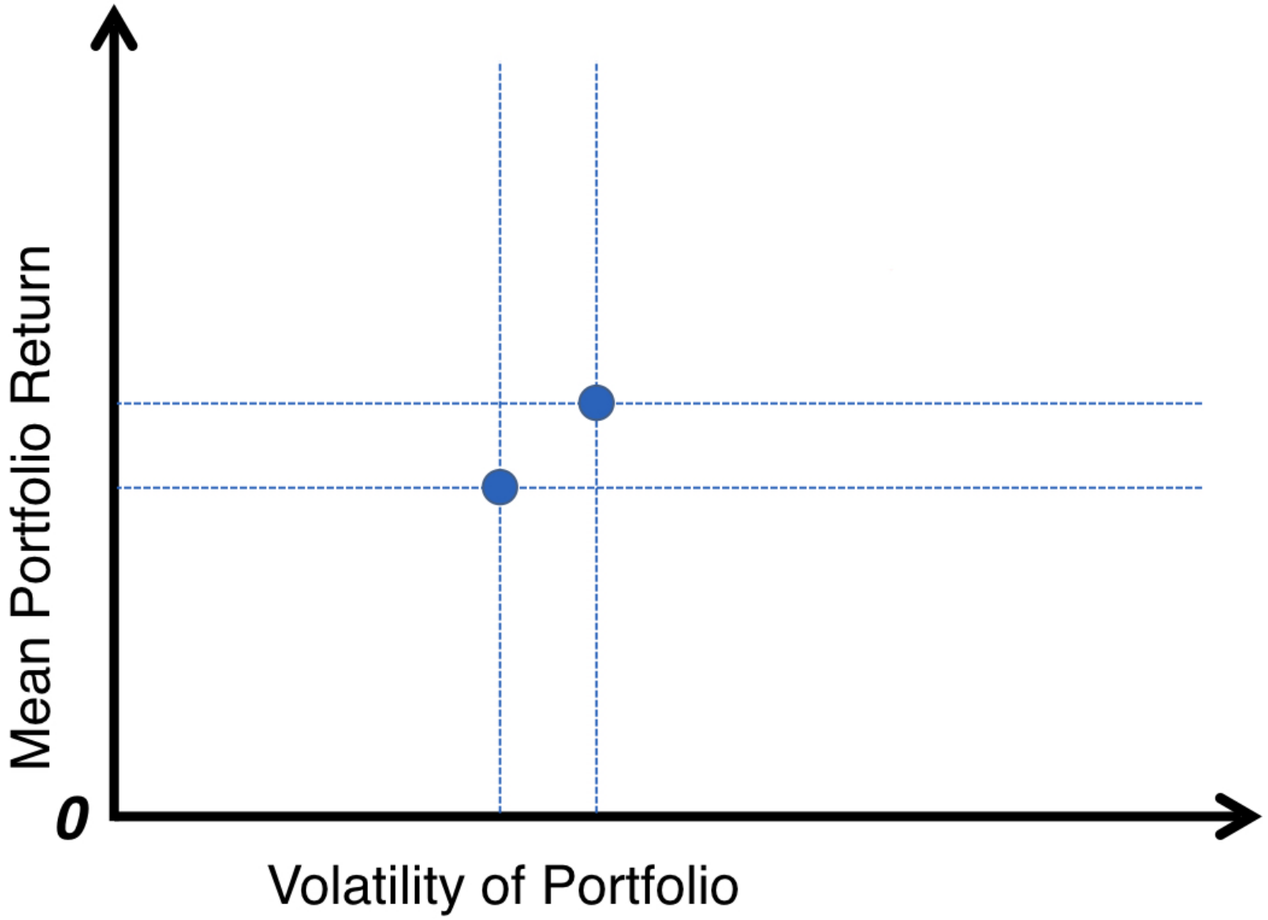

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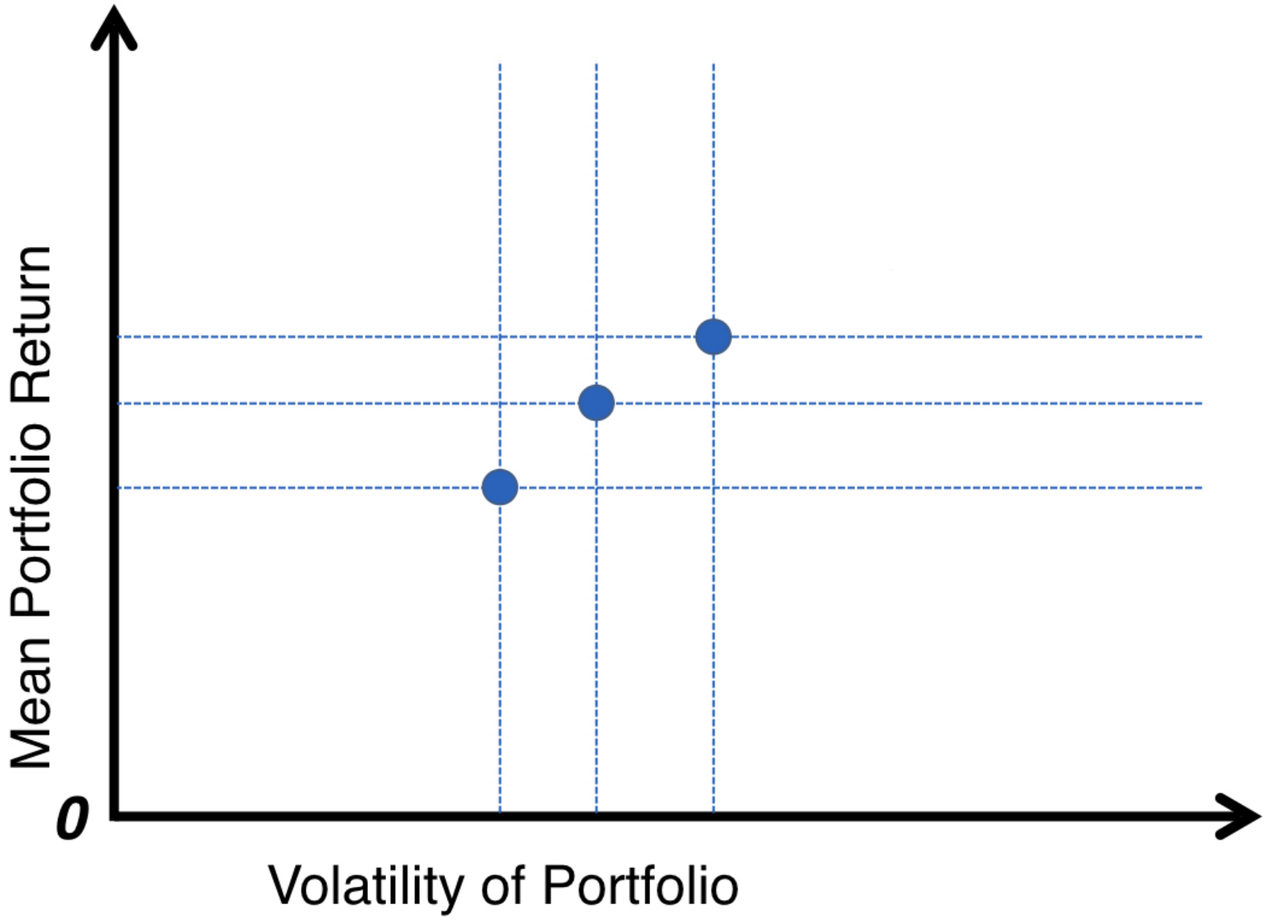

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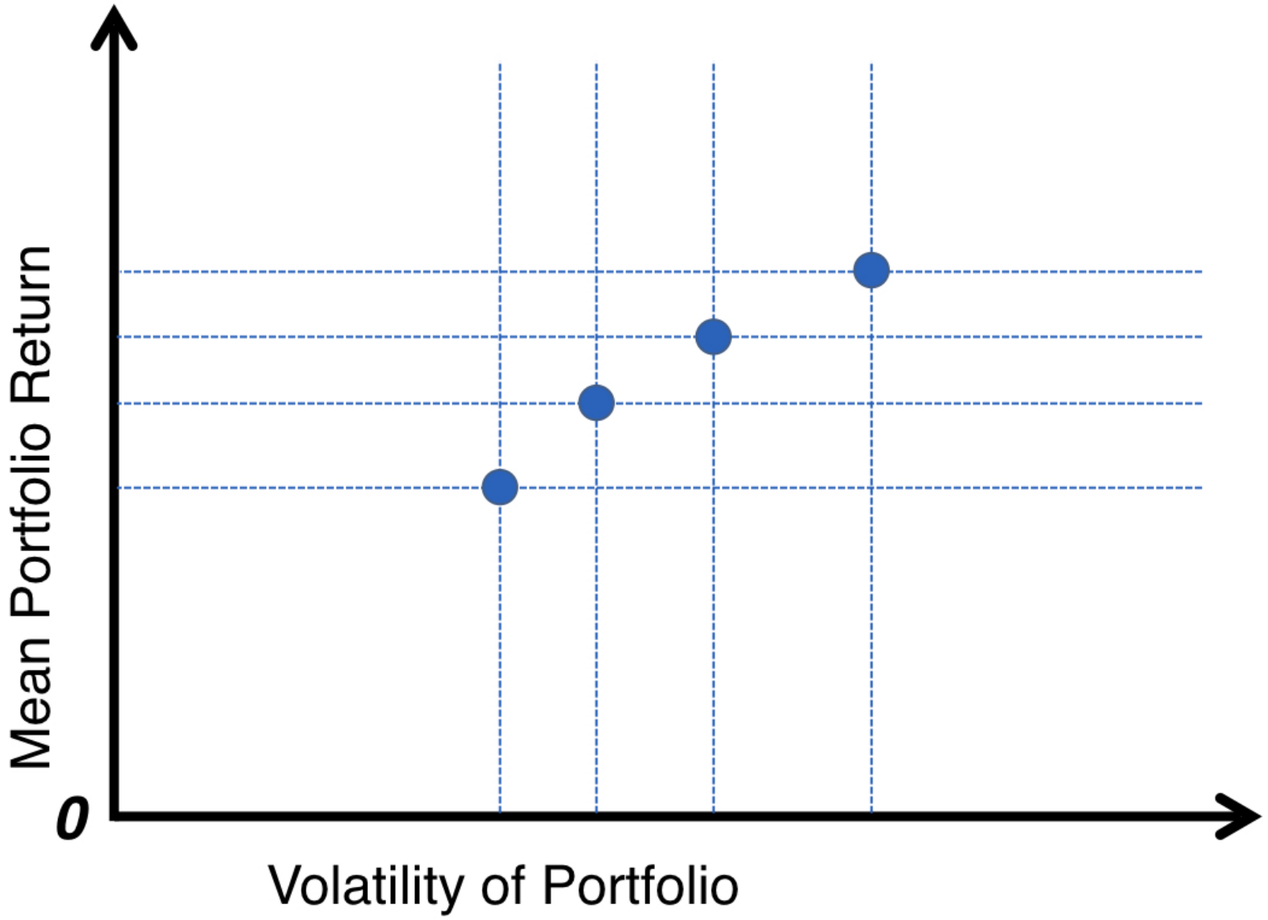

