Portfolio Designed Based on Combination of EIF Stocks, Futures, and Bonds

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Abstract. Contemporarily, investing in mutual funds have been a general trend for ordinary investors, as people hold the wish to earn the extra returns from the market. Among various underlying assets, portfolios are favorable ascribed to its risk separation based on the combinations of multiple assets. In this paper, the way to effectively use the limited initial capital based on investment in securities investment in order to obtain maximum benefit will be investigated and discussed in terms of model establishment and data derivation. According to the analysis, investors use the three stocks as a portfolio to diversify their investments, so that they can maximize profits and minimize risk. Moreover, according to the rise and fall rates of the three stocks in the previous period, the proportion that investors should allocate to the three stocks is obtained. These results shed light on guiding further exploration of investing in a portfolio of securities and allocating funds.

Keywords: Linear programming; corporate investment; stocks; profits.

1. Introduction

The research of this paper is based on China's investment market in modern times (after 2015). This reason is that China's investment market in the early stage of reform and opening up has just changed from centralized to diversified. Therefore, enterprises in that period choose venture capital with small scale, small quantity and small capital. As a result, these enterprises cannot diversify their risks through portfolio investment. In addition, China established and implemented the QFII system (Qualified Foreign Institutional Investors) in the early 1990s. This system essentially imposes certain restrictions on foreign access to the domestic securities market. The establishment of this system also promoted the development of domestic enterprises to a large extent, because these enterprises were reduced from the competitive pressure of foreign powerful enterprises. However, after nearly 40 years of development, that is, after 2015, enterprises gradually have diversified sources of funds, which means that enterprises have a certain ability to resist risks [1-5].

The investment portfolio can diversify the risk under the condition that the enterprise has enough funds and can resist certain risks, so that the enterprise can obtain the maximum profit. The basic theory of Portfolio theory is Portfolio Selection put forward by Markowitz in 1952. He says people make investments by choosing between uncertain returns and risks. Generally, mean - variance analysis method is used. Here, the mean refers to the expected return of the portfolio and is a weighted average of the expected return of individual securities, with the weight being the corresponding investment proportion. The variance is the variance of the portfolio return. Typically, the standard deviation of returns is called volatility, which is also an important reference object for portfolio risk. Meanwhile, Royproposed the safety-first portfolio theory. He selected the mean and variance of the portfolio as a whole, and proposed to minimize the probability that the portfolio return is less than a given Risk level as the model decision, providing an idea for VaR (Value at Risk). Tobin proposed the separation theorem: in the portfolio selection problem that allows short selling, each efficient portfolio is a combination of risk-free assets and special risk assets. Subsequently, William F. Sharpe proposed a single index model, which assumed that asset returns were only related to total market returns [6-13].

This paper will design the investment portfolio with the maximum return rate by studying the three known schemes in recent times. Here are three known options. First, companies (or investors) use their initial capital to buy Kweichow Moutai shares.Second, companies (or investors) use their initial capital to buy BILBIL shares. Third, companies (or investors) use their initial capital to buy shares in Tong Ren Tang.

In order to establish a model, this study has to make a bunch of assumptions. First of all, regarding investors who means the final practitioner of the scheme. The investors have the initial capital (100 million), which was mentioned earlier. In addition, they want to get the maximum return, which means that they want to buy the stock because of the optimal plan can generate the maximum profit. However, they do not like risk, and their risk aversion value is 2. Accordingly, the expected rate of return and variance (or standard deviation) can be used to measure the utility of the investor, and the variance (or standard deviation) can be used to measure the risk of the security. Second, the yield rate of securities is a random variable that satisfies the normal distribution, and the utility function of investors is quadratic. In addition, there is a positive proportion between risk and return. When investors choose the securities with the highest return, they will face the greatest risk. So, investors mostly spread their money across different securities, building a portfolio of securities and thereby reducing risk. However, although diversification can reduce risks, returns will also be reduced. Finally, in the establishment of a portfolio, it is necessary to meet the following requirements, i.e., the risk is minimized for a given level of payoff, or maximized for a given level of risk.The rest part of the paper is organzied as follows. The Sec. 3 will Basic notation and definition. The Sec. 4 will data. The Sec. 5 will results and discussion. The Sec. 6 will limitations and prospect. The Sec. 7 will the summary.

