Abstract of the Ph.D. Work

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Title : Secure Portfolio Optimization Using Soft Computing Techniques

Modern portfolio theory is inspired by the Markowitz forerunner work that introduced the classical mean-variance framework. Markowitz postulated the abstraction of portfolio optimization and variation that helped in the assimilation of financial information. The portfolio optimization issue is concerned about allocating a finite capital to several existing financial assets in an optimal manner such that a suitable trade-off amidst return and risk is achieved. In the portfolio optimization problem, the risk is calculated using the expected return variance, which is minimized for the maximized value of the expected return. Markowitz's theory had a profound impact on research activities as well as financial markets. Nevertheless, this theory is widely applied in portfolio application, still computing precise values of return and co-variance of assets is a complicated task considering dynamic market trends. The inclusion of preferences of the financial manager and investors leads to a complex framework of the portfolio optimization problem, and designing a pertinent model for its solution is a complicated task.

Further, the task of assessing magnitudes of return using a model based on several predicated values is a challenging work since these values are computed using forecasting methods. Therefore, it is customary to treat parameters affecting returns with a degree of inexactness. Numerous internal and exterior elements influence the return and risk, thus extracting an appropriate trade-off amidst these two values is an extensive direction for performing research. This study proposes a novel framework for solving the portfolio selection problem. This framework is designed using two nascent parameters α_{new} and β_{new} which are derived from the existing mean-variance model and CVaR value. This method intends to minimize the overall cost, which is computed using the quadratic equation of these parameters. A six-layered structure of ANFIS is also designed for obtaining the solution of the portfolio optimization problem. The application of the modified S.A. algorithm for computing the minimal cost based on the cost equation of these parameters is also presented in the study. A new scheme is also presented for obtaining the weights in the cost equations of these parameters. This scheme uses ANN and NSGA-II algorithm. This study puts forth a tri-objective model comprising three objectives apart from the return, risk, modelled decision-maker preferences using an index based on decision parameters. The third objective used in the model is based on single index formulated using aggregate values of the three decision parameters. The first decision parameter focuses on selecting a suitable trade-off between the objectives of expected return and variance. The second decision parameter is used in the third objective to select appropriate weights for different categories of portfolios. The third decision parameter used in the third objective signifies an appropriate value of downside risk.

The portfolio optimization problem gets complex when many constraints are present that are related to effective solutions to the problem. Furthermore, traditional multi-objective computational methods often need sufficient change to fit the problem of portfolio

optimization. The current approaches can not be used to prepare future portfolio optimization techniques, as additional data specifications are not accessible. New procedures are also required to find efficient solutions to the portfolio optimization problem. The portfolio optimization problem becomes more complicated when a portion of the data becomes uncertain and tainted with deviations. All these issues are considered in this study. The proposed tri-objective model has been designed based on a third objective using a single index formulated using three decision parameters. The MOEAs algorithms are modified based on new procedures used in the proposed model. The modified MOEAs have been successfully applied to obtain suitable outputs for the portfolio optimization problem. To check the effectiveness of the proposed approach, it is tested on four state of the art multi-objective evolutionary algorithms (MOEAs) viz. NSGA-II, SPEA2, MOPSO, and MOEA / D. Lastly, a security protocol has been designed using an extended version of the Kummer-surface for key exchange and a modified version of the AES algorithm based on a content-based matrix for encrypting and decrypting financial data used in a portfolio optimization problem. This protocol also uses machine learning techniques and the NSGA-II algorithm.

In a nutshell, this study puts forth the design of new frameworks for solving portfolio optimization problem based on decision parameters and newly designed parameters derived from existing portfolio optimization models. Moreover, the proposed framework also uses modified MOEAs that are beneficial for solving portfolio optimization problem. These frameworks are applicable for generic category of portfolio optimization problems; it is observed that NSGA-II adapted algorithm gives better empirical results when compared with some other recent MOEAs.