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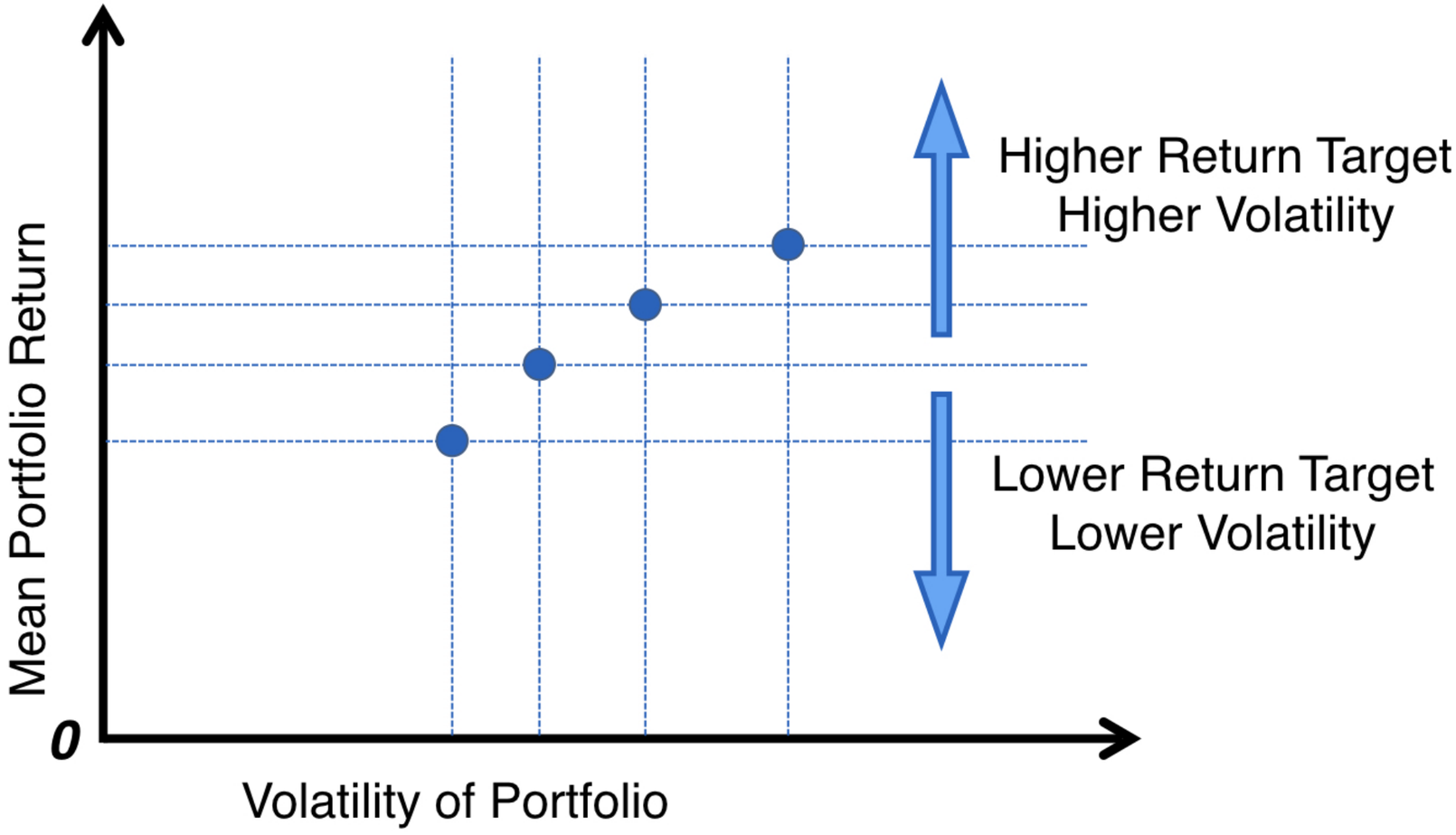