2. Basic notation and definition

The specific definition of investors being risk averse comes from Portfolio Selection written by Harry M.Markowitz. In this paper, he mainly introduced the E-V rule (Expected rear-variance rule), that is, Markowitz used geometric relations to explain why rational investors want to maximize expected returns and avoid risk. First, Markowitz proposes that the assumption that rational investors only wish to maximize returns is not valid because in incomplete markets, if this assumption holds, it implies that there is no diversified portfolio preferred by the majority. However, diversity can be observed and perceived. Moreover, if this assumption holds, it implies that investors only need to buy stocks with the largest returns.

To reject the above hypothesis, Markowitz proposes a new one: investors should maximize returns by diversifying their investments.This rule is consistent with the law of large numbers, which states that the portfolio real return will tend to its expected average.

$$E = \sum_{i=1}^{N} X_i \mu_i \tag{1}$$

$$V = \sum_{i=1}^{N} \sum_{j=1}^{N} \sigma_{ij} X_i X_j \tag{2}$$

Here, this is the probability theory. N is the number of possible future prices, i and j are two different quantities, respectively, and μ_i are the probabilities corresponding to N. In this formula, only X_i is not random, and X_i is a fixed value of the investor's own design. Given that there are n stocks to buy in the portfolio, that can form a self-imposed constraint, which means that the sum of ownership weights is 1 and the weight of the Nth stock is greater than 0, allowing us to analyze a portfolio consisting of n−1 stocks. In the n-1 dimensional space, there exists a point X that minimizes the variance of the portfolio. Two new curves are introduced here, the isometric line and the iso-variance line. In both cases (whether point X is within the reachable set), the effective frontier has the common point that it moves in the direction of rising isomean line value and isovariance line value.

The following is about one of the assumptions mentioned in the introduction, that is, investors want more profits but do not like risks. The definition of this comes from the points mentioned by Sharpe in A Simplified Model for Portfolio Analysis. This article amounts to a continuation of Markowitz's Portfolio Selection earlier. A new variable phi and a specific value lambda are introduced, which can be used to represent the relationship between portfolios E and V on the efficient frontier. Geometrically can be thought of as the tangent line on the efficient frontier, but can be thought of as the slope of the tangent line.

If the value of lambda is close to infinity, it means that there is a relatively abnormal element at this point (high return rate but low risk), and this element accounts for much more portfolio weight than other elements. By finding the tangent line of the point on the effective front, the element weights on the point can be determined.

Sharpe calls this method the Critical Line Method, and it has two important features. The first is a specific corner portfolio, like a SET. It refers to an interval on the effective frontier. In a certain interval, the elements on the portfolio remain unchanged, and the element weight interval is the open interval (0,1). There should be a linear relationship between two different points in the set. The second is the relationship between corner portfolios. When the weight of any element at a point drops to 0, the point belongs to the new Corner portfolio. So there must be additions and subtractions of valid elements between corner portfolios. The inputs required for this combination analysis are $n^2 \times \frac{n^2+3n}{2}$.

Subsequently, Sharpe proposed a new linear model: The Diagonal Model. The first idea for this model is to reduce the required inputs to 3n+2. Where variables A,B and C are used to determine the relationship between portfolio return R and market index correlation factor I, which is determined by the specific parameter An+1 and the normally distributed C parameter.

$$R_p = \sum_{i=1}^{N} X_i\,(A_i + C_i) + I\sum_{i=1}^{N} X_i B_i \tag{3}$$

Sharpe replaced the part of the top box with Xn+1. In this case, due to the property of I, the whole expression can be rewritten as the following expression. Then find the set containing only A in the expectation formula, and the variance formula also contains only variance set in the C distribution:

$$R_p = \sum_{i=1}^{N} X_i(A_i + C_i) + X_{n+1}(A_{n+1} + C_{n+1}) = \sum_{i=1}^{N+1} X_i(A_i + C_i) \tag{4}$$

The definitions of different variables are given in Table. 1

Table 1. The symbolic interpretation needed in the course of the argument

σ_p	Total risk of a portfolio of securities
$\bar{r}_p$	Total return on a portfolio of securities
σ_i	Risk of individual securities i (1,2,3,…, n)
ρ_{ij}	Relationship between two securities portfolios($-1 \le \rho_{ij} \le 1$)
r_i	The expected return on security i in the security portfolio
$\bar{r}_p$	Total expected return on portfolio i
x_i	The proportion of security i in the security portfolio
N	The type of securities in a portfolio
cov_{ij}	Covariance of returns of security I and security j
w_i	The weight of investment security i
μ_i	The expected rate of return on investment security i

