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Two-level linear programming for fuzzy random portfolio optimization through possibility and necessity-based model

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Abstract

In this paper, we deal with a portfolio optimization model involving fuzzy random variabels. Portfolio optimization is an important research field in modern finance**.** We consider the problem to maximize the the degree of both possibility and necessity that the objective function values satisfy the fuzzy goals. Using the possibility and necessity-based model, we reformulate the problem as a linear programming problem. In order to find the optimum solution, we propose two-level linear programming model to calculate the upper bound and lower bound of the objective function value separately. The lower bound calculates by historical data and the upper bound calculates by new information of stock market which is received during the constant time. Finally, we provide a numerical example to illustrate the proposed model.

Keywords: ***Portfolio optimization model ; Possibility and Necessity-based model ; Fuzzy random variables***

1. Introduction

In this paper, we propose a new portfolio model based on possibility and necessity, with fuzzy random variables. This portfolio optimization model is similar to Markowitz's model (Markowitz, 1952).In many

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industries, there are many decision problems; i.e., scheduling problem, logistics. In these problems, it is important to predict future total returns and to decide an optimal asset allocation maximizing total profits under some constraints. It is easy to decide the most suitable allocation if we know future returns a priori. We consider how to reduce a risk, and it becomes important how we earn the greatest profit. We call such industrial assets allocation problems portfolio selection problems. Markowitz formulated mean-variance models mathematically in two ways: minimizing variance for a given expected value, or maximizing expected value for a given variance. Since then, the mean–variance models have been well developed in both theory and algorithm (Crama and Schyns, 2003. Xia et al., 2000). In 1959, Markowitz (1959) defined a semi-variance for asymmetric random returns because researchers pointed out that the asymmetric returns make the variance a deficient measure of risk. Konno and Yamazaki (1991) introduced an advanced model in which a mean-absolute deviation model and absolute deviation are utilized as a measure of risk.These studies solved the portfolio selection problem in different stochastic or fuzzy situations. However, when selecting portfolio, an investor may encounter with both fuzziness and randomness. In fact, for an investor, the fuzziness and randomness of security returns are often mixed up with each other. In such situations, we may employ fuzzy random theory (Liu, 2004) to deal with this uncertainty of fuzziness and randomness. Fuzzy random variable can be a new useful approach to solve this kind of problem. A Fuzzy random variable was first introduced by Kwakernaak (1978), and its mathematical basis was constructed by Puri and Ralescu (1986) In this paper, the asset return in portfolio selection problem are fuzzy random variables and we use the concept of both possibility and necessity-based model to develop a solution method for the fuzzy random portfolio optimization problem.In the context of two-level programming, the decision maker at the upper level first specifies a strategy, and then the decision maker at the lower level specifies a strategy so as to optimize the objective with full knowledge of the action of the decision maker at the upper level . However, to utilize two-level programming for resolution of conflict in decision-making problems in real world decentralized organizations, it is important to realize that simultaneous considerations of fuzziness (Sakawa, 1993) and randomness (Birge and Louveaux, 1997) would be required.It means, we reformulate the Mekowits portfolio model by possibility and necessity and construct the two-level linear programming models to find the upper bound and lower bound of the return. The lower bound will be calculated by historical data and the upper bound will be obtained by new information of stock market which is received during the constant time. First of all we calculate our results by posibiliity based-model, then with necessity-based model to compare these results with eachother and show what the defrence between optimistic and pessimistic decision makers is? These results and comparing must provide the manager with more information for making decision. The rest of the paper is organized as follow: Section 2 includes basic concept on fuzzy and fuzzy random theory. In Section 3, the problem formulation is presented. In section 4, a numerical example is solved to to illustrate the the proposed model. Finally conclusion and future work will be present in section 5.

2. Basic concepts

The concept of fuzzy random variable was introduced as an analogous notion to random variable in order to extend statistical analysis to situations when the outcomes of some random experiment are fuzzy sets.The term fuzzy random variable was coined by Kwakernaak (1978), who introduced FRVs as “random variables whose values are not real, but fuzzy numbers,” and conceptualized a FRV as a vague perception of a crisp but unobservable RV, and its mathematical basis was constructed by Puri and Ralescu (1986). An overview of the developments of fuzzy random variables was found in the recent article of Gil et al.(2006) . In general, fuzzy random variables can be defined in an n dimensional Euclidian space R^n. We present the definition of a fuzzy random variable in a single dimensional Euclidian space R.