Operations Research Perspectives 4 (2017) 136–141

Contents lists available at ScienceDirect

Operations Research Perspectives

journal homepage: www.elsevier.com/locate/orp

A robust optimization model for a decision-making problem: An application for stock market

Massimiliano Ferrara[a,b,*], Sepideh Rasouli[c], Mehrnoosh Khademi[c], Mehdi Salimi[d]

[a] Department of Law and Economics, University Mediterranea of Reggio Calabria, Italy
[b] ICRIOS - The Invernizzi Centre for Research on Innovation, Organization, Strategy and Enterpreunership - Bocconi University, Milano, Italy
[c] MEDAlics, Research Center at Università per Stranieri Dante Alighieri, Reggio Calabria, Italy
[d] Center for Dynamics, Department of Mathematics, Technische Universität Dresden, 01062 Dresden, Germany

ARTICLE INFO

Article history:
Received 27 March 2017
Revised 19 August 2017
Accepted 11 October 2017
Available online 12 October 2017

Keywords:
Decision making
Robust LINMAP
Stock

ABSTRACT

In this paper we apply robust linear programming technique for multidimensional analysis of preference (LINMAP) method for a decision making problem. During the last two decades, many methods have been extensively used for decision making problems. However, there is no investigation among many existing studies where the uncertainty in data is possible. The robust LINMAP method with the assumption of uncertainty on parameters is implemented in the stock market in order to rank priorities of the stocks.

1. Introduction

Multi attribute decision making (MADM) methods are practical and useful techniques for real-world decision making situations. Many financial decision problems which include several criteria applied MADM methods as an effective tool. Optimum choice of stock is an issue which investors are tackling permanently. A large number of studies have been expanded in this field. Diakoulaki et al. [7] presented a MADM method for assessment of the companies' operation and applied the results of a multi criteria analysis to a large sample of Greek pharmaceutical industries. A multi criteria industrial evaluation system was provided by Mareschal and Bransj [15]. which is useful for decision-makers when they want to make decisions about their industrial clients. Samaras et al. [18] introduced a system to utilize multi criteria analysis methodologies in order to evaluate and rank the Athens Stock Exchange (ASE) stocks. MADM problems can be divided into different categories. Technique for order preference using similarity to the ideal solution (TOPSIS) is a method based on distance measures which has been introduced by Hwang and Yoon [13]. The other method which is similar to the TOPSIS is a linear programming technique for multidimensional analysis of preference (LINMAP) developed by Srinivasan et al. [20]. Nevertheless, the TOPSIS and LINMAP methods need various kinds of data and decision conditions. In the LINMAP method decision makers compare alternatives in form of pairs and the best solution is the alternative that has shortest distance to the positive ideal solution (PIS), while in the TOPSIS method shortest distance to the PIS and the farthest from the negative ideal solution (NIS) is considered.

Ordinal regression is one of the methods used in decision making problems. It can represent a set of holistic preference information provided by the Decision Maker (DM). Greco et al [11]. presented an ordinal regression method for multiple criteria ranking of alternatives. A Regression with Intensities of Preference (GRIP) method was presented for ranking a finite set of actions which was based on indirect preference information and the ordinal regression paradigm [8]. Greco et al. [12] introduced an ordinal regression model for multiple criteria problems by using a set of additive value functions computed through the resolution of linear programs. Robust Ordinal Regression (ROR) is one of the recent approaches concerning the development of preference models. ROR designed for multiple criteria ranking is a non-statistical methodology of preference learning. The basic concepts and the main developments of ROR were introduced by Corrente et al. [6]. Corrente et al. [5] clarified the specific interpretation of the concept of preference learning adopted in ROR. They focused on ROR, which is closer to preference learning practiced in Machine Learning.

Nevertheless, in many real-world decision problems results produced by deterministic approaches could lead to neglect of inaccurate information. Consequently, a large number of methods were

* Corresponding author at: Department of Law and Economics, University Mediterranea of Reggio Calabria, Italy.

E-mail addresses: massimiliano.ferrara@unirc.it, massimiliano.ferrara@unibocconi.it (M. Ferrara), sepi_rasoli@yahoo.com (S. Rasouli), mehrnoosh.khademi@medalics.org (M. Khademi), mehdi.salimi@tu-dresden.de, msalimi1@yahoo.com (M. Salimi).

https://doi.org/10.1016/j.orp.2017.10.001

developed to manage uncertainty on the decision problems, like robust solution, stochastic and fuzzy programming . The concept of fuzzy logic, initially introduced by Zadeh et al. [22] is more applicable when there is no access to historical information and the information are based on decision maker's prejudgment. Recently, fuzzy logic has been widely applied in decision making problems. Chen and Tan [4] developed a LINMAP method to deal with multiple criteria decision analysis problems based on interval type-2 trapezoidal fuzzy numbers. Wang and Lie [21] presented a fuzzy logic approach to solve multi-attribute group decision making problems in which all the preference information provided by the decision makers and the preference data about the alternatives are generally unknown. Zarghami et al. [23] introduced a fuzzy-stochastic modelling of MCDM problems by using the stochastic and fuzzy approaches in order to obtain a robust decision under uncertainly. Different fuzzy methods that are multi-criteria decision making were introduced by Li et al. [14].

