Cemile Özgür
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Univariate and Cross-Sectional Ranks of Asset Returns: Are They Relevant to Portfolio Allocation?

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Preface

Asset allocation is a prominent and highly active research topic in finance. The term, asset allocation, has a broad meaning consisting of an individual's (investor, trader, analyst, portfolio manager, etc.) activities of searching for asset types and their properties to construct a portfolio that will best suit his/her preferences under different states of the world as well as uncertainty.

The mean – variance model proposed by Markowitz constitutes the backbone of portfolio asset allocation literature in finance, including most of the industry applications and the further scientific developments. Under the quadratic expected utility maximization framework, the mean – variance model suggests a set of portfolios that either yield the lowest risk for a given level of return or the highest return for an accepted level of risk. An investor can estimate his/her optimal investment portfolio depending on the predefined preferences or constraints.

Albeit its popularity, the mean – variance model is highly criticised. The criticisms are mainly related to its underlying assumptions, definition of risk and/or parameter uncertainty, estimation risk of parameters and model instability issues. As a result, there is a vast literature in finance trying to improve the predictions of the mean – variance model or propose new methods / strategies that can be employed in portfolio asset allocation tasks.

The aim of this book is not to cover all the theoretical and application-based developments in portfolio asset allocation. But it focuses on the proposed methods or strategies that apply univariate and/or cross-sectional ranks of asset returns in portfolio asset allocation context.

The intended audience of the book is the undergraduate / graduate level students of economics and finance programs as well as the students enrolled in study programs including portfolio or investment management subjects. Additionally, the book might be useful for academic researchers and industry practitioners interested in the subject.

We hope that this text will be beneficial to the reader and contribute to the development and spread of knowledge on the subject.

Cemile ÖZGÜR
Vedat SARIKOVANLIK
September, 2024

Chapter 1

Asset Allocation

Asset allocation refers to an individual's (e.g., a portfolio manager, investor, or trader) activities of searching for asset types and their properties to construct a portfolio that will best suit certain preferences under different states of the world as well as uncertainty. The practice of asset allocation is an aggregate version of portfolio building and requires a wider top-down approach to generate views about different states of the world, market dynamics and asset classes.

Until the 1950s, the practice of asset allocation was mainly associated with collecting as many assets as possible to build a portfolio. Back then, a simple diversification approach that was arguing the existence of a negative linear relation between the number of assets and portfolio risk, was applied. This approach ignored the relations or co-movements between the portfolio constituents and did not employ any quantitative method to choose among the investment alternatives.

Since the groundbreaking work of Markowitz in 1952, the mean-variance framework has become the leading source of portfolio asset allocation and investment management research of academicians as well as practitioners. For the first time, the mean-variance model of Markowitz (1952) suggested and developed a formal risk/return approach in investment decision making. In the following sections of this chapter, the main foundations of the mean-variance model of Markowitz (1952) are explained.

1.1. The Mean – Variance Model

Under the mean-variance (M-V) framework, return is the desired and risk is the undesired property of a financial asset. The M-V model defines risk in quantitative terms using the volatility statistic of asset returns. Additionally, the model is the first to consider the co-movement or relations between the assets to construct a well-diversified portfolio. In doing so, the M-V makes it possible to construct portfolios depending on the risk – return preferences that will maximize an individual's expected utility. In other words, M-V model assumes that investors are risk-averse and rational individuals who are willing to maximize their expected utility by making investment decisions among various assets. A rational investor will prefer the portfolio yielding the highest return for a given level of risk or the portfolio with the lowest risk for a given level of return. More formally, the objective function of the expected utility maximization problem is defined as follows:

$$\max_{w} \left(\boldsymbol{w}^T \boldsymbol{\mu} - \frac{\gamma}{2}\, \boldsymbol{w}^T\, \Sigma\, \boldsymbol{w} \right) \tag{1}$$

