The Study of Model for Portfolio Investment Based on Ant Colony Algorithm

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Abstract. The risk and benefits are considered synthetically in portfolio investment based on the Markowitz portfolio theory. A multi-objective programming model of portfolio investment is established and studied the model solution with the ant group algorithm, then obtained a better result compared to using the Lingo model. Unified the ant group algorithm and the modern computer’s formidable operational capability, making the investor to be more convenient in the actual operation.

Keywords: multi-objective programming, portfolio investment, ant colony algorithm, Lingo1.

1 Introduction

China’s stock market is full of vigor and vitality, and also full of confusion and risk. Speeding up the research step in the field of financial and investment will provide certain theoretical support for the development of capital market and investors to improve the investment activities, so it is imperative to explore operational mechanism which adapts to Chinese socialist market economy. For a long time, the investor’s decision-making depends on the experiences in the practice and has not risen to the theory altitude. Since the 1950s Markowitz founded the modern portfolio theory, many scholars underwent the difficult research work to carry on and have enriched and developed this theory, so they obtained many effective methods in solving many problems of the portfolio, but how to make the portfolio model become optimization decision-making model is an urgent problem that needs to be solved.

In recent years, with the development of artificial intelligence, applied the intelligent optimization method in the investment portfolio question has become the broader research area. This paper used the continuous optimization ant algorithm to solve the optimal solution problem of the portfolio model, the experimental result has indicated that this model is accuracy and validity.

2 Multi Objective Decision-Making Model of Portfolio Investment

Supposed invest n kinds securities, the kind of i securities’s returns rate is \( r_i (i = 1,2,\cdots,n) \). Due to \( r_i \) receives the influence of stock market’s various factors,
thus $r$ could be regarded as a random variability. $R = E(r)$ is the mean of $r$, $\sigma_i^2 = E(r - R)^2$ is the variance of $r$, $x_i$ indicates the proportion of portfolio investment which $i$ security invests in ($\sum x_i = 1$). Then the portfolio investment's expectation returns ratio and the variance respectively are:

$$R = \sum_{i=1}^{n} x_i R_i, \sigma^2 = \sum_{i=1}^{n} x_i \sigma_{ij}$$

(1)

Here $\sigma_i = E(r_i - R)(r_j - R_j)$ is the covariance of $i$-securities and $j$-securities then multi-objective programming model of portfolio investment can be reveived:

$$\begin{align*}
\max R &= \sum_{i=1}^{n} x_i R_i \\
\min \sigma^2 &= \sum_{i=1}^{n} \sum_{j=1}^{n} x_i x_j \sigma_{ij} \\
\text{s.t.} & \sum_{i=1}^{n} x_i = 1 \\
& x_i \geq 0 \quad i = 1, 2, \ldots, n
\end{align*}$$

(2)

$x_i \geq 0$ expressed that our country does not permit short selling.

$$X = (x_1, x_2, \ldots, x_n)^T, R = (R_1, R_2, \ldots, R_n)^T, C = (\sigma_{ij})_{n \times n}$$

C is symmetric positive definite matrices, $R$ is covariance matrix, $E = (1, 1, \ldots, 1)^T$ and (2) expresses the matrix:

$$\begin{align*}
\max R &= R^T X \\
\min \sigma^2 &= X^T CX \\
\text{s.t.} & E^T X = 1 \\
& X \geq 0
\end{align*}$$

(3)

Namely:

$$\min F(x) = \left\{ \left[ f_1(x), f_2(x) \right]^T \left| \sum_{i=1}^{n} x_i = 1 \right. \right\}$$

$$f_1(x) = -R^T X, f_2(x) = X^T CX$$

(4)

Hence constructed a multi-objective decision making model to be able to optimize the income and the risk simultaneously. The solution of multi-objectives optimize emerges one after another incessantly, but transforming the multi-objective questions as the simple target question is the basic philosophy, with the aim that using a maturer simple-target optimize method to obtain optimal solution. Each kind of solution may divide into two kinds approximately: One kind aims at optimizing one component of the multi-objective functions, but takes other components become the constraints, or constructs a sequence simple target to optimize; Another kind make the multi-objective function