However, the approaches have been applied to decision-making problems without assuming any uncertainty in information, have been under some severe examination where a minor perturbation can make a significant modification on the ranking. Ben-Tal and Nemirovski [1] showed a small perturbation on information might lead to infeasible solutions and the results of the ranking might be unreliable. Recent researches on robust optimization have developed some models which are capable of considering uncertainty in data and generating the ranking that is more reliable and a minor modification in input and output parameters might not change the outcomes.

When input and output data in a mathematical linear programming are uncertain, could not solve by traditional methods, robust optimization can cope with this uncertainty on decision making problem. Soyster [19] introduced robust optimization method but it was too conservative. A new robust optimization for handling uncertainty on linear programming was presented by Ben and Nemirovski [1]. A robust optimization which has been widely used for MCDM problems was introduced by Bertsimas and Sim [3]. In some studies the robust optimization method was applied in the industrial cases. It was utilized for measuring the efficiency of telecommunication companies [17]. In addition, Sadjadi and Omrani [16] were presented Data Envelopment Analysis model (DEA) with uncertain data for performance assessment of electricity distribution companies. In this paper, the proposed robust optimization technique is implemented to stock market in order to select best stock. The task of the choosing stocks including several fundamental indicators to invest is a decision making process. There are many unknown and uncertain criteria and an investor should take into account all available data. The main objective of this paper is to apply a method considering all parameters for selecting stocks. As, there are many criteria for choosing stock that some of them are uncertain and some criteria are changing during the time, applying robust LINMAP method can cope with uncertainly in data. We organize the paper as follows. Section 2 contains description of the LINMAP method. Robust form of LINMAP is presented in Section 3. Finally, the method is implemented in a real case in Section 4.

2. LINMAP formulation for multiple attribute

A LINMAP issue is to catch the best compromise solution from all appropriate alternatives assessed on multiple attributes. Suppose that there is a collection existing of V decision makers who choose one(s) of (or rank) m alternatives based on n attributes. Alternatives composed of attributes are represented as m points in the n-dimensional space. Assume that ratings of alternatives on attributes are given using LINMAP through judgments of the decision makers. A decision maker considers an ideal point in his mind based on his preference. Then the alternatives which have the shortest distance from the ideal point are selected. Therefore, for each alternative A_i the distance from ideal point is shown by d_i as follow [13]:

$$d_i = \left[\sum_{j=1}^{n} w_j (x_{ij} - x_j^*)^2\right]^{1/2}, \qquad i = 1, 2, \dots, m,$$

where weights of attributes are w_j (j=1,2,... ,n). Weights are unknown and must be determined, x_{ij} is the value of i_{th} alternative based on j_{th} attribute in decision matrix and x_j^* is the ideal point value, so that the square of the distance from the ideal point is;

$$s_i = d_i^2 = \sum_{j=1}^{n} w_j (x_{ij} - x_j^*)^2, \qquad i = 1, 2, \dots, m.$$

Decision makers give the preference between alternatives by $\Omega = \{(k, l)\}$ that denotes a set of ordered pairs (k, l), where k represents the preferred alternative basis on results from a pair wise comparison involving alternatives k and l. Generally not perforce Ω has all alternatives. For each pair in Ω, the solution (w, x^*) might be consistent with the weighted Euclidean distance while the following condition holds,

$$s_l \geq s_k.$$

Otherwise if $s_l < s_k$ means an error happened and we generally define

$$(s_l - s_k)^- = \begin{cases} 0 & \text{if} \quad s_l \geq s_k \\ s_k - s_l & \text{if} \quad s_l < s_k, \end{cases} \tag{2.1}$$

that could measure inconsistency between the ranking order of alternatives a_k and a_l determined by s_k and s_l and the preference relation $(k, l) \in \Omega$ given by the decision maker. Obviously, the index in (2.1) can be rewritten as follows:

$$(s_l - s_k)^- = \max\{0, \ (s_k - s_l)\},$$

and $(s_l - s_k)^-$ represents error for the pair of $(k, l) \in \Omega$. We define a total inconsistency index of the decision maker by:

$$B = \sum_{(k,l)\in\Omega} (s_l - s_k)^- = \sum_{(k,l)\in\Omega} \max\{0, \ (s_k - s_l)\}.$$

By definition, $(s_l - s_k)^-$ and B are nonnegative. Finding (w, x^*) based on which B is minimal is our problem. Similar to B, we define a total consistency index of the decision maker by:

$$G = \sum_{(k,l)} (s_l - s_k)^+,$$

where:

$$(s_l - s_k)^+ = \begin{cases} s_l - s_k & \text{if} \quad s_l \geq s_k \\ 0 & \text{if} \quad s_l < s_k. \end{cases}$$

If $G > B$ we define $G - B = h$, where h is a positive number. It suddenly shows that $(s_l - s_k)^+ - (s_l - s_k)^- = (s_l - s_k)$. Furthermore, h can be extended as $\sum_{(k,l)\in\Omega} (s_l - s_k)$.

We construct the auxiliary mathematical programming model to determine w; thus (w, x^*) could be acquired by solving the following model,

$$\min B = \sum_{(k,l)\in\Omega} \max\{0, \ (s_k - s_l)\},$$

$$\text{subject to} \quad \sum_{(k,l)\in\Omega} (s_l - s_k) = h,$$