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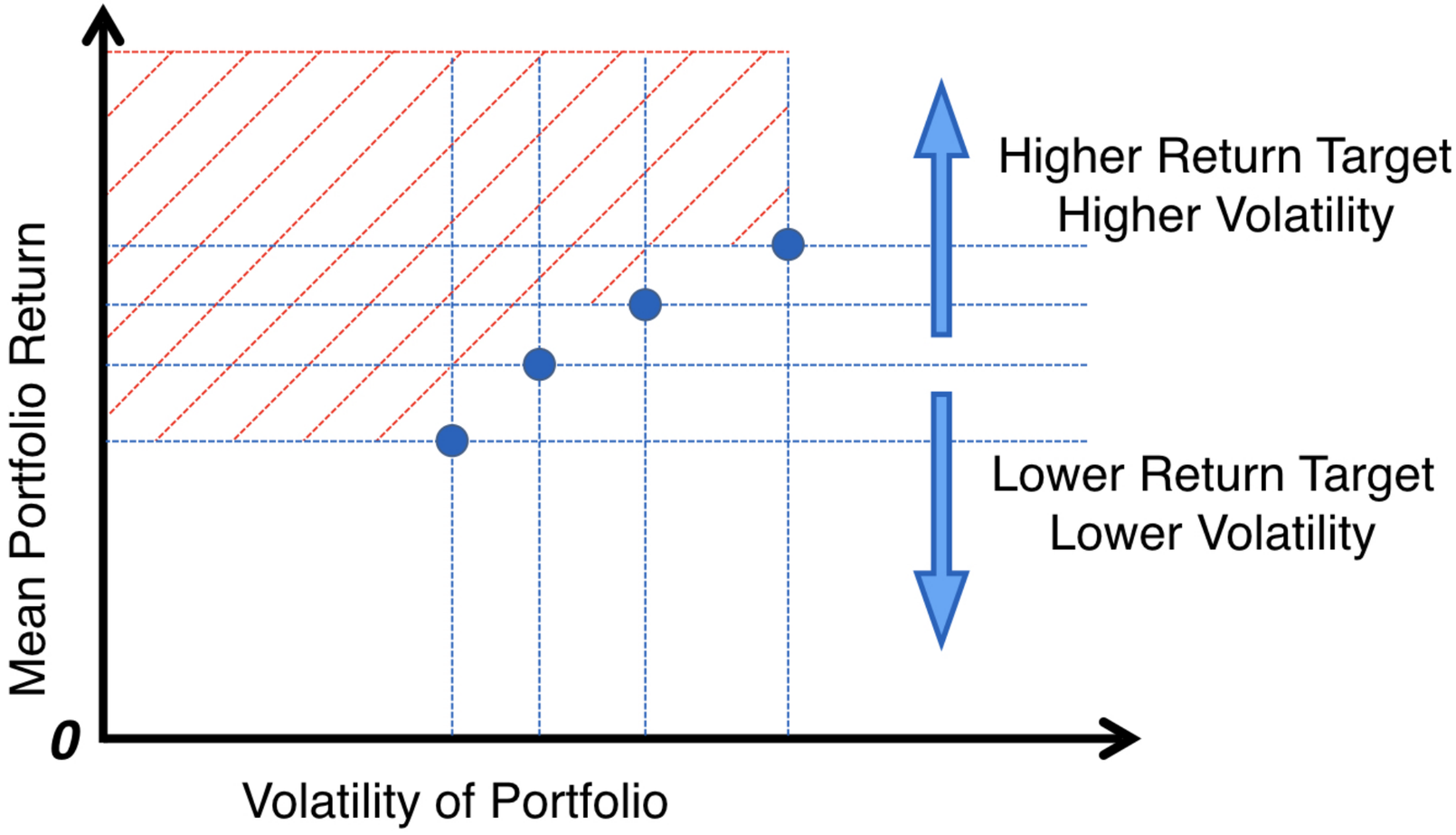
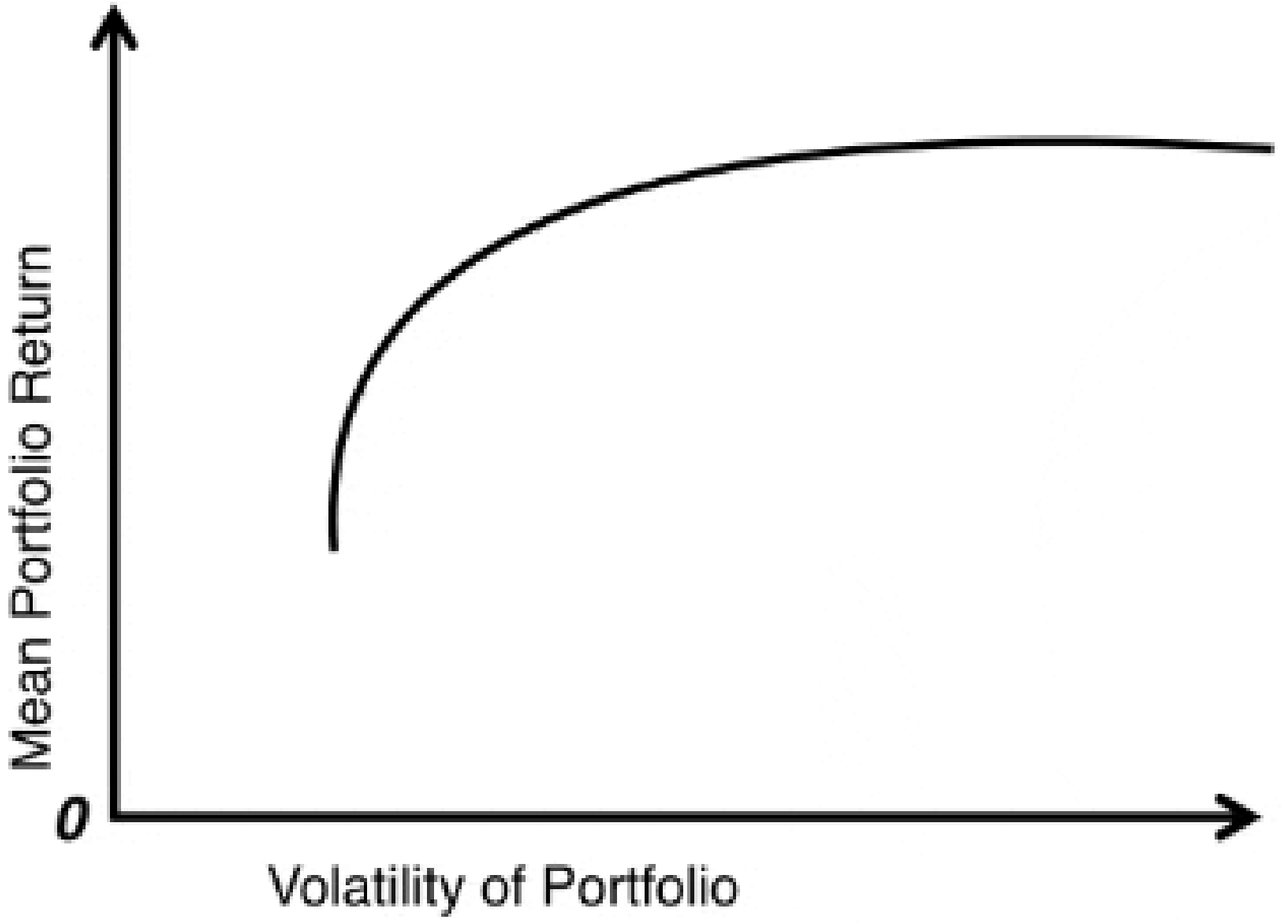
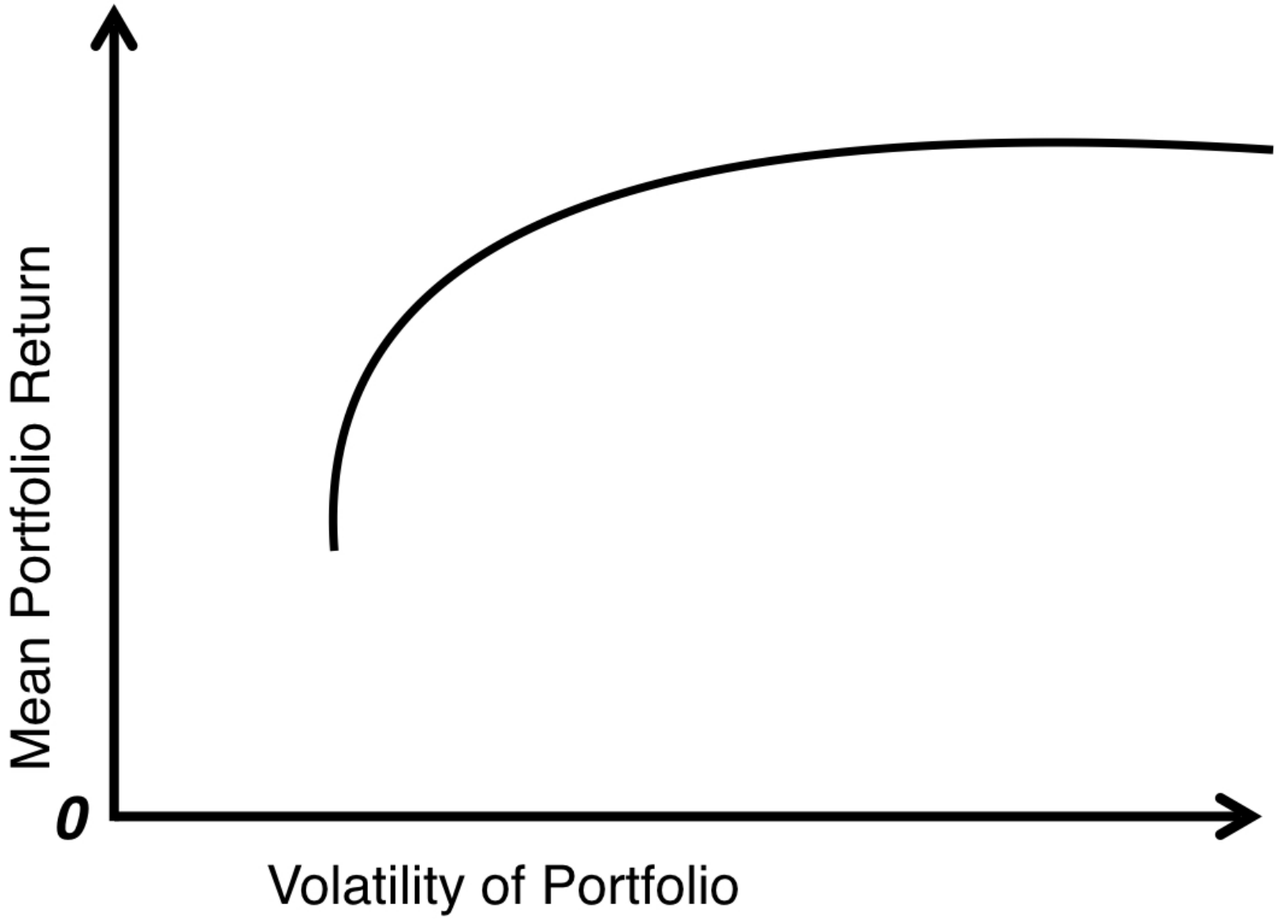


The efficient frontier



Minimum variance portfolio



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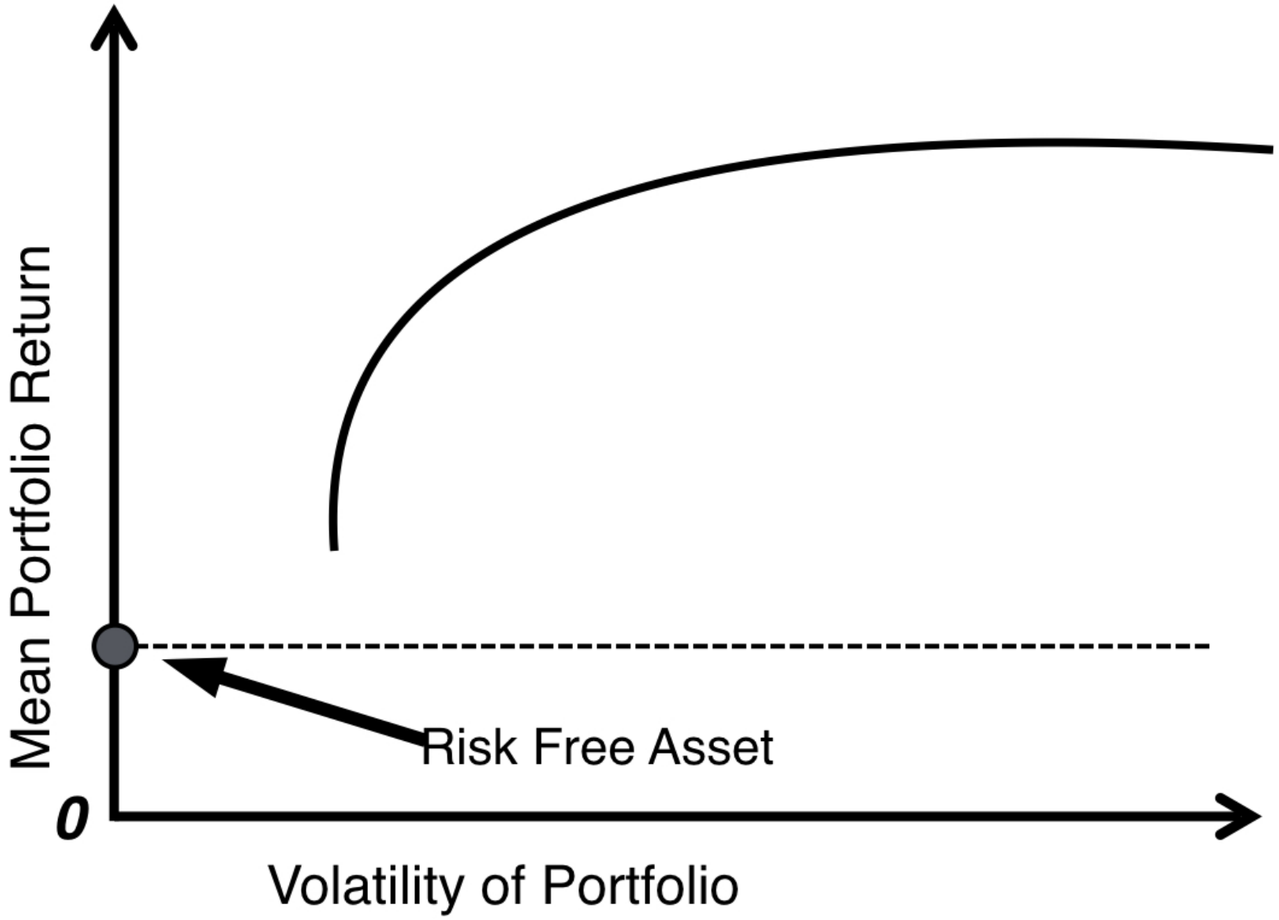

