



Group Multi-Criteria Decision Making to Select Investment Companies

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Abstract

With problems spread around the world, evaluating the performance of the investment companies and being able to identify potentially weak investment companies which will get into trouble becomes more interesting for investors, managers and the public. The aim of this study was to propose an integrated approach, the combination of traditional and downside risk performance measures, for evaluating the strategies of selecting the optimal combination of the investment companies' stock in Iran over the period of 2006-2011. For the evaluation of investment companies' performance, an original methodology in the context of group Multiple Criteria Decision Making has been used. The result of this study indicated that the combination of the two stocks is the optimal solution.

Keywords: Pperformance evaluation, selection strategy, investment company, multiple criteria, group decision making.

Introduction

Over the past decade, Iranian investors have increasingly turned into funds to lay aside for retirement and other financial goals. Funds can provide the advantages of diversification and professional direction. In other words, one of the primary advantages of mutual funds is that they give small investors approach to professionally managed, diversified portfolios of equities, bonds and other securities, which will be rather hard (if not impossible) to build with a little money. In this kind of investment, each shareholder participates proportionally in the profit or loss of the investment company.

Merely, as with other investment alternatives, investing in funds involves risk, fees and taxes which will decrease a fund's yield. Then it is important to have independent and objective information when investing on funds because investors want a transparent view of its performance and a glimpse of the outlook going forward. Then, Investors, brokers, analysts and creditors try to find firms which possess the potential ability to perform well in stock¹.

The leading performance measures of firms can be grouped into two main categories. The first category consists of mean-variance framework; which includes the Sharp Ratio, Treynor Index and Jensen Alpha. Traditional framework is valid only if the returns are normally distributed function, then its risk can be measured by the variance of its returns; and because of that they are targeted ratios which are criticized. The second category of potential leading performance measures of firms contains other, somewhat more acceptable metrics than traditional, downside risk measures of financial performance, such as Sortinoratio, the Upside Potential ratio, Omega ratio, Mamoghli and Daboussi Index and Alpha of Mamoghli and Daboussi.²

One important benefit of the downside risk is categorizing good and bad returns: good returns are more smashing than the destination, while bad returns are the ones under the goal. The downside risk measures incorporating an investor's goal clearly and defines risk as not reaching the goal.³ The other benefit of downside risk is considered of asymmetry of returns and the risk attitude of investors².

In the empirical literature on investment companies' performance evaluation, two approaches were used: the parametric and non- parametric approach.

At the parametric approach the chief care of investors is the return and the associated risk of his/her investment. Most of these works concentrate on famous traditional performance standards which are based on variance and beta as risk measures. Because of deficiency of these traditional criteria, alternative performance criteria in the downside risk framework were recommended.

Literature on the performance evaluation by non-parametric approach is quite limited compared to the numerous researches, using the parametric approach. For evaluating financial performance of the funds, Murthi et al.(1997) were applied Data envelopment analysis (DEA) method. After that many studies were done by applying this method¹⁰. Another method which was used in many studies is Balanced Score Card (BSC). In late years, certain arrangements such as the US Department of Commerce, Canadian Government, and etc have begun to see the benefits of the balanced scorecard techniques and use these methods to diverse sorts of performance-based appraisal schemes, including occupation, environment, quality, etc. Literature confirms that balanced scorecard has been

successfully employed in various construction fields to measure the service/product quality¹¹.

Multiple Criteria Decision Analysis (MCDA) method has been used by many researchers. These methods are complimentary from the former criticisms and provide the necessary methodological tools to execute both the evaluation of mutual funds' performance as well as manufacturing a portfolio of mutual funds, through a realistic and an integrated approach.¹²

Cook et al.(1993) believed that using a multi criteria, methodology for selecting mutual funds allows numerous factors to be considered, letting investors formulate different ratings of the set of competing mutual funds. Their work was based on a model by Cook and Kress which seems to pioneer in using a multi criteria approach to mutual fund selection¹³. Although Fuzzy logic has been applied to performance evaluation in different fields of science¹⁴, Wang et al. used to give the fuzzy hierarchical analytic approach to define the weighting of subjective judgment and presented a no-additive fuzzy integral technique to appraise a mutual fund case as a fuzzy multi criteria decision making (FMCDM) problem¹⁵.

Pendaraki et al. used integrated methodological framework for the evaluation of mutual fund performance in Greece. Their methodology was based along the combination of discrete and continuous multi criteria decision aid methodology (MCBA) and their answers were encouraging.¹⁶

Again, Wanget al. applied Fuzzy Multiple Criteria Decision Making (FMCDM) to select mutual funds' investments in Taiwan. They establish that the model of FMCDM predicts the rate of return very exactly and it helps investors to reach conclusions in different conditions¹⁷. Recently, Babalos et al. employed a unique dataset of risk adjusted returns such as Carhart's Alpha and operational variables in Greece's domestic equity funds. Their primary conclusion was that among employed variables, the sophisticated Carhart's alpha plays the most significant part in determining funding ranking and on the other hand, fund's rankings are affected only marginally by operational attributes¹⁰.