In Equation 1, $\boldsymbol{w} = \begin{bmatrix} w_1 \\ \vdots \\ w_N \end{bmatrix}$ and $\boldsymbol{\mu} = \begin{bmatrix} \mu_1 \\ \vdots \\ \mu_N \end{bmatrix}$ define the weight and mean return vectors of *N* number of assets, respectively. Moreover, $\boldsymbol{w}^T$ denotes the transpose of vector $\boldsymbol{w}$. The term $\Sigma = \begin{bmatrix} \sigma_{11} & \cdots & \sigma_{1N} \\ \vdots & \ddots & \vdots \\ \sigma_{N1} & \cdots & \sigma_{NN} \end{bmatrix}$ defines the variance-covariance matrix and γ is the individual degree of risk-aversion.

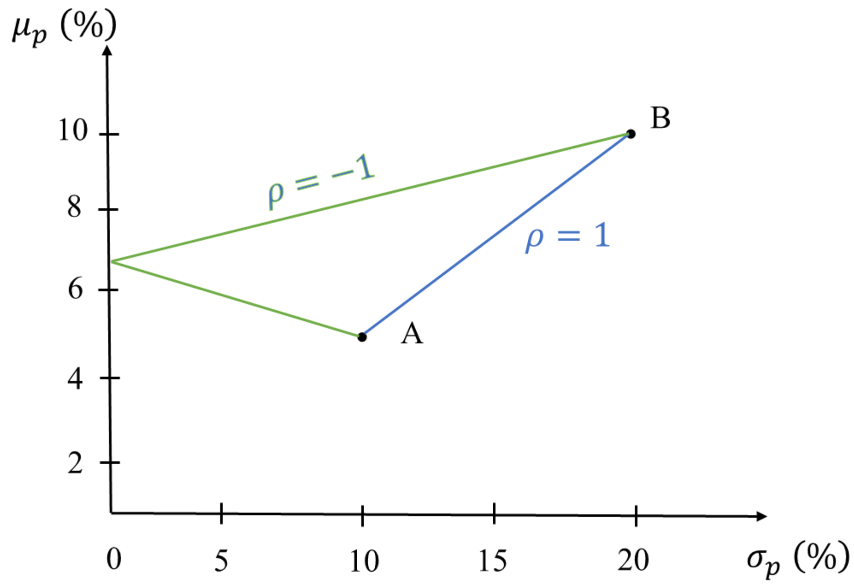
In other words, the quadratic expected utility function in Equation 1 is maximized in terms of the portfolio expected return $\left(\mu_p = \boldsymbol{w}^T \boldsymbol{\mu} = \sum_{i=1}^{N} w_i \mu_i\right)$, portfolio risk $\left(\sigma_p^2 = \boldsymbol{w}^T\, \Sigma\, \boldsymbol{w} = \sum_{i=1}^{N} \sum_{j=1}^{N} \sigma_{ij} w_i w_j\right)$ and the degree of individual risk-aversion.

As mentioned previously, the M-V model of Markowitz (1952) also considers the co-movement or relations between the assets when constructing a portfolio. The covariance statistic $\left(\sigma_{ij}\right)$ employed in estimating portfolio risk $\left(\sigma_p^2\right)$, is a measure of the co-movement of asset returns. The covariance statistic can take values between -∞ and +∞. While a positive value of covariance indicates a co-movement in the same direction, the negative value shows a co-movement in the opposite direction. However, the value of covariance alone does not give a clue about the strength of the co-movement. As a result, covariance is divided by the multiplication of standard deviations of assets and the correlation coefficient statistic is obtained $\left(\rho_{ij} = \sigma_{ij} \,/\, \left(\sigma_i * \sigma_j\right)\right)$. The correlation coefficient is a linear measure of asset return co-movement that takes values between -1 and +1. When the estimated value of correlation coefficient is equal to 1 (-1), then it indicates a perfect positive (negative) linear co-movement between the returns. Using the correlation coefficient, the portfolio risk consisting of *N* number of assets is estimated as below:

$$\sigma_p^2 = \sum_{i=1}^{N} \sum_{j=1}^{N} w_i w_j \sigma_i \sigma_j \rho_{ij} \tag{2}$$