3. Results & Discussion

The indifference Curve can be described as:

$$v = r - \frac{1}{2}A\sigma_p \tag{5}$$

For investing in two projects,

$$\sigma_p{}^2 = \sum_{i=1}^{N}\sum_{j=1}^{N} x_i x_j Cov_{ij} = x_1{}^2 \cdot \sigma_1{}^2 + x_2{}^2 \cdot \sigma_2{}^2 + 2x_1\sigma_1 x_2\sigma_2\rho_{12} \tag{6}$$

This is the standard deviation of returns, which is the sum of portfolio risk. In $-1 \le \rho_{ij} \le 1$ this interval the classification discussion is carried out and the image is derived

$$x_1 = \frac{rx - r_2}{r_1 - r_2}, x_2 = \frac{rx - r_1}{r_2 - r_1} \tag{7}$$

The original formula with the variance will be changed into:

$$Var(\bar{r}_p) = \left(\frac{rx - r_2}{r_1 - r_2}\right)^2 \cdot \sigma_1^2 + \left(\frac{rx - r_1}{r_2 - r_1}\right)^2 \cdot \sigma_2^2 + 2\left(\frac{rx - r_2}{r_1 - r_2}\right)\left(\frac{rx - r_1}{r_2 - r_1}\right)\sigma_{1\sigma_2\rho_{12}} \tag{8}$$

After simplification when $\rho_{ij} = -1$, it brings into

$$\sigma_p = \frac{\sigma_2(rx - r_1) + \sigma_1(rx - r_2)}{r_1 - r_2} \tag{9}$$

$$\sigma_p = \frac{\sigma_2(rx - r_1) + \sigma_1(rx - r_2)}{r_2 - r_1} \tag{10}$$

Similarly, when $\rho_{ij} = 1$, one derives

$$\sigma_p = \frac{\sigma_1(rx - r_2) - \sigma_2(rx - r_1)}{r_1 - r_2} \tag{11}$$

$$\sigma_p = \frac{-\sigma_1(rx - r_2) + \sigma_2(rx - r_1)}{r_1 - r_2} \tag{12}$$

By changing x1 and x2 (weights), different points can be obtained. The solution in the upper part of the curve is called the feasible solution, for every rational investor, they choose the combination of low risk and high return. Because any combination of other positions does not satisfy the condition of "rational investor".

To computer it, one needs to import the formulae from the packages "numpy", "Pandas", "pandas_Datareader.data", "matplotlib.pyplot", "scipy.optimize". From these we calculate the correlation coefficient, the volatility, the return and the weights. In addition, by running the ratio of different weights for 10,000 times in Python, a graph like this can be obtained, which contains 10,000 different weight allocation schemes. At the same time, this graph conforms to the expected graph, starting from the point where the minimum volatility is in the graph, it is the efficient set. The optimal matching scheme needs to be found from this red line segment.

Through Python running 10,000 times of the ratio of different weights, we finally arrive at a graph like this, which is also in line with our previous expectation. Starting from the point of the minimum volatility in the graph, it is the effective set. We need to find the optimal matching scheme from this red line segment. The investors choose two out of three stocks to invest in, and after analysis as shown in Tables. 2~5. The Expected return on portfolio $\overline{r_p}$ is 0.236 and Portfolio return volatility σ_p is 0.411. The effective frontiers are given in Fig. 1

Table 2. Average return of each stock

Kweichow Moutai	-0.146393
Tong Ren Tang	0.656901
BILBIL	0.015510

Table 3. Coefficient of association ρ_{ij}

	Kweichow Moutai shares	Tong Ren Tang	BILBIL
Kweichow Moutai	1.000000	0.273057	0.497766
Tong Ren Tang	0.273057	1.000000	0.220336
BILBIL	0.497766	0.220336	1.000000

