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Discrete Optimization

Decision making in stock trading: An application of PROMETHEE

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Abstract

The key issue for decision making in stock trading is selection of the right stock at the right time. In order to select the superior stocks (alternatives) for investment, a finite number of alternatives have to be ranked considering several and sometimes conflicting criteria. Therefore, we are faced with a special multicriteria decision-making problem. The purpose of this paper is to develop a decision-making model for selecting superior stocks in stock exchange and a model is provided in order to structure this problem. The proposed model is structured around two pillars: Industry evaluation and Company evaluation. The preference ranking organization method for enrichment evaluation (PROMETHEE) has been used for solving the problem. The model has been applied at Tehran Stock Exchange (TSE) as a real case and a survey from the experts in order to determine the effective criteria for industry evaluation and company evaluation has been conducted.

Keywords: Multicriteria decision making; Industry evaluation; Company evaluation; PROMETHEE; Tehran Stock Exchange (TSE)

1. Introduction

The key issue for decision making in stock trading is selection of the right stock at the right time. There are many analytical approaches for decision making in stock exchange, which are categorized in two groups of technical analysis and fundamental analysis.

Technical analysts believe that the prediction of stock future price is possible through studying stock prices in the past [8]. There are technical indicators for studying price patterns and trends of each stock such as moving averages, relative strength index (RSI), moving average convergence divergence (MACD) and so on. In this approach, the future price of stock is predicted based on the decision-making rules of each indicator.

Fundamental analysts analyze audit reports, income statement, quarterly balance sheets, dividend records, sales records, management capabilities and competitive situation of the company and then calculate intrinsic value of each stock based on prediction of cash flow for next few years. If the market price of a stock is lower than its intrinsic value then its price is expected to rise and they decide to buy it [3].

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Many methods are applied based on one of these two approaches or the combination of them. For example, Kwasnica and Ciosmak [12] have applied a fuzzy expert system for technical analysis and artificial neural network for fundamental analysis in order to analyze the stock market and calculate the attractiveness of the companies and identifying buy signals.

Various approaches of artificial intelligence have also been used for this purpose. Genetic programming has been used for discovering appropriate technical trading rules in stock exchange [18]. Intelligent agents technology has been applied for retrieving stock market data from distributed Internet sources [21] and decision support tasks for buy or sell decisions [13] based on fundamental analysis principals and technical indicators. Garcia et al. [9], reported a framework for implementing a deli- berative multi-agent system for this domain. This system can be used as a proactive tool for expressing and implementing high-level stock trading strategies.

In the stock selection problem, there are a finite number of stocks existing in stock exchange that have to be ranked considering many different and conflicting criteria. Accordingly, this problem is considered as a mulicriteria decision-making problem. Here, it has been divided into two different but related pillars namely: industry evaluation, and company evaluation. In industry evaluation, industries member of the stock exchange have to be ranked over effective criteria about industry. In company evaluation, companies existing in each superior industry have to be ranked over appropriate criteria of the company.

To solve the above-mentioned problems, the PROMETHEE has been proposed as an outranking method. This method has some strengths in comparison with analytic hierarchy process (AHP) method [14], such as: the PROMETHEE I does not aggregate good scores on some criteria and bad scores on other criteria, it has less pairwise comparisons and it does not have the artificial limitation of the use of the 9-point scale for evaluation. There is a software called DECISION LAB [7] that supports this method and also sensitivity analysis on results is possible through using the software. This method provides a visual and powerful tool called GAIA plane (Geometrical Analytic for Interactive Aid) to identify conflicts between criteria and to group the alternatives [15]. However, the AHP method has a graphical representation tool [6].

In this paper, the selected method has been applied in Tehran Stock Exchange (TSE) as a real case. Tehran Stock Exchange is a major stock market in Iran and its market value is more than 40 billion dollars.

2. The PROMETHEE method

The PROMETHEE method (preference ranking organization method for enrichment evaluation) is a multicriteria decision-making method developed by Brans et al. [5]. It is a quite simple ranking method in conception and application compared with other methods for multicriteria analysis. It is well adapted to problems where a finite number of alternatives are to be ranked considering several, sometimes conflicting criteria. The evaluation table is the starting point of this method. In this table, the alternatives are evaluated on the different criteria. The implementation of PROMETHEE requires two additional types of information, namely:

- Information on the relative importance (i.e. the weights) of the criteria considered.
- Information on the decision-maker's preference function, which he/she uses when comparing the contribution of the alternatives in terms of each separate criterion.

The following steps are required for the implementation of the method:

(1) Alternatives are compared in pairs for each criterion. The preference is expressed by a number in the interval $[0,1]$ (0 for no preference or indifference to, 1 for strict preference). The function relating the difference in performance to preference is called the generalized criterion and it is determined by the decision maker.
(2) A multicriteria preference index is formed for each pair of alternatives as a weighted average of the corresponding preferences computed in step (1) for each criterion. The index $\Pi(a,b)$ (in the interval $[0,1]$) expresses the preference of alternative a over b considering all criteria. The weighting factors express the relative importance of each criterion and are chosen by the decision maker.
(3) Alternatives can be ranked according to:
    - The sum of indices $\Pi(a,i)$ indicating the preference of alternative a over all the