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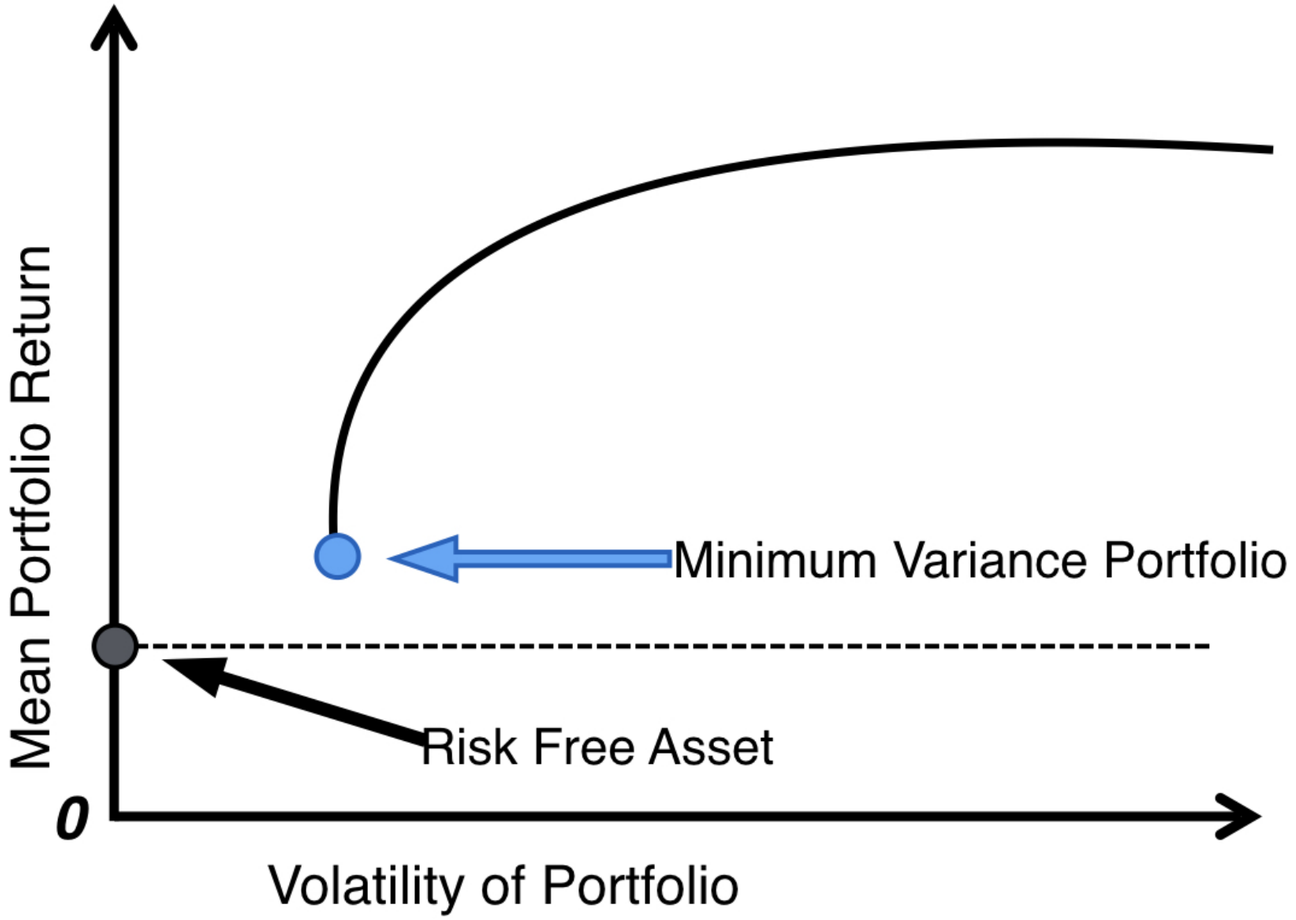
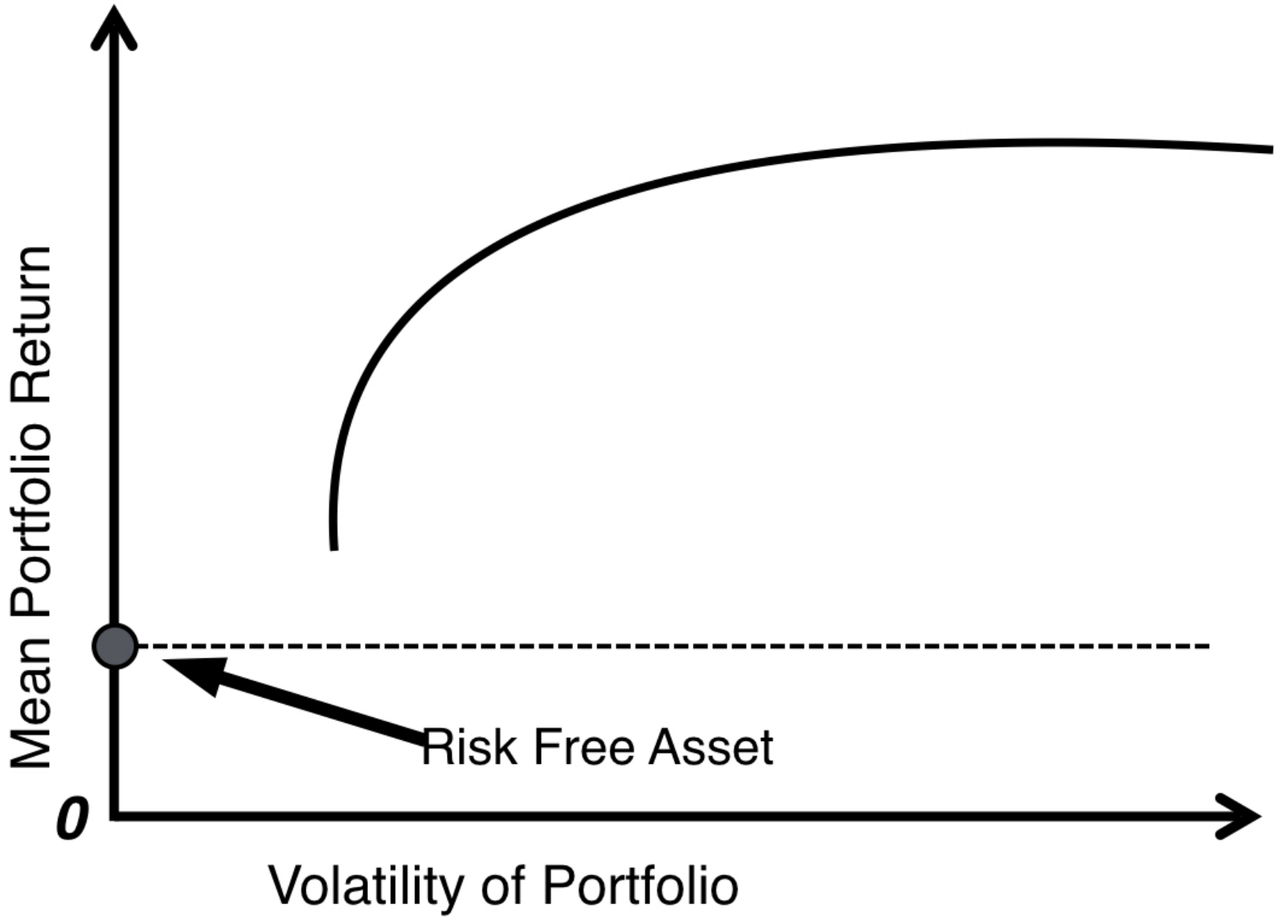


Maximum Sharpe ratio portfolio



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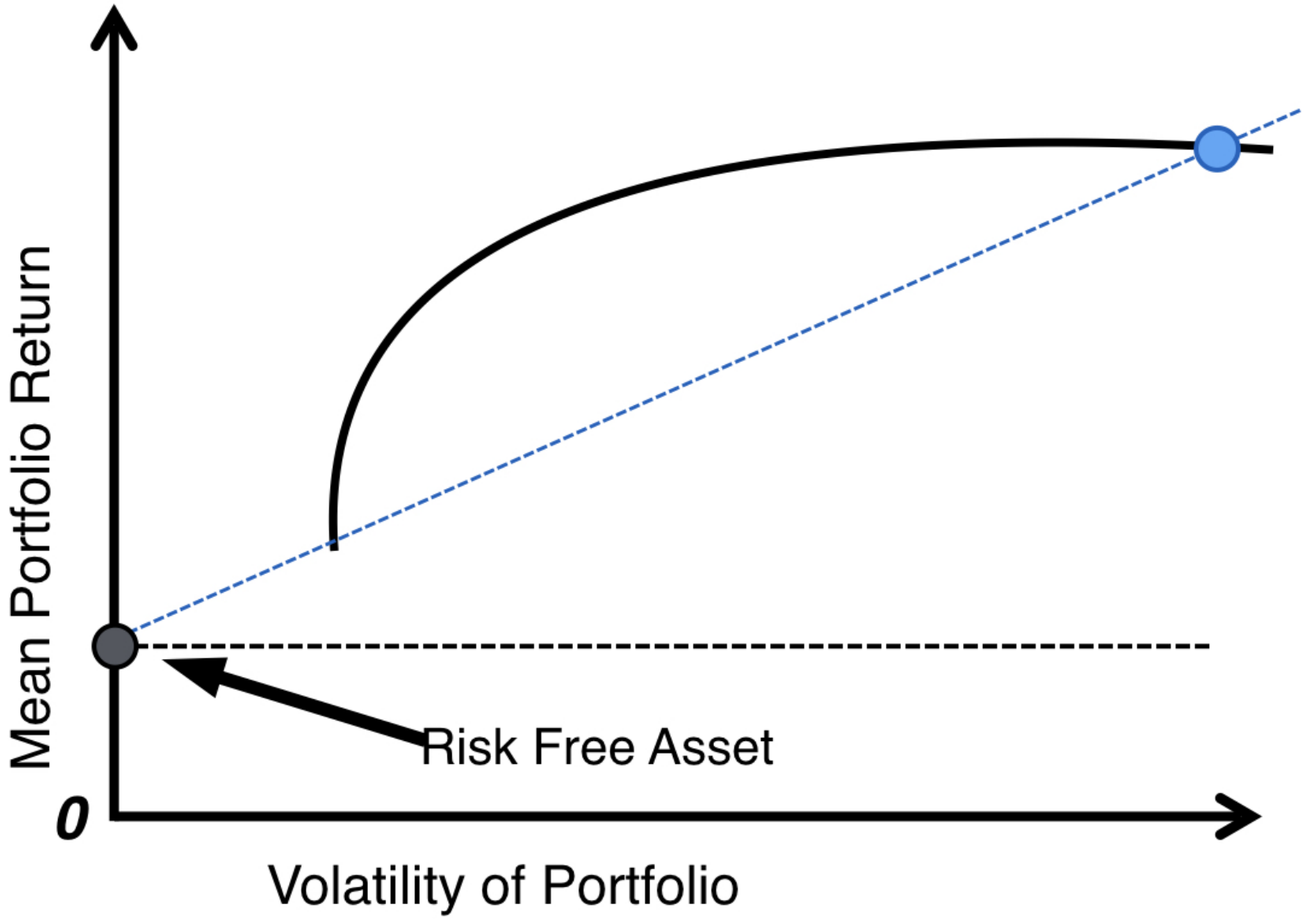