This work differs from other studies in several ways. First, this study pursues a new direction in the analysis of the evaluation of financial performance by using Multiple Criteria Decision Making models and different risk frameworks as a group decision making. Second, using these models enables us to select a combination of investment companies with considering all of the performance measures simultaneously rather than using a few of them.

Data and Methodology: **Data:** The data set used in this study includes 23 investment companies which most of them have been listed as the most active 50 stocks in Iran regarding their values and volumes. We have collected annual data from

Rahavarde Novin and Tadbir Pardaz database separately during the period of 2006-2011.

Variables: The variables in this study involve traditional performance measures and alternative performance measures based on the database. Because of the different characteristics of return distributions of the firms, we have used both frameworks. In order to get comparable results with previous studies, which evaluated the financial performance measurement of the firms, we take the asymmetry of returns into account.

Methodology

The methodology of this study had three phases. In the first phase the performance evaluation of investment companies by traditional and alternative measures were evaluated. Then, the highest ranks were determined by Borda's function in the second phase. In the last phase, the best combination of the firms' accordance with the aggregate rank or portfolio was selected.

First Phase: In the first phase, among the best reporting listed companies during 2006-2011 in Iranian Stock Exchange, 23 investment companies have been chosen. We have only seen the percentage of each firm portfolio's total value placed in a particular asset called asset's listed securities. The major reason for the selection of this part of the firm's portfolio is that we couldn't calculate the value of the entire portfolio at the point in time the market value and return of non-listed assets were not available.

Stock returns were calculated using monthly stock returns on the basis of monthly Tadbir Pardaz and Rahavarde Novin data base. We use monthly returns to calculate an annualized geometric return during the mentioned period. In the data related to the combination of portfolios we have not concerned other investment, financial accounts because the combination was not clear and it was less than 3 percent of the entire portfolio.

With the purpose of evaluating financial performance of investment companies, the traditional (Sharp Ratio, Treynor Ratio) and alternative measures (Mamoghli and Daboussi Alpha, Sortino Ratio, Mamoghli and Daboussi, Upside Potential Ratio and Omega Ratio) were used. We found that returns were normally distributed.

Second Phase: In this phase, because there were so many of firms and we could just invest in eight of them, we used the Board's method. The board's method was applied for ranking the order of the firms, according to eight financial performance measures.

Each firm, was assigned a mark of m-1, m-2... 1, 0 to the first ranked, second ranked and last ranked firms for each measure; then the *Borda's* score for each firm was determined as the sum

of the measure's mark for that factor. In other words, the Borda's score of firm x is equivalent to the sum of the numbers of measures that calculated x preferred to y for all $y \in A \setminus \{x\}$.

Borda's Function:

$$\text{Let } f_B(x) = \sum_{y \in A} \#(i; xP_i y)$$

Therefore, performance measure of the firms was ranked in the order of the value of f_B .¹⁸

Then, the first eight firms with the highest Borda's score were chosen as high performing firms which (Table1).

Table-1
The highest-performing firms

Rank	Investment Company	Rank	Investment Company
1	Mines and metals	5	Alborz
2	Behshahr Industrial Group	6	Building
3	National Bank	7	Behshahr Industrial Development
4	Sepah Bank	8	Pension Fund

Third Phase: In the third phase, there is one method; Bernardo's Assignment Approach, which determines the combination of high-ranking firms. In other words, applying this method, two goals will be achieved simultaneously; the goal is the combination of the most high-ranking firms which seem to be the best for investing.

Bernardo's Assignment Approach: Bernardo believed that the selection process should be not only based on the rank order of the alternatives which considers multi-person, committee, etc.; and multi criteria decision procedure, but also on the consideration of total resources available.

In this research, Bernardo's approach was applied to find a maximization of index numbers which represents the rank position of each investment company, occupying an index number obtained as the solution of the mixed integer problem.

A general formulation: The problem is to put priority on picking out courses of action from a finite set of alternatives: $A = \{a_1, a_2, \dots, a_m\}$, by members of the committee or (8 performance measures in this research): $N = \{1, 2, 3, \dots, n\}$. There exists a finite form of measures: $S = \{s_1, s_2, \dots, s_L\}$.

