



The admissible portfolio selection problem with transaction costs and an improved PSO algorithm

Wei Chen^a, Wei-Guo Zhang^{b,*}

^a School of Information, Capital University of Economics and Business, Beijing, 100070, PR China

^b School of Business Administration, South China University of Technology, Guangzhou, 510641, PR China

ARTICLE INFO

Article history:

Received 19 September 2007

Received in revised form 8 January 2010

Available online 18 January 2010

Keywords:

Portfolio selection

Admissible return

Admissible risk

Transaction costs

Particle swarm optimization

ABSTRACT

In this paper, we discuss the portfolio selection problem with transaction costs under the assumption that there exist admissible errors on expected returns and risks of assets. We propose a new admissible efficient portfolio selection model and design an improved particle swarm optimization (PSO) algorithm because traditional optimization algorithms fail to work efficiently for our proposed problem. Finally, we offer a numerical example to illustrate the proposed effective approaches and compare the admissible portfolio efficient frontiers under different constraints.

© 2010 Elsevier B.V. All rights reserved.

1. Introduction

In 1952, Markowitz [1] published his pioneering work which laid the foundation of modern portfolio analysis. Markowitz's mean–variance model has served as a basis for the development of modern financial theory over the past five decades. With the continuous effort of various researchers, Markowitz's seminal work has been widely extended. In the mean–variance portfolio selection problem, previous research includes Refs. [2–4]. More researches on portfolio selection may be found in Refs. [5–7].

Recently, a number of researchers have investigated fuzzy portfolio selection problems. Tanaka et al. [8] proposed the portfolio selection model based on fuzzy probabilities, which can be regarded as a natural extension of Markowitz's model because of extending probability into fuzzy probability. By using fuzzy approaches, the experts' knowledge and investors' subjective opinions can be better integrated into a portfolio selection model. Ida [9], Lai et al. [10] and Giove et al. [11] constructed interval programming models of portfolio selection. Zhang and Nie [12], Zhang et al. [13], and Zhang and Wang [14] discussed the admissible efficient portfolio selection under the assumption that the expected return and risk of assets have admissible errors to reflect the uncertainty in real investment actions and gave an analytic derivation of admissible efficient frontier when short sales are not allowed on all risky assets.

It is well known that transaction cost is one of the main concerns for portfolio managers. It has an important effect on the portfolio optimization and the frequency of time rebalancing the portfolio. Arnott and Wagner [15] found that ignoring transaction costs would result in an inefficient portfolio. The experimental analysis done by Yoshimoto [16] also verified this fact. Moreover, when some more realistic constraints such as transaction costs, bounded constraints, liquidity constraints, minimum transaction lots constraints, and cardinality constraints are considered, the portfolio selection problem becomes a complex programming problem and traditional optimization algorithms fail to find the optimal solution

* Corresponding author.

E-mail addresses: wgzhang@scut.edu.cn, zhwg61@263.net (W.-G. Zhang).

efficiently. Therefore, many researchers solve the complex constrained portfolio problems by using heuristic algorithms. For example, Xia et al. [17] designed a genetic algorithm for portfolio selection problem with order of expected returns. Chang et al. [18] used heuristics algorithms based upon genetic algorithms, tabu search and simulated annealing for the cardinality constrained mean–variance model. Speranza [19] used linear programming based heuristics algorithms for a portfolio optimization model with transaction costs, minimum transaction units and limits on minimum holdings. Jobst et al. [20] designed two heuristic solution procedures, ‘integer restart’ and a two-stage ‘reoptimization’ heuristic, for the mean–variance model with buy-in thresholds, cardinality and round lots constraints. Fernández and Gómez [21] presented heuristics algorithms based upon neural networks for the standard Markowitz mean–variance model with cardinality and bounding constraints. Crama and Schyns [22] applied simulated annealing to a portfolio problem with cardinality, turnover and trading constraints.

However, there are few researches in modelling and solving portfolio selection problems by using the particle swarm optimization (PSO) algorithm proposed by Kennedy and Eberhart [23,24] in previous work. In this paper, we will discuss the admissible portfolio selection problem with transaction costs and bounded constraints. We also present an improved PSO algorithm for the portfolio selection problem.

The organization of this paper is as follows. We present the admissible portfolio selection model with transaction costs and bounded constraints in Section 2. An improved PSO algorithm is designed to solve the corresponding portfolio problem in Section 3. A numerical example is given to illustrate our proposed effective means and approaches, and the admissible portfolio efficient frontiers under different constraints are compared in Section 4. Some concluding remarks are given in Section 5.

