Modern Portfolio Theory (MPT) and Capital Asset Pricing Model (CAPM)

Learning Objectives

- Understand the key concepts of Modern Portfolio Theory (MPT)
- Explain the relationship between risk, return, and diversification
- Describe the Capital Asset Pricing Model (CAPM) and its assumptions
- Apply CAPM to estimate expected returns and understand systematic risk

What is Modern Portfolio Theory?

- Developed by Harry Markowitz (1952),
- MPT proposes that investors can construct a portfolio to maximize expected return for a given level of risk by diversifying across assets with low correlations.

Key Principles of MPT

- Risk is measured by standard deviation of returns.
- Diversification reduces portfolio risk when assets are imperfectly correlated.
- Rational investors prefer higher return for the same risk level.
- The Efficient Frontier shows optimal portfolios.

Risk, Return, and Diversification

- Diversification aims to lower total portfolio risk by combining assets that do not move perfectly together.
- Perfect correlation ($\rho = 1$): No diversification benefit.
- Zero correlation ($\rho = 0$): Partial diversification.
- Negative correlation ($\rho < 0$): Maximum risk reduction.

Efficient Frontier

The Efficient Frontier

- The Efficient Frontier plots the best portfolios offering maximum expected return for a given risk.
- Portfolios below the curve are inefficient, as they provide less return for the same risk.

The Capital Market Line (CML)

- When a risk-free asset is added to the efficient frontier, the Capital Market Line (CML) shows combinations of risk-free and market portfolios.

- Formula:
- $E(Rp) = Rf + [(E(Rm) - Rf) / \sigma m] \times \sigma p$

- $E(Rp)$: Expected portfolio return
- Rf: Risk-free rate
- $E(Rm)$: Market return
- σp: Portfolio risk

Limitations of MPT

- Assumes rational investors
- Assumes efficient markets.
- Based on historical correlations which may change.
- Ignores behavioral factors.
- Does not consider liquidity or transaction costs.

Introduction to CAPM

- The Capital Asset Pricing Model (CAPM), developed by William Sharpe, builds on MPT.
- It explains how expected returns relate to systematic risk, measured by beta (β). CAPM is used to estimate the required rate of return for an asset.

CAPM Formula

- $E(Ri) = Rf + \beta i \times [E(Rm) - Rf]$

Where:

- $E(Ri)$: Expected return of asset i
- Rf: Risk-free rate
- $E(Rm)$: Market return
- βi: Beta, measuring sensitivity to market movements

Understanding Beta (β)

- $\beta = 1$: Asset moves with the market
- $\beta > 1$: More volatile than the market
- $\beta < 1$: Less volatile (defensive)
- $\beta = 0$: Unrelated to the market (risk-free)
- $\beta < 0$: Moves opposite to the market (e.g., gold)

Example: Applying CAPM

- If $R_f = 5\%$, $E(R_m) = 12\%$, $\beta = 1.3$

- Then:
- $E(R_i) = 5\% + 1.3 \times (12\% - 5\%) = 5\% + 9.1\% = 14.1\%$

- Interpretation: The investor should expect 14.1% return for taking on this level of risk.

Assumptions & Limitations of CAPM

Assumptions:

- Investors hold diversified portfolios
- All investors can borrow/lend at Rf
- Markets are efficient

Limitations:

- Relies on historical beta
- Market portfolio is theoretical
- Behavioral factors are ignored

Conclusion

- Modern Portfolio Theory and CAPM are foundational to modern finance.
- MPT explains diversification and the efficient frontier.
- CAPM links expected return to systematic market risk.
- Together, they guide portfolio construction and investment valuation.