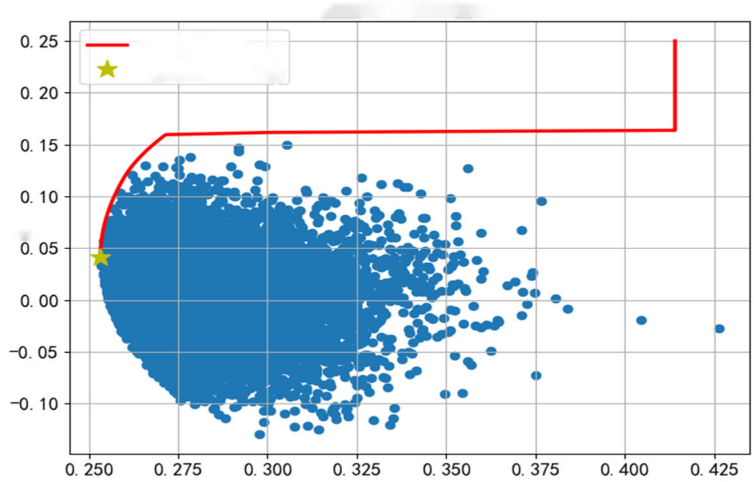

Fig. 1. The efficient frontier.

Table 4. Volatility σ_i

Kweichow Moutai	0.376307
Tong Ren Tang	0.463632
BILBIL	0.767729

Table 5. Stock portfolio weights

Kweichow Moutai	Tong Ren Tang	BILBIL
0.25370204	0.40783431	0.33846365

4. Limitations & Prospects

Securities still belong to emerging markets for the current society, and the emergence of modern securities portfolio theory is risky but profitable investment activity. The emergence of modern portfolio theory helps these investors well. However, this theory is still in the development stage, including some arguments in this paper will also need to be discussed and improved. This paper refers to China's securities market, while the development of China's securities market is still in the primary stage of development. China's securities market itself has great risks, which also makes it impossible to achieve the purpose of modern securities portfolio investment theory to reduce risks through investment portfolio. The risk of securities investment itself can be divided into systemic risk and non-systemic risk. Systemic risk includes policy risk, interest rate risk and purchasing power risk. These risks cannot be avoided by individuals or individual enterprises. Therefore, effective application of modern securities portfolio theory cannot resolve these risks. Modern securities portfolio can only diversify those non-systematic risks, that is, those uncertain risks that only affect individual enterprises due to enterprise operation, income and other factors, Such as credit risk and financial risk. At present, the systemic risk is relatively large in the total risk of China's securities market. On this basis, it is not ideal to reduce the risk of securities investment market by using modern securities portfolio theory.

Moreover, the investment group also has drawbacks. Modern securities portfolio theory has high requirements for investors, requiring investors to have the theory of using this theory for analysis and selection, investors must have sufficient knowledge reserve and executive ability. For most of the Chinese investor community does not share these attributes. Primarily, in the Chinese investor group, individual investors account for a large proportion, while institutional or enterprise investors account for a small proportion. Individual investors tend to have great uncertainty and are not conducive to management. Secondly, the education level of Chinese investors is generally not high and the amount of knowledge reserve is small, which leads to the inability of most people to understand the modern securities portfolio theory and make good use of the theory.

To solve the above problems and effectively use modern securities portfolio theory, the following changes need to be made in the future. First, reduce government intervention, reduce systematic risks that cannot be solved by theory, and give sufficient development space to the securities investment market. Second, improve information efficiency and ensure rapid and accurate information transmission. Because securities related information is an important way for securities market and investors to judge risks and returns. Having timely information is a great way to reduce risk.

5. Conclusion

In conclusion, this paper will investigate an appropriate portfolio of securities based on theoretical basis and data analysis of Markowitz and other researchers. Specifically, this paper describes the emergence of modern securities investment market theory and the views of predecessors on this theory. According to the analysis, aggregated the theory, the formulae and the data of the securities in the portfolio over the previous eight months. Nevertheless, the data study does not consider the systematic risk caused by the instability of the Chinese market, i.e., the research of this paper assumes that the systematic risk remains in the normal category. In the future, if investors invest their funds in Kweichow Moutai, Tong Ren Tang and BILBIL at a ratio of about 0.25, 0.40 and 0.35, respectively. They can ensure the minimum risk acceptable to investors under the premise of maximizing profits. Overall, these research data provide a good reference for subsequent investors to invest in securities, and give suggestions for the construction of China's securities investment market.

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