The foremost step in problem solving is to set for each alternative a_i On the basis of its different criteria. This process could be acquired by ranking, rating, voting or sampling. To

aggregate the ordering of the expert opinions (performance measures), we make an agreement matrix which maps how the methods rank each option for each measure.

An agreement matrix Π is a square $m \times m$ non-negative matrix in which entry Π_{ij} represents the number of individual ordering where the i^{th} alternative is placed in the j^{th} position.

It is quite possible that some criteria may be more important than others; therefore, we represent a vector of weights, $W = \{w_1, w_2, \dots, w_l\}$ where w_i is the weight assigned to the s_i criterion.

And P is a $m \times m$ non-negative permutation matrix which in each row and column has one coefficient equal to 1 and the remainders equal to 0.

A decision maker wants to take the particular P that agrees best with Π . In other word, we want to put the 1's in the permutation matrix such that:

$$\sum_{ij} \Pi_{ij} P_{ij} \quad (1)$$

Is a maximum when P_{ij} is the element of P_0 .

$$\begin{aligned} \sum_{i=1}^m P_{ij} &\leq 1, i=1, 2, \dots, m \\ \sum_{j=1}^m P_{ij} &\leq 1, j=1, 2, \dots, m \\ P_{ij} &\in \{0, 1\} \end{aligned} \quad (2)$$

Procedure: However, not all rank orders need to be met, those that are met should be sequential, starting with order one. The constraint representing this option is akin to lead constraint in rate scheduling. Its form is:

$$\sum_{i=1}^m P_{ij} - \sum_{j=1}^m P_{ik} \geq 0 \quad \text{for } j \leq k \quad (3)$$

Where k is the number of rank orders filled.

Resource Availability: Because of the rarity of the resources, not all orderings may exclude a combination of options that violate one or more resource constraints.

Let d_{ig} be the value of the g^{th} constraining factor on the i^{th} alternative, and C_g be the g^{th} resource availability; then the constraints as follows:

$$\sum_{i=1}^m d_{ig} P_{ig} \leq C_g \quad g = 1, 2, \dots, G \quad (4)$$

Where, G is the total amount of the conclusive constraints.

In choosing alternatives, a decision maker not only is necessarily interested in arranging according to the rank of the individual alternatives; but also determines the rank order over a

set of alternatives which can be taken disregarding of the ranking within the set.

Then maximizing agreement of inclusion is:

$$\Pi = [r_{ik}]$$

Where:

$$r_{ik} = \sum_{j=1}^k \Pi_{ij} I, k = 1, 2, \dots, m$$

r_{ik} illustrates the number of times the i^{th} alternative is ranked in position 1 through k.

The target function can be written as:

$$\text{Max } \sum_{ij} r_{ij} p_{ij} < K, p > \quad (7)$$

Now we must appraise between sets containing varying numbers of alternatives.

We rank the indexed objective function,

$$(1/kn) \sum_{ij} r_{ij} p_{ij} \quad (8)$$

A match for all values of $k = 1, 2, \dots, m$ where m is the number of voters or methods. Then, the final formulation of the problems is:

$$\text{Max } 1 \{ \max (1/1 (8)) s \}$$

Subjected to:

$$\sum_{i=1}^m p_{ij} \leq 1, j = 1, 2, \dots, m$$

$$\sum_{j=1}^m p_{ij} \leq 1$$

$$\sum_{j=1}^m p_{ij} - \sum_{j=1}^m p_{i(j+1)} \geq 0$$

$$j = 1, 2, \dots, m-1$$

$$\sum_{j=1}^m d_{ij} \sum_{j=1}^m p_{ij} \leq c_g$$

$$g = 1, 2, \dots, G$$

$$p_{ij} \in \{0, 1\}$$

Empirical Results: The problem is to select portfolio - a self-managed portfolio of investment companies as determined by our investment goals, risk measure and constraints. A finite set of investment companies: $A \{a_1, a_2, \dots, a_8\}$, by performance measures:

$N = \{1, 2, 3, \dots, 8\}$. There is a limited class of criteria:

$$S = \{s_1, s_2, \dots, s_8\}.$$

The basic step in the problem solving was to show each investment company a_i on the basis of its various measures. This representation process was obtained via ranking in phase two by Borda's function which is shown in table 1.

To aggregate the ordering of the performance measures, we provide an agreement matrix which defines how the measures rank each investment company for each performance measure.

