Markowitz’s Mean-Variance Portfolio Optimization

Markowitz’s mean-variance analysis was a breakthrough in modern portfolio theory to solve for an optimal portfolio to maximize returns at a low risk. The analysis is based on the process of weighing risk, expressed as variance, against expected return, expressed as a probability on estimated returns. A key factor in Markowitz’s portfolio optimization is diversification and based on such statistical measures a single asset’s performance is less critical on the overall impact for the portfolio. The model aims to allow investors to select assets to maximize returns with a trade-off in an acceptable level of risk. If two different assets A and B have similar expected returns but asset A has lower variance, asset A is selected over the asset B. Similarly, if asset A and B have approximately the same variance, the asset with higher expected returns in preferred.

The solution of this problem can be visualized as a ‘Efficient Frontier’, a graphical representation of all possible combinations of portfolios that shows the optimal returns given a particular level of risk. This curvature depicts how diversification in assets can improve the portfolio’s risk and return profile. Portfolios that lie below the curve are not optimal as there are other potential portfolios that outperform with either lower risk or have higher returns. Ultimately, the optimal portfolio is located somewhere on this curve. The right end of the curvature includes portfolios that have higher degree of risk paired with higher potential returns. Conversely, portfolios that lie on the left end have lower risk, with lower potential returns.

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