Chapter 9
Portfolio Selection Models and Their Discrimination

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ABSTRACT
The stochastic nature of financial markets is a barrier for successful portfolio management. Besides traditional Markowitz’s model, many other portfolio selection models in Bayesian and Non-Bayesian frameworks have been developed. Starting with the basic Markowitz model, several cardinal models are used to find optimum portfolios with select stock set. Having developed the regression model of the return of each stock with the market return, the unsystematic part of the uncertainty was used to find the optimum portfolio and efficient risk–return frontier within each portfolio selection model. The average stock return as estimated from its historical data and the forecasted stock return were used for maximizing return with quadratic programming formulation in Markowitz model. In the models involving Fuzzy probability and possibility distributions, the future return was estimated using the similarity grade of past returns. In the interval coefficient models, future return was estimated as interval variable. The optimum portfolios of different models were widely divergent and DEA was used to identify the model giving the best portfolio with higher appraisal, both overall and by peers, and least Maverick behavior. Use of Signal to Noise ratio proved equally efficient for model discrimination and yielded identical results.

INTRODUCTION
The problem of Portfolio optimization for selecting the best portfolio is an area which received constant attention from leading economist, statistician and mathematicians of the world. The foundation of modern portfolio theory for solving portfolio selection problems was laid by Markowitz (1959, 1987). The theory combined probability and optimization theories to model the behaviour of agents of economic change. The agents were assumed to strike a balance between maximizing the
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reward (quantified as mean return) and minimizing the risk (quantified as the variance of return from the portfolio) of investment decisions thus focusing on the overall risk-reward characteristics. Mathematical representations of return and risk facilitated risk-return trade-off by formulating and solving the investment decision problem as dual objective (profit maximization and risk minimization) optimization problem. Later Rambaud, Perez, Sanchez Granero, and Trinidad Segovia (2009) studied the Markowitz portfolio selection model with Euclidean vector space concept and presented quantitative and explicit solutions of the optimal portfolio. Baptista (2008) studied the problem as total income variance (TIV) minimization problem from investor’s point of view and error variance (TEV) minimization problem from portfolio manager’s point of view.

With passage of time, the limitation of using probabilistic approach in conventional portfolio selection models for characterizing the uncertainty of the financial markets particularly from the viewpoint of accommodating the influence of many non-probabilistic factors, experts’ knowledge and the investors’ subjective opinions was pointed out by a number of empirical studies. Steadily growing interest was noticed in handling optimization problems by means of stochastic, fuzzy or possibilistic programming (Fei, 2007) with a view to address vagueness, ambiguity, subjective opinions and such types of fuzziness that affected financial markets as also financial managers’ decisions. Probability theory of Fuzzy events, proposed by Zadeh (1968) and Possibility theory based on possibility distributions, proposed by Zadeh (1978) and advanced by Dubois and Prade (1988, 1997) paved the avenue for fuzzy and possibilistic programming and led to the development of Fuzzy portfolio selection models. In the portfolio optimization models based on possibility distribution, the expected return rates of the securities were treated as fuzzy variables associated with possibility distributions exactly the same way as the random variables are associated with probability distributions. Since a possibility distribution depends on importance grades of data given by an expert, possibility portfolio selection can reflect the characteristics of expert judgment on importance grades. The possibility portfolio selection model was constructed as a quadratic programming problem involving fuzzy membership function. The objective of the possibility portfolio selection problem was to minimize the spread of possibility return of a portfolio subject to the given centre return. In Tanaka and Guo (1999) and Tanaka, Guo, and Turksen (2000) models, fuzzy probabilities and possibility distributions were obtained depending on possibility grades of security data offered by experts’ knowledge and judgement.

Ramaswamy (1998) presented a bond portfolio selection model based on the fuzzy decision theory. In Inuiguchi and Ramik (2000) and Inuiguchi and Tanino (2000) presented the minimax regret criterion has been also adopted to formulate possibilistic portfolio selection problems. The idea was that an investor wants to minimize the worst i.e. maximum regret, which represents the maximum deviation between the return that the investor could receive if he/she invests in the optimal portfolio and the portfolio return that he/she actually realizes. Wang and Zhu (2002) and Fang, Lai, and Wang (2008) discussed how quantitative and qualitative analyses, the experts’ knowledge and the managers’ subjective opinions could be better integrated in a financial optimization model using fuzzy approaches and gave an overview on the chronological development of fuzzy portfolio selection.

Besides fuzzy and possibility portfolio selection models, another group of portfolio selection models were developed to deal with imprecision and subjectivity in data. The basic tenet of these models were that, input data, although imprecise, could be considered as varying within some specific interval, which could be treated mathematically more easily with a view to avoid using probability variables or fuzzy variables with
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