An Exploration into Modern Portfolio Optimization Theory

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Rabbi Issac bar Aha in the fourth century said, “One should always divide his wealth into three parts: a third in land, a third in merchandise, and a third ready to hand” (Rodkinson, 1900). About a decade and a half later, Harry Markowitz developed the first financial portfolio optimization model in 1952 called “Portfolio Selection”. My passion for portfolio optimization stems from my interest in applying mathematics to study financial markets. This project is an exploration of the Markowitz portfolio model. At its premiss, it is a very simple idea, for a given level of risk, and a selection of assets, what weightage of those assets would yield the highest expected return. In modern times, portfolio models are quite complex, considering economic factors, making assumptions about the distribution of asset prices, and even factoring investor psychology into their models. Portfolio optimization is used by banks, hedge funds, pension funds and insurance firms to make investment decisions. For example, pension funds need to find a balance between the amount of cash on hand for pensioners and how aggressively they should invest so they can outpace inflation for future pensioners.

The included pdf file has 4 main sections. We begin with the history of portfolio optimization, then I state the assumptions of this model and give a mathematical formulation of the model. I then implement a function that that solves this optimization problem and use a dataset of US sector performance data to show how you can use this to develop your own investment portfolios based on different risk tolerances. Lastly, I discuss some criticism and shortfalls of this model.

References

Michael Levi Rodkinson. (1900). New Edition of the Babylonian Talmud: Tract Baba Metzia. folio 42a.