Figure 1 shows portfolio return and risk for different correlation values between two assets. The expected return of Asset A is 5% and the standard deviation is 10%. Asset B has an expected return of 10% and a standard deviation of 20%. Expected return and risk of an equally weighted portfolio ($w_1 = 0.5$ and $w_2 = 0.5$) with a perfect negative correlation ($\rho = -1$) are equal to 7.5% and 5%, respectively. On the other hand, while the portfolio expected return is still the same (7.5%), the risk of the equally weighted portfolio with a perfect positive correlation ($\rho = 1$) is equal to 15%.

Figure 1: Portfolio Risk and the Correlation Coefficient



Source: Authors' own illustration

As can be seen from Figure 1, for different asset weights it is possible to eliminate portfolio risk ($\sigma_p = 0$) when the correlation coefficient between the two assets is equal to -1. The asset weights yielding a portfolio with zero risk and an expected return of 6.67% are estimated as $w_1 = 0.6667$ for asset A and $w_2 = 0.3333$ for asset B.

1.2. Efficient Portfolios and the Optimal Choice

The M-V framework suggests a set of portfolios called *efficient portfolios* that either yield the lowest risk for a given / target level of return ($\boldsymbol{\mu} = r_{target}$) or the highest (maximum) return for a given / accepted level of risk (σ_{accept}). The curve combining all the efficient portfolios is named as the *efficient frontier* that is shown in Figure 2. The objective functions of the related optimizations are as follows:

$$\min \boldsymbol{w}^T \Sigma \, \boldsymbol{w} \tag{3}$$

$$\boldsymbol{\mu} = r_{target} \tag{4}$$

$$\textstyle\sum_{i=1}^{N} w_i \ = 1, \quad w_i \geq 0, \quad i = 1,2\ldots, N \tag{5}$$

Equation 3 produces the most risk-averse efficient portfolios for a target or acceptable return level as given by Equation 4. The constraints of the optimization problem are provided by Equation 5. Solving the following optimizations is another method for locating the efficient portfolios:

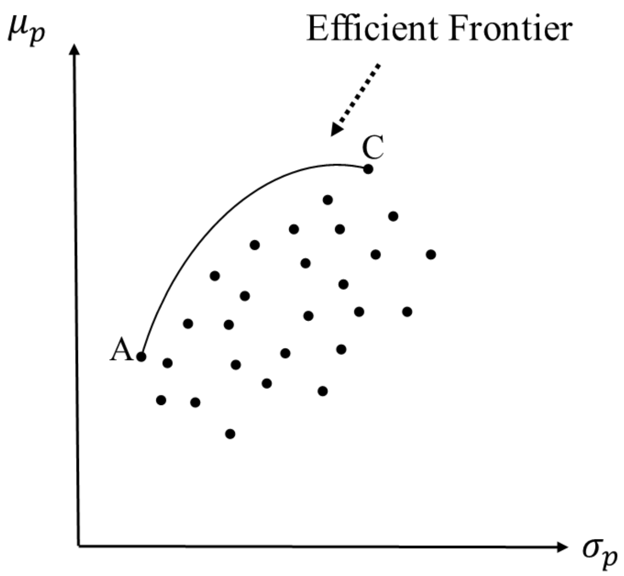
$$max \ \boldsymbol{w}^T \boldsymbol{\mu} \tag{6}$$

$$\boldsymbol{w}^T \Sigma \, \boldsymbol{w} = \ \sigma_{accept}^2 \tag{7}$$

$$\textstyle\sum_{i=1}^{N} w_i \ = 1, \quad w_i \geq 0, \quad i = 1,2\ldots, N \tag{8}$$

The efficient portfolios with the highest level of return for a specified or acceptable amount of risk are determined by Equation 7 and can be found using Equation 6. The efficient portfolio in Figure 2 with the lowest portfolio risk (variance) is indicated by the point labelled "A".