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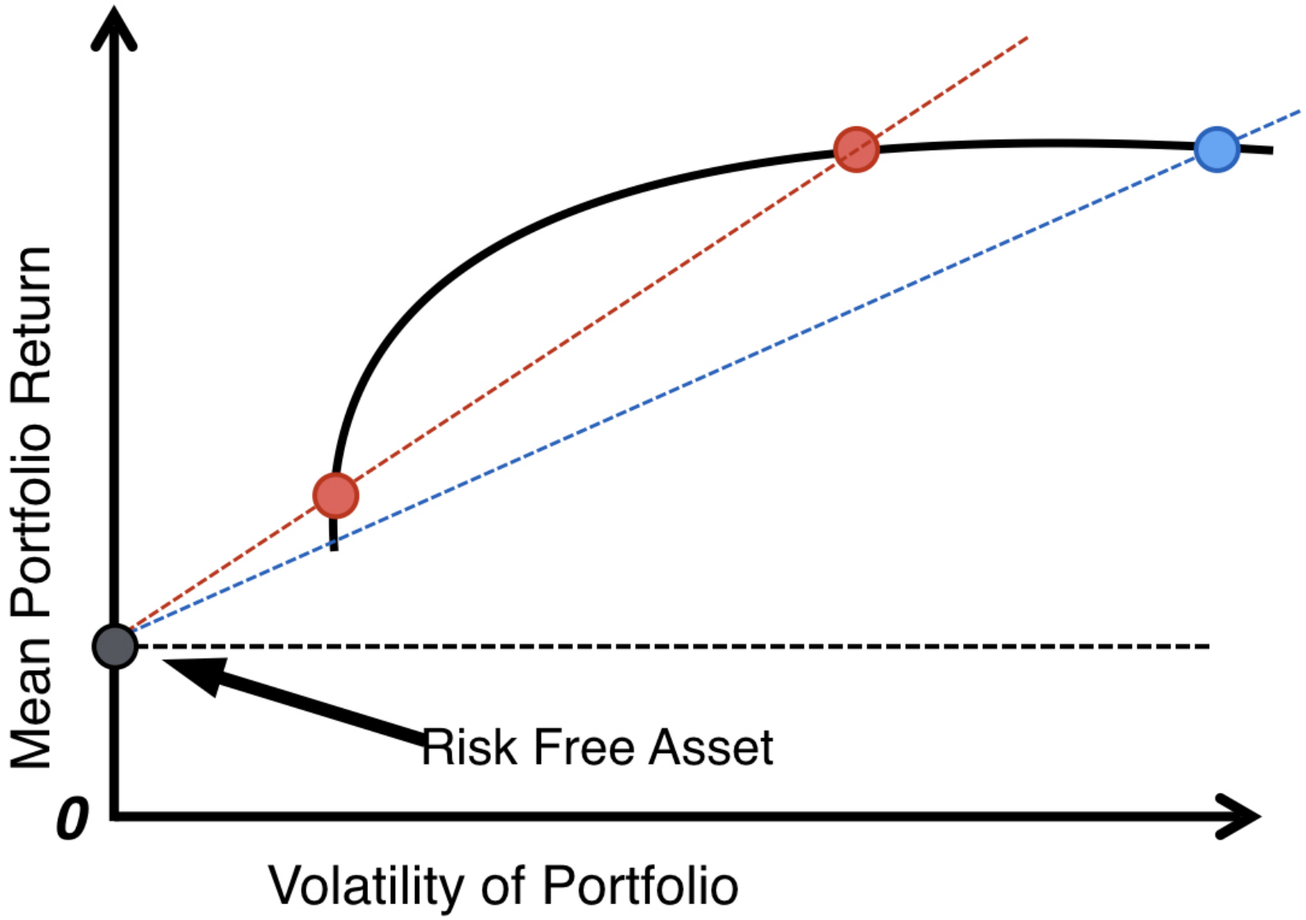

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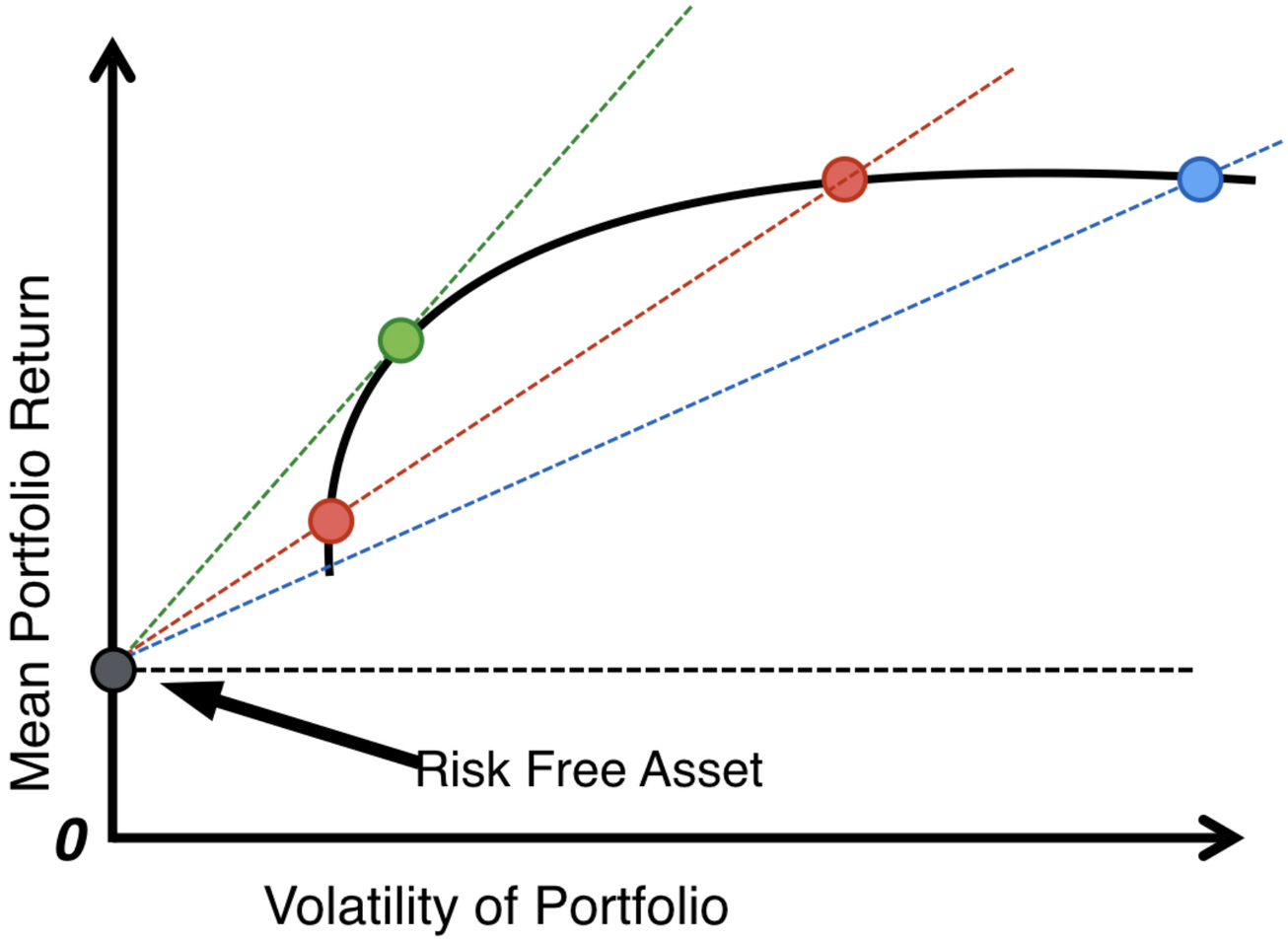

