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# Multiperiod Portfolio Investment Using Stochastic Programming with Conditional Value at Risk

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## Abstract

This paper proposes the portfolio stochastic programming (PSP) model and the stagewise portfolio stochastic programming (SPSP) model for investing in stocks in the Taiwan stock market. The SPSP model effectively reduces the computational resources needed to solve the PSP model. Additionally, the conditional value at risk (CVaR) is used as a risk measure in the models. In each period of investment, 200 scenarios are generated to solve the SPSP model. The experimental data set consists of the 50 listed companies with the greatest market capitalization in the Taiwan stock exchange, and the experimental interval began on January 3, 2005 and ended on December 31, 2014, consisting of 2484 trading periods (days) in total. The experimental results show that the SPSP model is insensitive to small variation of the portfolio size and the historical period for estimating statistics. The portfolio size of the SPSP model can be set with two cases:  $M = M_c$  and  $M \leq M_c$ . When  $M = M_c$ , the  $M$  invested target stocks have been predetermined. When  $M \leq M_c$ , a set of  $M_c$  candidate stocks are given, but the  $M$  real target stocks have not been decided. The average annualized returns are 13.09% and 12.06% for the two portfolio settings, respectively, which are higher than that of the buy-and-hold (BAH) rule (9.95%). In addition, because the CVaR is considered, both portfolio settings of the SPSP model exhibit higher Sharpe and Sortino ratios than the BAH rule, indicating that the SPSP model provides a higher probability to earn a positive return. The superior predictive ability test is performed to illustrate that the SPSP model can avoid the data-snooping problem.

*Keywords:* multiperiod portfolio investment; stochastic programming; conditional value at risk; moment matching; superior predictive ability

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## 1. Introduction

This paper proposes the portfolio stochastic programming (PSP) model and the stagewise portfolio stochastic programming (SPSP) model for guiding an investor in allocating assets appropriately to earn higher return with risk management in each period. The portfolio problem is crucial in investment. A rational investor prefers to attain the

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