Figure 2: Efficient Portfolios and the Efficient Frontier



Source: Authors' own illustration

The portfolio optimization yielding the point “A” in Figure 2, that is named as the *minimum-variance* portfolio, is defined as follows:

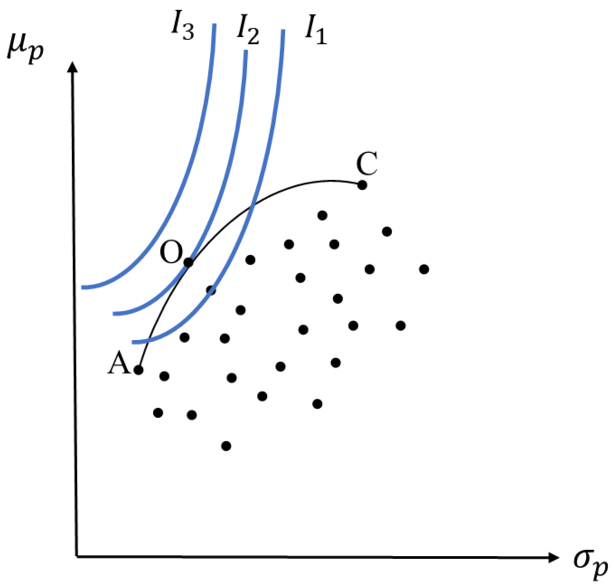
$$\min_{w} \ (\boldsymbol{w}^T \, \Sigma \, \boldsymbol{w}) \tag{9}$$

$$\sum_{i=1}^{N} w_i \ = 1, \quad w_i \geq 0, \quad i = 1,2...,N \tag{10}$$

In Equation 9, $\boldsymbol{w}$ and Σ represent the weight vector and the variance-covariance matrix as defined in Equation 1.

Among the portfolios on the efficient frontier, the question of which portfolio an investor should invest in depends on the investor’s degree of risk-aversion. M-V states that it is the best possible portfolio, as determined by Equation 1, that maximizes the investor's expected utility function. An investor's ideal portfolio is depicted in Figure 3 with point "O" indicated on the efficient frontier.

Figure 3: Optimal Portfolio of an Investor



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The optimal portfolio (point “O”) is the point in which the highest attainable indifference curve (I_2 in this case) is tangent to the efficient frontier. Each indifference curve represents a certain level of utility, which means that as one moves along an indifference curve, the obtained level of utility does not change. As a result, if an investor wants to increase the utility, he/she needs to select a portfolio on a different

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The term *asset allocation* has a broad meaning consisting of an individual's activities of searching for asset types and their properties to construct a portfolio that will best suit his/her preferences under different states of the world as well as uncertainty. The mean – variance model proposed by Markowitz constitutes the backbone of portfolio asset allocation literature in finance, including most of the industry applications and the further scientific developments. Albeit its popularity, the mean – variance model is highly criticized. There is a vast literature in finance trying to improve the predictions of the mean – variance model or propose new methods / strategies that can be employed in portfolio asset allocation tasks. While the first chapter of this book reviews the traditional theory, the rest of the chapters are focused on the question of whether asset ranks (univariate and/or cross-sectional ranks of returns) are relevant to portfolio asset allocation. Chapter 2 reports the findings of extensive research on the studies contributed to the finance literature by using ranks. The last chapter employs a recently developed portfolio allocation strategy using ranks.

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Cemile ÖZGÜR (born in 1982), graduated from Hacettepe University in Türkiye with a bachelor's degree in Business Administration in 2005. She obtained Master of Science degree in Economics and Finance in 2014 at Rhine-Waal University of Applied Sciences in Germany, where she undertook various academic activities, such as being a tutor, scientific assistant and lecturer. In 2017, she continued her academic research at Istanbul University Business School and obtained PhD degree in Finance in 2022.

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