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Research Paper

Multi-Asset Portfolio Management Including Fixed Income Securities by Value at Risk-based Models in Iran Market[1]

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Introduction

Iranian investment portfolios, following their risk aversion attitude, usually consist of gold, foreign currencies, stock, investment funds, and cryptocurrencies. Asset selection and portfolio optimization is the most prominent part of the investor's decision-making process. Markowitz proposed the mean-variance model for portfolio optimization for the first time in 1952 (Markowitz, 1952). However, variance is not a good risk measure in finance and investment problems. Further studies proposed some downside risk measures, such as semi-variance, absolute deviation, value at risk (VaR), and conditional value at risk (CVaR). Recently, some real-world constraints have been added to portfolio optimization models (Kumar & Mishra, 2017). It makes the multi-asset portfolio optimization problem to be an NP-hard problem (Sabrido et al., 2016), and the ability of the mathematical methods to solve these problems is questionable (Rahmani et al., 2019). Therefore, researchers gradually turned to metaheuristic algorithms to solve portfolio optimization models (Karaboga & Garkameli, 2014; Mousavi et al., 2014; Mousavi et al., 2021). Considering the importance of portfolio diversification in different asset classes and the lack of Iranian studies in this field, this paper deals with multi-asset portfolio optimization taking into account the limitations of the real world and using the appropriate risk measure.

Materials and Methods

In this paper, different investment opportunities are evaluated in Iran's financial market to form a portfolio of 20 assets in five asset classes, including Cryptocurrencies, foreign

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currencies, gold, stock, and mutual investment funds in three groups of fixed-income investment funds, stock investment funds, and Mutual investment funds. To select the best multi-asset portfolio optimization model, it evaluates and compares the performance of mean-variance, mean-semi variance, mean-absolute deviation, mean-VaR, and mean-CVaR models. Also, the profitability of the models is evaluated in the presence of three real-world constraints, i.e., quantity constraints, class constraints, and both, using three metaheuristic algorithms, i.e., artificial bee colony, imperialist competitive, and particle swarm optimization algorithms. Our investigation period is from August 2015 to December 2020. The period is divided into the in-sample (August 2015 to March 2020) and the out-of-sample (March 2020 to December 2020) periods. The performance of the extended models and algorithms is evaluated based on return on risk, Sharpe, and conditional Sharpe ratios. Additionally, Wilcoxon's paired test is used to compare the performance of multi-asset portfolio optimization models and the metaheuristic algorithms.

Numerical results and Discussion

In this paper, the above-mentioned models have been executed 50 times for multi-asset portfolio optimization in Iranian financial markets using three metaheuristic algorithms. Based on our experimental results, the mean-CVaR model is more profitable in this market. Also, the artificial bee colony algorithm reached the return on risk ratio of 0.237 and the conditional Sharpe ratio of 0.204, which was superior to the imperialist competitive algorithm with the return on risk ratio of 0.209 and the conditional Sharpe ratio of 0.179 as well as particle swarm optimization with the return on risk ratio of 0.235 and the conditional Sharpe ratio of 0.202. The average performance of the multi-asset portfolio optimization models in the out-of-sample period is reported in Table 1. According to Table 1, the mean-CVaR model outperforms the other multi-asset portfolio optimization models with/without real-world constraints. For mean-CVaR portfolio optimization, the ability of three metaheuristic algorithms, i.e., imperialist competitive, particle swarm optimization, and artificial bee colony algorithms, are investigated in the out-of-sample period. According to Table 2, the superiority of the artificial bee colony algorithm is confirmed based on the Sharpe and the conditional Sharpe ratios.

Table 1. The performance of multi-asset portfolio optimization models with/without constraints (out of sample)

Constraints Model	Without constraints	Quantity constrained (0.02-0.2)	Class constrained (0.05-0.35)	Both constraints
Mean-variance	0/095*	0/071*	0/063*	0/052*
	0/045**	0/025**	0/015**	0/018**
Mean-absolute deviation	0/094*	0/056*	0/037*	0/043*
	0/044**	0/026**	0/007**	0/021**
Mean-semi variance	0/095*	0/054*	0/038*	0/039*
	0/045**	0/025**	0/019**	0/019**
Mean-VaR	0/095*	0/042*	0/037*	0/038*
	0/046**	0/029**	0/028**	0/025**
Mean-CVaR	0/096*	0/063*	0/054*	0/055*
	0/046**	0/032**	0/031**	0/027**

* Sharpe ratio ** Conditional Sharpe ratio

Source: research findings

Table 2. The performance of metaheuristic algorithms in multi asset portfolio optimization (out of sample)

Constraints Algorithm	Without constraints	Quantity constrained (0.02-0.2)	Class constrained (0.05-0.35)	Both constraints
Imperialist competitive	0/078*	0/049*	0/033*	0/044*
	0/035**	0/030**	0/028**	0/026**
Particle swarm optimization	0/090*	0/056*	0/046*	0/049*
	0/043**	0/031**	0/030**	0/027**
Artificial bee colony	0/096*	0/063*	0/054*	0/055*
	0/046**	0/032**	0/031**	0/027**

* Sharpe ratio ** Conditional Sharpe ratio

Source: research findings

Conclusion

This paper tried to provide the best approach for multi-asset portfolio optimization among five asset classes, including cryptocurrencies, foreign currencies, gold, stock, and investment funds in three groups of fixed income investment funds, stock investment funds, and Mutual investment funds. The mean-value at risk and mean-conditional value at risk models have been developed and solved using the artificial bee colony algorithm. The performance of the value at risk-based models is compared with the mean-variance, mean-semi variance, and mean–absolute deviation models. Also, the profitability of the models is evaluated in the presence of three real-world constraints, i.e., quantity constraints, class constraints, and both. The in-sample and out-of-sample results showed that the conditional value-at-risk model outperforms the other models, without the importance of the presence of constraints. Also, the artificial bee colony algorithm was superior to the imperialist competitive and particle swarm optimization algorithms in multi-asset portfolio management, based on Sharpe, conditional Sharpe, and return on risk ratios.

Keywords: Multi-asset Portfolio, Conditional Value at Risk, Cryptocurrencies, Fixed Income Securities.

JEL Classification: G11, G32, D81.

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