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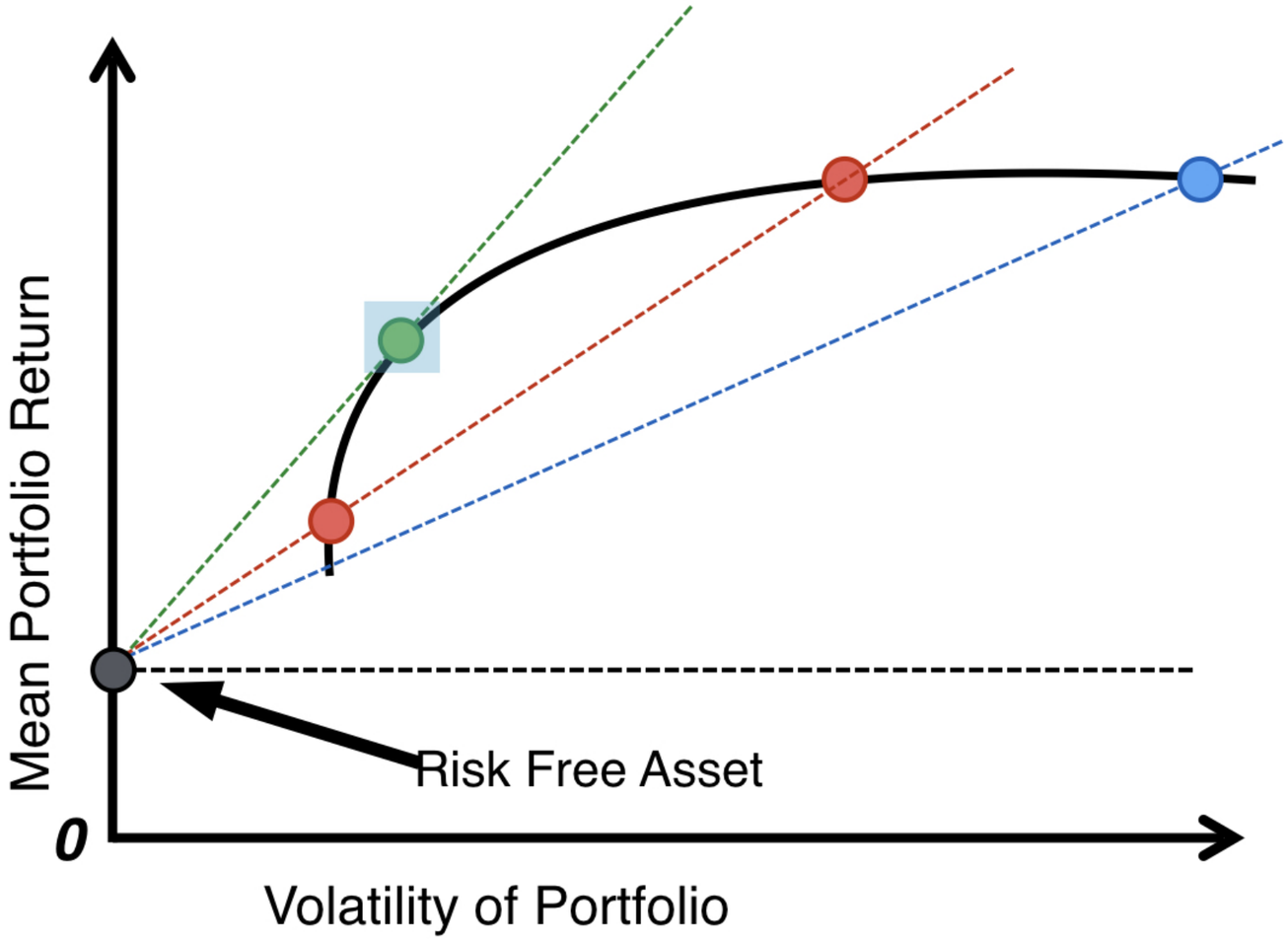
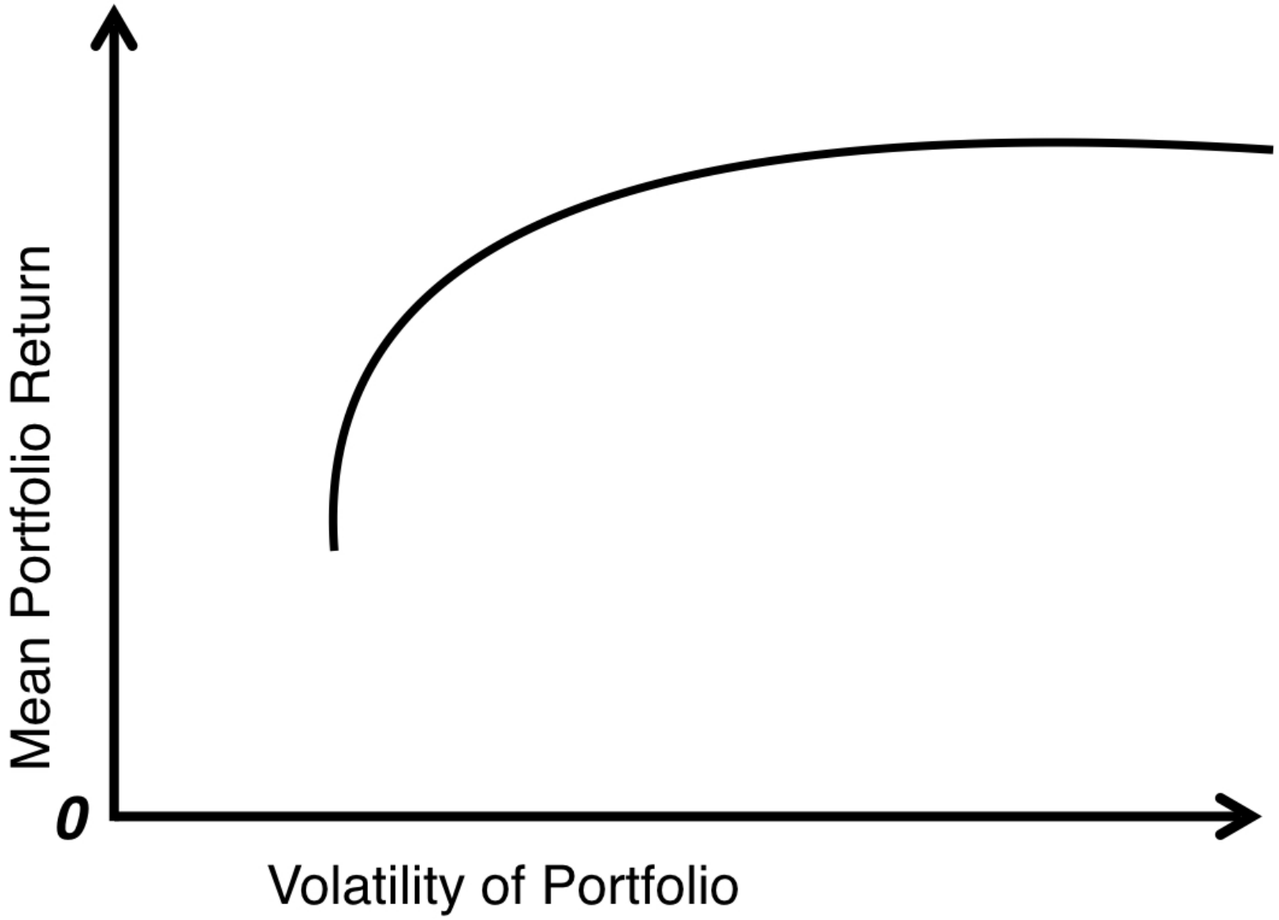


Time for practice



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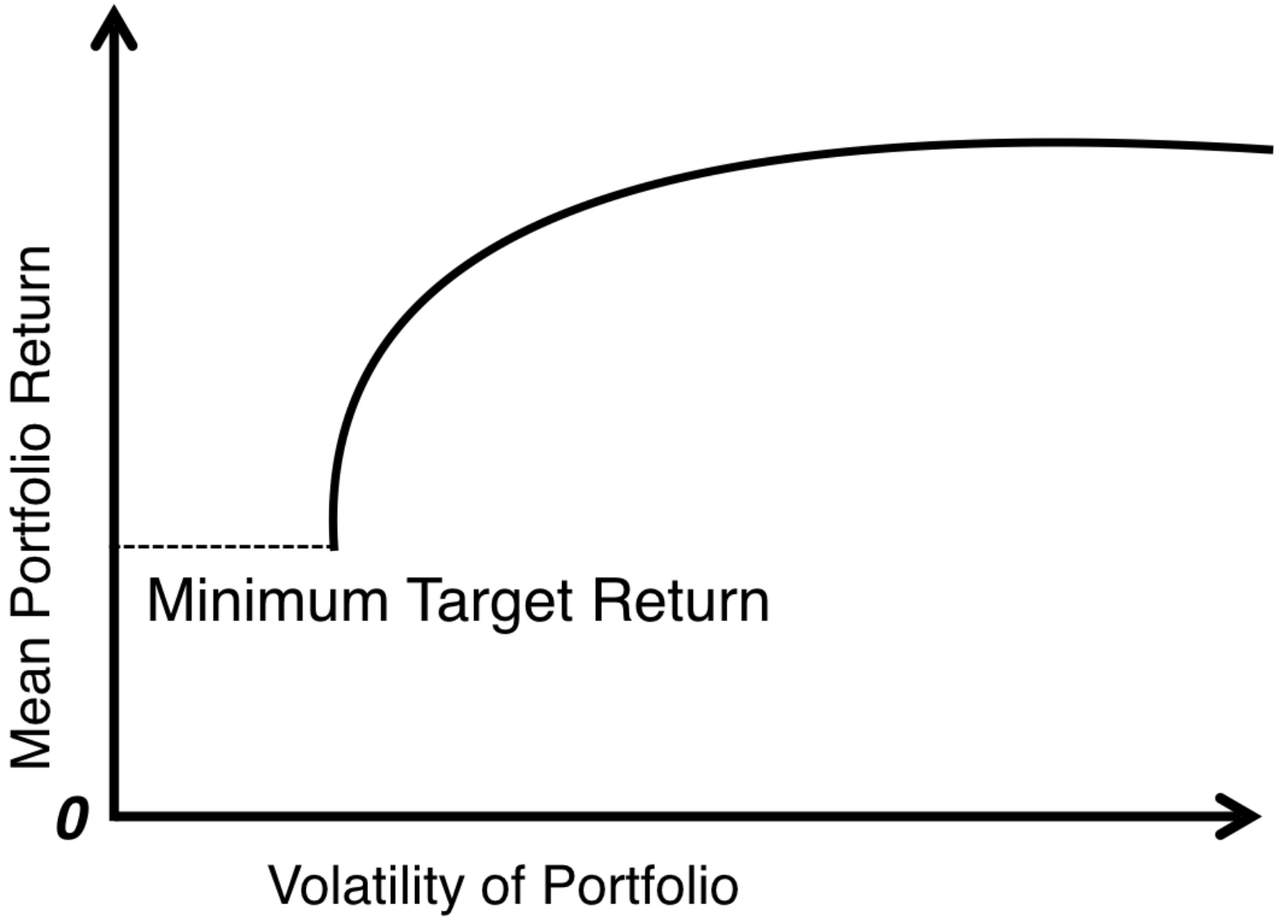