An agreement matrix Π is a square 8×8 non-negative matrix. We have not defined a vector of weight.

$$\begin{pmatrix} 8 & 0 & 0 & 0 & 0 & 0 & 0 & 0 \\ 0 & 7 & 1 & 0 & 0 & 0 & 0 & 0 \\ 0 & 0 & 4 & 0 & 0 & 2 & 5 & 0 \\ 0 & 0 & 0 & 2 & 2 & 1 & 2 & 0 \\ \Pi = 0 & 0 & 0 & 2 & 3 & 1 & 0 & 1 \\ 0 & 0 & 0 & 3 & 2 & 0 & 0 & 1 \\ 0 & 0 & 0 & 0 & 0 & 0 & 1 & 3 \\ 0 & 0 & 0 & 0 & 0 & 0 & 2 & 1 \end{pmatrix}$$

As one of the most important constraint was budget limitation, 30 Billion Rials, allocated to investing. Then, the complete formulation of the first problems is:

$$(1/(1)8) \max \{8P_{11}\}$$

Subjected to:

$$P_{11} + P_{21} + P_{31} + P_{41} + P_{51} + P_{61} + P_{71} + P_{81} \leq 1$$

$$P_{12} + P_{22} + P_{32} + P_{42} + P_{52} + P_{62} + P_{72} + P_{82} \leq 1$$

$$P_{11} + P_{12} \leq 1$$

$$P_{21} + P_{22} \leq 1$$

$$P_{31} + P_{32} \leq 1$$

$$P_{41} + P_{42} \leq 1$$

$$P_{51} + P_{52} \leq 1$$

$$P_{61} + P_{62} \leq 1$$

$$P_{71} + P_{72} \leq 1$$

$$P_{81} + P_{82} \leq 1$$

$$(P_{11} + P_{21} + P_{31} + P_{41} + P_{51} + P_{61} + P_{71} + P_{81}) - (P_{12} + P_{22} + P_{32} + P_{42} + P_{52} + P_{62} + P_{72} + P_{82}) \geq 0$$

$$1.5(P_{11} + P_{12}) + 10.25(P_{21} + P_{22}) + 1.75(P_{31} + P_{32}) + 2.25(P_{41} + P_{42}) + 8.25(P_{51} + P_{52}) + 3.75(P_{61} + P_{62}) + 4.21(P_{71} + P_{72}) + 5.21(P_{81} + P_{82}) \leq 30$$

$$p_{ij} \in \{0, 1\}$$

And more times we have formulated problems for the other combination of investment companies. A combination is a choice of some or all of a number of various objects. It is an unordered selection of unique sizes; in other words, our purpose is selecting the number of possible combinations of 1, 2, ..., and 8 stocks from a set of 8 investment companies which is resulted from the highest optimal value. The solutions of integer programming problems were shown in Table 2. We have used Linear Program Solver (LiPS) software for solving solutions. The LiPS is an optimization package adopted on solving integer, linear and goal programming problems.

The optimal value of problem one reveals that if we want to select just one stock for our portfolio, the highest rank (mines and metals) is the best choice, but from one hand the optimal value of this selection is not the highest one and from the other hand investing in one asset is not desirable for us.

Table-2
The optimal Value of the objective functions

Solution	Optimize Value
Solution of the Problem 1	0.276
Solution of the Problem 2	1.875
Solution of the Problem 3	0.625
Solution of the Problem 4	0.625
Solution of the Problem 5	0.45
Solution of the Problem 6	0.5625
Solution of the Problem 7	0.3035
Solution of the Problem 8	1

We want to make a portfolio of investment companies 'stocks (not more than 8), which is a portion of our portfolio.

The result shows that the best combination of the investment companies is the combination of two investment companies with a set of 8 (Mines and Metals and Behshahr Industrial Development) which belong to the most optimal value.

After this combination, if we add Sepah and National Bank, the result will be the same as we add Alborz and Building to our portfolio. However, we can select Mines and Metals and Behshahr Industrial Development, Sepah and National Bank or Mines and Metals, Behshahr Industrial Development, and adding Alborz and Building the results are the same.

It means that we can diversify the portfolio of four assets, but the result might not be so satisfying because of the transaction costs. Then, we selected Mines and Metals and Behshahr Industrial Group as a portion of our portfolio.

With the time pass and in the light of this methodology, the importance of using traditional and alternative performance measures becomes increasingly clear. The result was encouraging at that time period.

Discussion

The aim of this research was to propose an integrated methodological framework for the performance evaluation and portfolio selection simultaneously. However, several performance measures contributed to the portfolio selection process; whereas, many factors were ignored. The recommendation is that there needs to be a shift in the portfolio selection from using traditional methods and considering a few factors to integrate methods which consider many aspects of investment.

Conclusion

To identify potentially weak investment companies in Tehran Stock Exchange, we recommended specific Group Multiple

Criteria Decision making method. The result of making a portfolio of investment companies 'stocks, according to the optimal value held are presented in table 2. It seems that the combination of two stocks which are Mines and Metals and Behshahr Industrial Development is the optimum solution.

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