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An E-Service Model with Multicriteria Decision and Bundle Trading

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1 Introduction

Internet and computers have brought to the world a whole new way of business venture. Nowadays, financial institutions have to rethink the way that they do business and the investors have to rethink how to make an investment decision.

Since the portfolio management research direction was proposed, many empirical works have been published by applying different multicriteria decision analysis (MCDA) techniques to select and rank assets and portfolios [1], [2]. However, in these models the managers assign a numerical "weight" to each criterion directly, reflecting its "importance", which could make errors to the final result.

In this paper, we propose an Internet-based business model, which integrates the process of Portfolio Benchmarking and MCDA, as well as the "Bundle Trading" technique, aiming to help the fund managers to make their investment decisions better by constructing efficient portfolios and re-balancing their portfolios online. In this model, we consider the importance among the criteria by using the fuzzy set technique to weight the criteria in the process of multicriteria decision analysis.

2 A Framework of E-Service Model

Fig. 1 illustrates a general architecture of our e-service model, which outlines the process of constructing a benchmark portfolio, analyzing a multicriteria decision, and trading a bundle as the integral parts of our proposed model. This model is primarily designed to serve the fund managers to come up with efficient portfolios better, rebalance the portfolios to fit specific requirements, and finally make trading online.

In this model, a benchmark portfolio is required in order to obtain a final efficient portfolio. Fund managers should construct a benchmark portfolio themselves according to their analysis or select an index from a market as a benchmark.

Figure 1: Framework of an e-service model.

3 Process of MCDA

In general, in a portfolio constructed entirely on the basis of the multicriteria, the following steps should be taken into account when defining multiple criteria: evaluating each stock in every relevant criterion, weighting the criteria, and weighting the final portfolio according to an optimization model that takes the risk into consideration.

In a real-time system, we should provide enough criteria that can reflect the uncertainty of the financial market for a fund manager to select according to his/her preference. In order to explain our model, the following six criteria are chosen as evaluation criteria for each stock: Price-to-Earning Ratio (PER), Price-to-Cash Flows Ratio (PCFR), Dividend Yield (DY), Rate of GDP growth (RGDP), Interest Rate (IR), and Industry Factor (IF).

An evaluation for each stock in every relevant criterion can be made after we define the criteria. We use the "direct rate" method [3] in this paper, and assign a real number to each stock.

Here, we use the fuzzy set technique to weight the criteria. Each of the six criteria is given an interval weight to reflect the relative importance among them. The interval weights for PER, PCFR, DY, RGDP, IR and IF are defined orderly as: $[p_{i1}, p_{i2}]$ for $i = 1, 2, \cdots, 6$, where $\sum_{i=1}^{6} p_{i1} \leq 1$ and $\sum_{i=1}^{6} p_{i2} \geq 1$.

4 Selection of Final Portfolio

In order to get the final portfolio, we should give an adjusted portfolio based on the benchmark portfolio in the method. With the value scores and the interval weights, a weighted overall score can then be calculated for each stock, reflecting its overall attractiveness, by multiplying the stock's score on each criterion by the criterion's weight and summing up. Here, we let the weight of each criterion be: $p_i \in [p_{i1}, p_{i2}]$ for $i = 1, 2, \cdots, 6$, where $\sum_{i=1}^{6} p_i = 1$.

The proportions of the stocks in the benchmark portfolio are represented by y_i for $i = 1, 2, \cdots, n$, where n is the numbers of the stocks included in the benchmark portfolio. Then the proportions of the stocks in the adjusted portfolio can be calculated by normalizing the results of multiplying the stock's overall score by the proportion in the benchmark, and can be represented by z_i for $i = 1, 2, \cdots, n$.

In order to construct an "efficient" portfolio, the fund manager should take into account not only the global score but also a measure of risk. Given that the benchmark has the same degree of diversification with the market portfolio we consider the systematic risk only (Beta) in this model. Also, because different fund managers have different levels of risk preferences, we should take levels of risk performance into consideration. We give an optimization model to calculate the optimal portfolio according to these constraints in the following. In this model, we suppose that the fund manager is optimistic.