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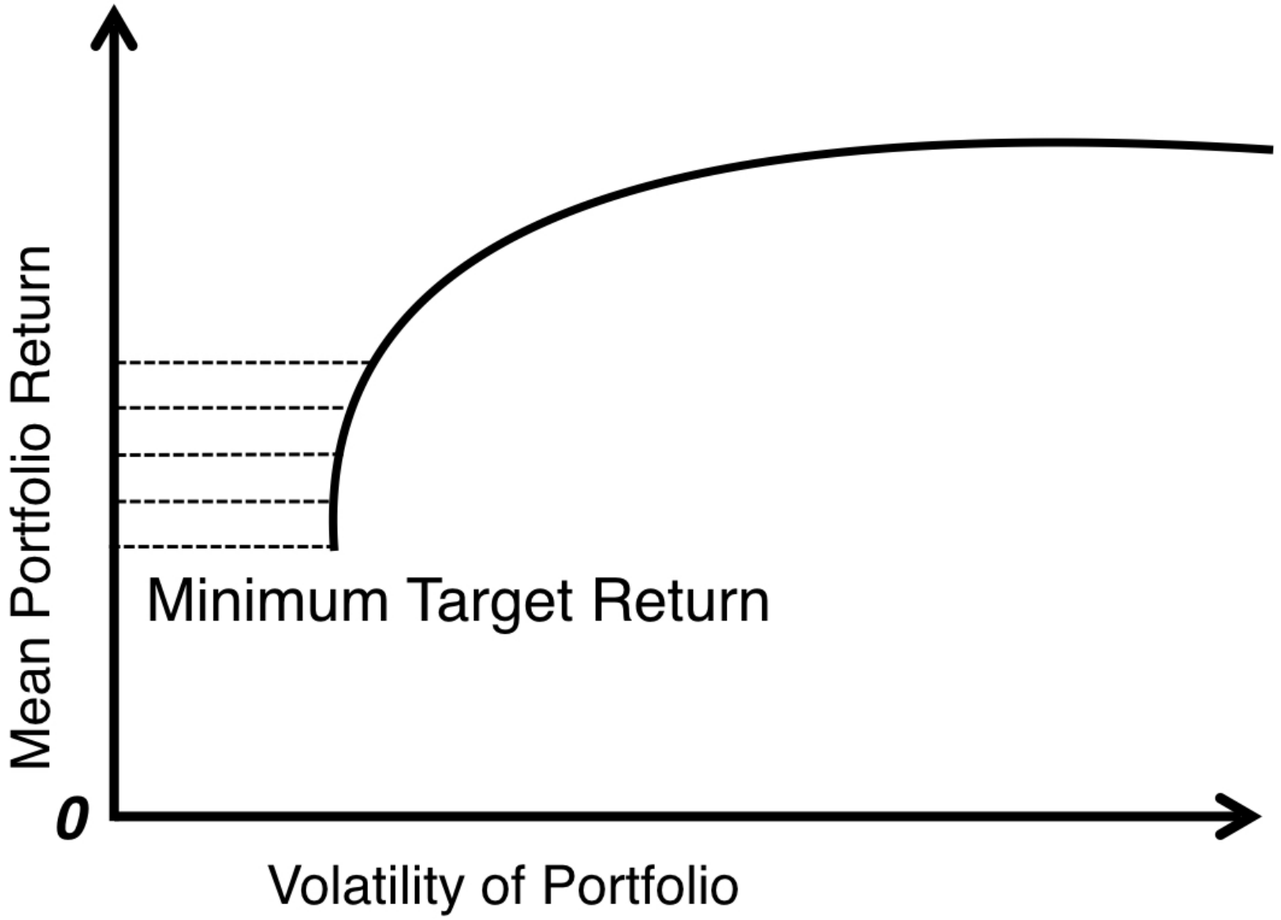

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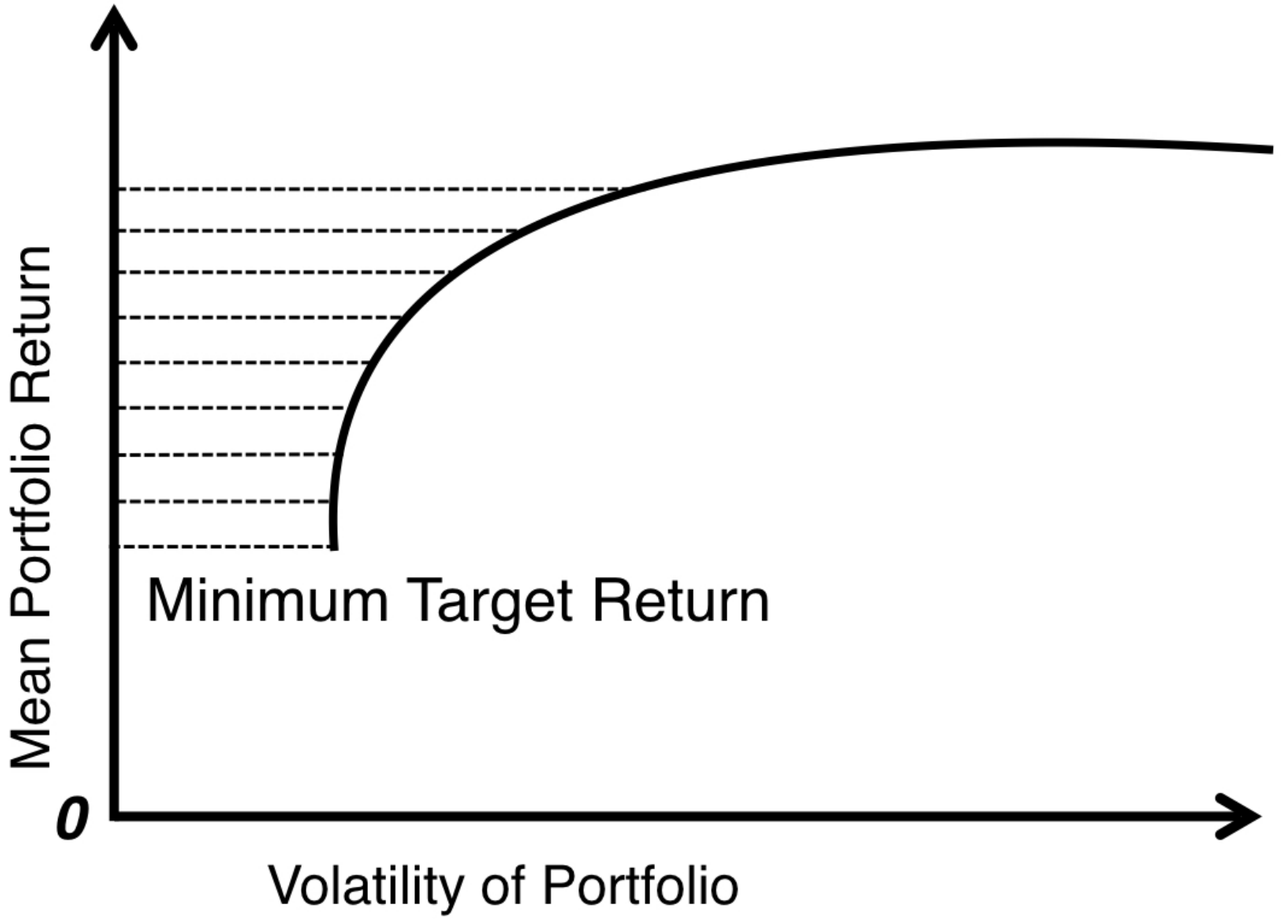

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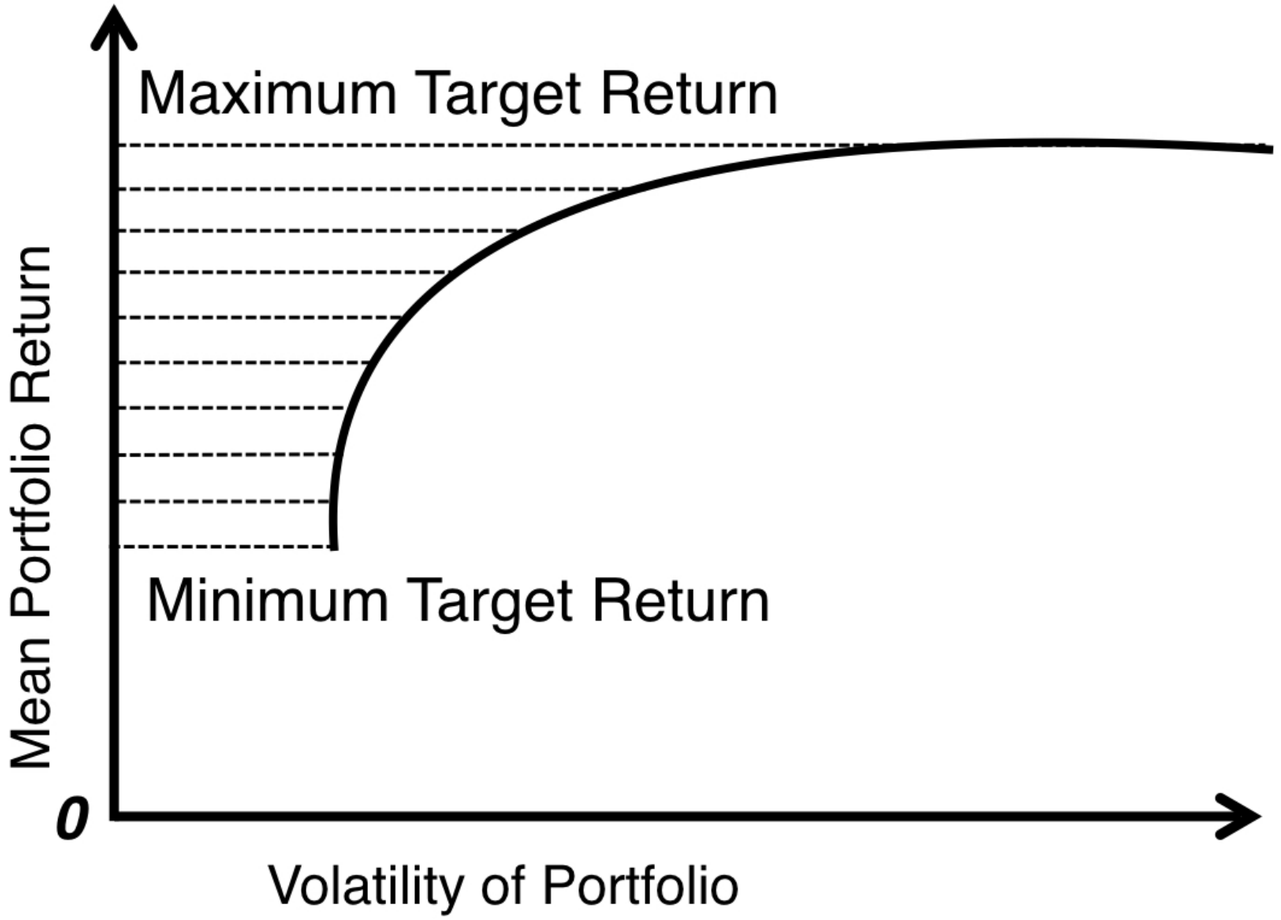

