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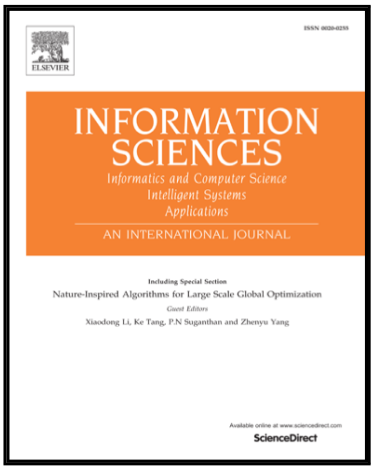

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Data envelopment analysis based fuzzy multi-objective portfolio selection model involving higher moments

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Abstract

We study the portfolio selection problem from the perspective of incorporating more information about the non-normality of asset returns by considering the mean-variance-skewness-kurtosis framework. Using additional criteria (namely asset turnover, earnings per share, earnings per share growth rate, leverage ratio, price/earnings ratio, and beta (β) value), we employ data envelopment analysis technique to construct a benefit criterion from the efficiency scores of the assets. To incorporate the uncertainty and vagueness of real financial markets, the input data (with respect of all criteria) are assumed as (λ, ρ) interval-valued fuzzy numbers constructed using the historical data. Marginal impacts of the assets on higher moments of the portfolio are used to formulate a fuzzy multi-objective linear programming model. The constraints of the proposed model include the bounds on investment in individual assets, full utilization of the investment capital, and no short selling of assets. The signed distance ranking method is used to obtain a numeric optimization model, which is solved through a weighted max-min approach (in order to incorporate the investor's preferences regarding investment criteria). A case of real financial market portfolio selection is presented to demonstrate the efficiency of both the proposed model and the solution method.

Keywords: Multi-objective optimization; Portfolio selection; Higher moments; (λ, ρ) interval-valued fuzzy numbers; Data envelopment analysis

1. Introduction

Modern portfolio analysis received much attention from both researchers and investors after the publication of seminal work of Markowitz [31], wherein he proposed the mean-variance portfolio selection model, which simultaneously maximizes portfolio return whilst minimizing portfolio risk. Markowitz's theory is primarily aimed at maximizing expected utility; only then focusing on quantifying investors' preferences with respect to investment risks. Various utility functions, such as polynomial, power, logarithmic, quadratic, and semi-quadratic have been suggested as risk measures. As the real expected utility changes over time and varies among investors, utility functions only functionally represent utility as a means to accommodating numerical implementations. Based upon the preferences of investors (e.g., higher return and lower risk (variance)), the standard mean-variance optimization model was conceptualized utilising both the mean and (co)variance of the asset returns. It has long been recognized that asset returns are generally non-normal; therefore, from time to

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