Let $s_i = \sum_{j=1}^{6} p_j s_{ij}$ be the overall score of the stock i, where s_{ij} is the score for stock i according to the criterion j. Let β_i be the Beta of stock i. Then we present the optimization model as follows:

$$\begin{array}{ll} \max & \sum_{i=1}^{n} x_i s_i, \\ s.t. & \sum_{i=1}^{n} x_i \beta_i \leq M, \\ & p_{j1} \leq p_j \leq p_{j2},\ j=1,2,\cdots,6, \\ & \sum_{j=1}^{6} p_j = 1, \\ & (1-h)z_i \leq x_i \leq (1+h)z_i,\ i=1,2,\cdots,n, \\ & \sum_{i=1}^{n} x_i = 1, \\ & x_i \geq 0,\ i=1,2,\cdots,n \end{array}$$

where x_i is the proportion of stock i, $p_j \in [p_{j1}, p_{j2}]$ is the weight of the criterion j, M is the upper limit of beta, n is the number of the stocks in the benchmark portfolio, h is a constant defining the range of variation of stocks' proportions, and $z_i = \frac{(s_i-1)y_i}{\sum_{j=1}^{n}(s_j-1)y_j}$ is the proportion of the adjusted portfolio.

5 Bundle Trading

Large institutional investors, such as mutual funds, often need to trade bundles in order to rebalance their portfolios after the portfolio allocations are made. A bundle trading mechanism developed by the Center for Research in Electronic Commerce of University of Texas at Austin [4] can be used to attain this objective. Fund managers can buy or sell bundles of securities by specifying a price for the bundle that they want to trade in bundle trading. In this model, after an efficient portfolio is constructed based on a benchmark, a bundle trading system can be used to assist a fund manager to trade the portfolio in a bundled price in order to acquire a balanced investment.

In bundle trading, investors buy or sell bundles of securities by specifying a price for the bundle that they want to trade. When all components of the bundle can be matched with other outstanding orders, the bundle executes. A bundle order is a combination of stocks or other financial instruments, such as options and bonds. The main advantage of the bundle trading is its ability to accept conditional orders. It provides concurrent transactions and reduce transaction costs. The automated matching mechanism does the matching by solving the following mathematical programming problem:

$$\begin{array}{ll} \max & px, \\ s.t. & Bx \leq 0,\ 0 \leq x \leq u \end{array}$$

where p is a vector to denote the limit price for each bundle submitted by traders, x is a vector to represent the proportion of the matched trade and each element of x should be positive, $B = [b_1, b_2, \cdots, b_n]$ is a matrix to contain n vectors, and $b_i (i = 1, 2, \cdots, n)$ is a vector to represent the composition of a particular bundle submitted for trade.

6 A Numerical Example

In order to testify this model, we use the Hang Seng Constituent Index (2003) from the Hong Kong Stock Exchange as a benchmark. The efficient frontier can be drawn and shown in Fig. 2 by using the multicriteria analysis method proposed in this paper to compare with the method in [2]. The numerical results reveal that our method is better than the method presented in [2].

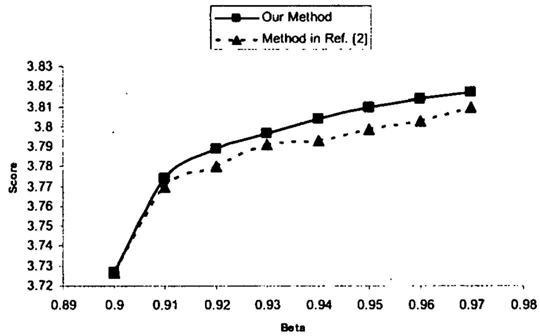

Figure 2: Efficient frontier.

7 Conclusions

In this paper, we established an e-service model for fund managers to effectively make their investment decisions and trade their portfolios online. However, there are still problems to should be solved in the future, such as scoring the stock, predicting the recommended purchase price, and selecting the criteria.

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References

[1] C. Zopounidis, "Multicriteria decision aid in financial management," *European Journal of Operational Research*, Vol. 119, pp. 404-415, 1999.

[2] C. A. B. Costa and J. O. Soares, "A multicriteria model for portfolio management," *Working Paper LSEOR 01.43*, London School of Economics and Political Science, London, 2001.

[3] D. V. Winterfeldt and W. Edwards, *Decision analysis and behavioral research*, Cambridge University Press, 1986.

[4] K. Saattcioglu, J. Stallaert and A. S. Whinston, "Design of a financial portal," *Communication of the ACM*, Vol. 44, No. 6, pp. 33-38, 2001.