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In-sample vs. out-of-sample evaluation

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Bad news: estimation error

- Limitation to data-driven portfolio allocation:

Use in Practice
Estimated mean $\hat{\mu}$
Estimated variance $\hat{\sigma}^2$

Bad news: estimation error

- Limitation to data-driven portfolio allocation:

Use in Practice	Use In Theory
Estimated mean $\hat{\mu}$	True (unknown) mean μ
Estimated variance $\hat{\sigma}^2$	True (unknown) variance σ^2

Bad news: estimation error

- Limitation to data-driven portfolio allocation:

Use in Practice	Use In Theory
Estimated mean $\hat{\mu}$	True (unknown) mean μ
Estimated variance $\hat{\sigma}^2$	True (unknown) variance σ^2
Optimized weights based on estimated mean & variance: $\hat{w}$	True optimal portfolio: w

Good news: opportunities

- Do not ignore estimation error
- Use split-sample analysis to do a realistic evaluation of portfolio performance

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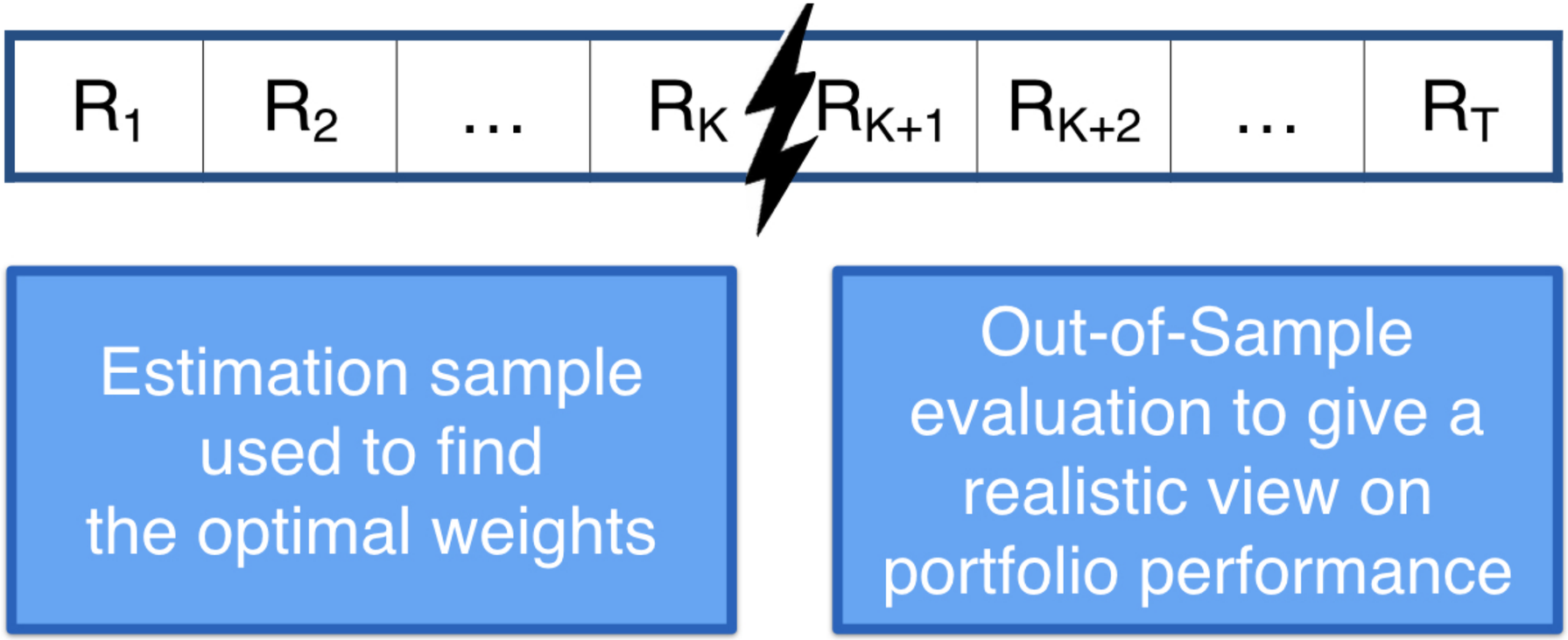
Estimation sample used to find the optimal weights

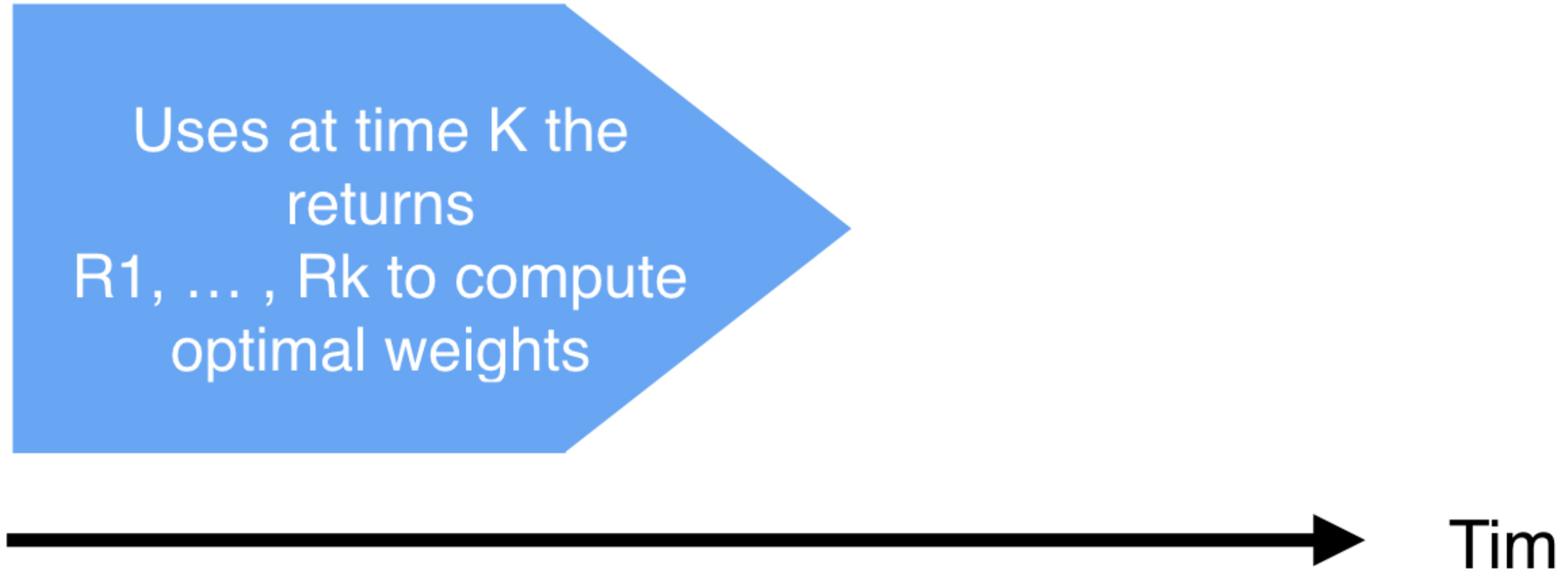
Good news: opportunities

- Do not ignore estimation error
- Use split-sample analysis to do a realistic evaluation of portfolio performance



No look-ahead bias in optimized weights

- Split-sample design matches with the investor who:



No look-ahead bias in optimized weights

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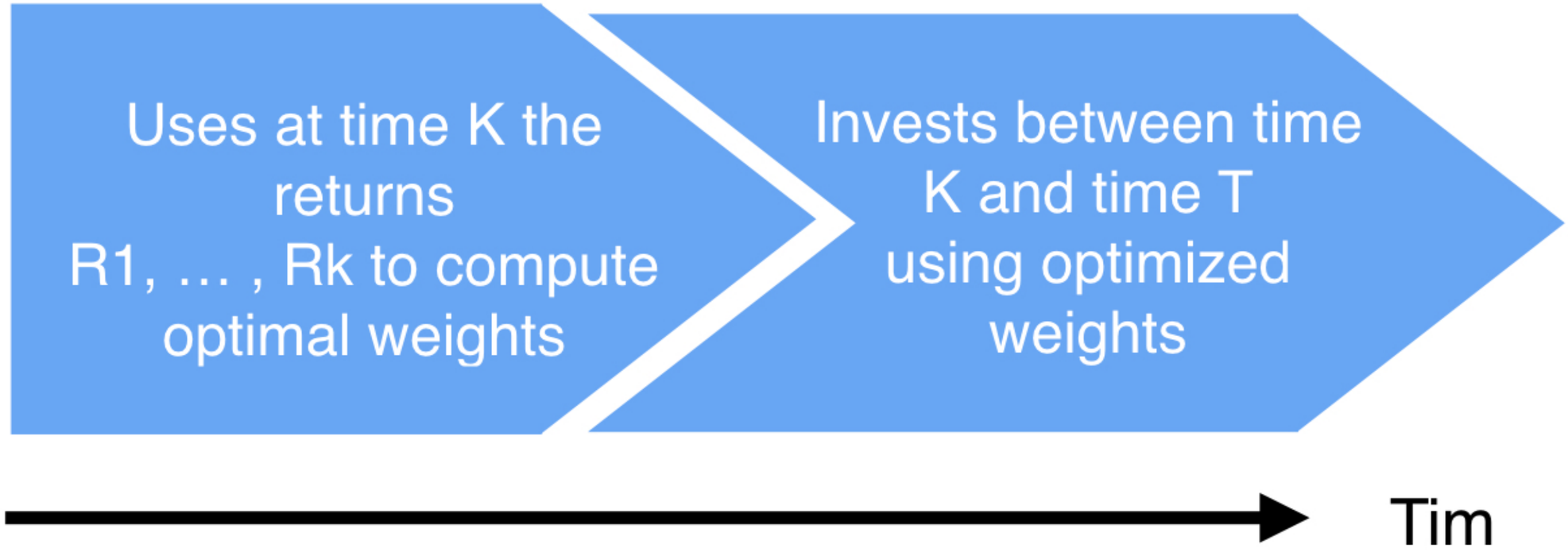

- Function `window()` to do split-sample analysis in R

Let's practice!

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