Chapter 4

Conditional Value-at-Risk-Based Portfolio Optimization: An Ant Colony Optimization Approach

Jhuma Ray
RCC Institute of Information Technology, India

Siddhartha Bhattacharyya
https://orcid.org/0000-0003-0360-7919
RCC Institute of Information Technology, India

N. Bhupendro Singh
National Institute of Technology, India

ABSTRACT

Over the past few decades, an extensive research on the multi-objective decision making and combinatorial optimization of real world’s financial transactions has taken place. The modern capital market theory problem of portfolio optimization stands to be a multi-objective problem aiming at the maximization of the expected return of the portfolio in turn minimizing portfolio risk. The conditional value-at-risk (CVaR) is a widely used measure for determining the risk measures of a portfolio in volatile market conditions. A heuristic approach to portfolio optimization problem using ant colony optimization (ACO) technique centering on optimizing the conditional value-at-risk (CVaR) measure in different market conditions based on several objectives and constraints has been reported in this paper. The proposed ACO approach is proved to be reliable on a collection of several real-life financial instruments as compared to its value-at-risk (VaR) counterpart. The results obtained show encouraging avenues in determining optimal portfolio returns.

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INTRODUCTION

In the present volatile market conditions in the field of Finance, Mathematics, Computational Literature and Statistics, the financial portfolio optimization has proved to be a problem to be researched widely enhancing to show an equitable balance between risks and returns which in turn stand vital for any investor to derive at an optimum standpoint (Brown, 2004; McNeil, Frey & Embrechts, 2005). Regardless the prevailing volatility, the impersonate advantage lies within the correlation about the combination of financial instruments/assets over a financial portfolio within a particular market condition. In recent times, the need for the study of portfolio management has cropped up because for making decision within the different investment opportunities in a high-risk scenario in turn proving the present day’s risks and returns to be undoubtedly interlinked emerging the importance in the decision making procedure in the investment opportunities. It provides the whereabouts of the risk-reward tradeoff allowance of investments into numerous assets so that returns can be maximized in order to minimize risk in a given investment period.

As stated by Markowitz (1952), valuation of risk as standard deviation of returns is done signifying diversification into different investment factors having limited or negative correlations in terms of their movements reducing overall risk which is measurable by a correlation coefficient varying between +1 and -1.

Hence for quantifying the value of an asset or else of a portfolio of assets in the market which usually gets decreased by a specific course of time (ordinarily considered over 1 day or 10 days) subservient to conventional market circumstances, Value-at-Risk (VaR) (Dowd, 2005; Holton, 2003; Jorion & Philippe, 2001) proves to be an effective tool. High value is also given to it for being incorporated within industry regulations (Jorion, 2001), nevertheless in case of normal distribution of losses it suffers from the unstableness as well as difficulty to work using numerical values because loss distribution often contribute to present “fat tails” or else empirical differentiation. Presumed by Artzner et al (1999), VaR moreover fails to be coherent.

Unlikely Value-at-risk, Conditional value-at-risk (CVaR) prevails to be one risk measuring technique subject to risk having significant advantages, for obtaining distribution of losses in finance which involves discreteness (Rockafellar & Uryasev, 2002). Different proposed structures derived on varied scenarios and finite sampling, the application of such distributions has become an important property in the financial markets because of its customariness.

CVaR can be ascertained along with the weighted average of VaR along with CVaR+ (the values themselves be contingent on the decision x along with the weights), where not even a single value of VaR and CVaR+ stands to be coherent. The specific method of assessing CVaR in terms of probability of VaR value generates the value of weights, when one exists.
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