2. The admissible portfolio selection model with transaction costs

We consider a portfolio selection problem with n risky assets. Let r_j be the expected return rate of asset j and let x_j be the proportion of capital to be invested in asset j , $j = 1, 2, \dots, n$. In order to describe conveniently, we set $\mathbf{x} = (x_1, x_2, \dots, x_n)'$, $\mathbf{r} = (r_1, r_2, \dots, r_n)'$, and $\mathbf{e} = (1, 1, \dots, 1)'$. Then the expected return and variance associated with the portfolio $\mathbf{x} = (x_1, x_2, \dots, x_n)'$ are, respectively, given by

$$E(r) = \mathbf{r}'\mathbf{x}, \quad D(r) = \mathbf{x}'\mathbf{v}\mathbf{x},$$

where $\mathbf{v} = (\sigma_{ij})_{n \times n}$ is the covariance matrix of expected returns.

Markowitz’s mean–variance model of the portfolio selection problem may be described by the following quadratic programming:

$$\begin{aligned} \min \quad & \mathbf{x}'\mathbf{v}\mathbf{x} \\ \text{s.t.} \quad & \mathbf{r}'\mathbf{x} = r_0, \\ & \mathbf{e}'\mathbf{x} = 1, \\ & \mathbf{x} \geq 0. \end{aligned} \tag{1}$$

In order to apply the model (1) in a practical investment problem, we need to estimate \mathbf{r} and $\mathbf{v} = (\sigma_{ij})_{n \times n}$. Let the observation data on returns of assets over m periods be given. At the discrete time k ($k = 1, 2, \dots, m$), n kinds of returns are denoted as a vector $\mathbf{r}_k = (r_{k1}, r_{k2}, \dots, r_{kn})'$. The expected return $\bar{\mathbf{r}} = (\bar{r}_1, \bar{r}_2, \dots, \bar{r}_n)'$ and covariance $\bar{\mathbf{v}} = (\bar{\sigma}_{ij})_{n \times n}$ are given as follows [12,13]:

$$\bar{r}_j = \frac{\sum_{k=1}^m (h_{kj} r_{kj})}{\sum_{k=1}^m h_{kj}}, \quad j = 1, 2, \dots, n, \tag{2}$$

$$\bar{\sigma}_{ij} = \frac{\sum_{k=1}^m (r_{ki} - \bar{r}_i)(r_{kj} - \bar{r}_j)h_{kij}}{\sum_{k=1}^m h_{kij}}, \quad i, j = 1, 2, \dots, n, \tag{3}$$

where h_{kj} is a possibility grade to reflect a similarity degree between the future state of asset j and the k th sample offered by experts, h_{kij} is a possibility grade to reflect a similarity degree between the future state of the relation between asset i and asset j and the k th sample offered by experts.

Since r_j , $j = 1, 2, \dots, n$ are affected by uncertain factors, the expected returns and risks of assets cannot be predicted accurately. In Zhang and Nie [12], Zhang et al. [13], and Zhang and Wang [14], the admissible average return and covariance are respectively defined as

$$r_j^* = \bar{r}_j + \phi_j, \quad \phi_{jl} \leq \phi_j \leq \phi_{jh}, \quad j = 1, 2, \dots, n, \tag{4}$$

and

$$\sigma_{ij}^* = \bar{\sigma}_{ij} + \varepsilon_{ij}, \quad \varepsilon_{ijl} \leq \varepsilon_{ij} \leq \varepsilon_{ijh}, \quad j = 1, 2, \dots, n, \tag{5}$$

where ϕ_j is the admissible error for \bar{r}_j , ϕ_{jl} and ϕ_{jh} are the lower and upper bounds of ϕ_j , ε_{ij} is the admissible error for $\bar{\sigma}_{ij}$, ε_{ijl} and ε_{ijh} are the lower and upper bounds of ε_{ij} .

متن کامل مقاله

دریافت فوری ←

ISIArticles

مرجع مقالات تخصصی ایران

- ✓ امکان دانلود نسخه تمام متن مقالات انگلیسی
- ✓ امکان دانلود نسخه ترجمه شده مقالات
- ✓ پذیرش سفارش ترجمه تخصصی
- ✓ امکان جستجو در آرشیو جامعی از صدها موضوع و هزاران مقاله
- ✓ امکان دانلود رایگان ۲ صفحه اول هر مقاله
- ✓ امکان پرداخت اینترنتی با کلیه کارت های عضو شتاب
- ✓ دانلود فوری مقاله پس از پرداخت آنلاین
- ✓ پشتیبانی کامل خرید با بهره مندی از سیستم هوشمند رهگیری سفارشات