OPTIMIZATION MODELS AND FORECASTS FOR EFFECTIVE MANAGEMENT OF INVESTMENT PORTFOLIOS

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Abstract:
Today, one of the most important concerns of investment and financial managers is making prompt and optimal decisions in the presence of large volumes of data and information related to stock and capital markets. In particular, as the level of diversification within investment portfolios increases, it becomes critically important to make sound decisions while taking into account constraints related to expected returns, asset risk levels, liquidity, and other variables.

Keywords: Particle swarm optimization, genetic algorithm, artificial neural networks, simulated annealing, Markowitz model, Value at Risk (VaR), Conditional Value at Risk (CVaR), Fuzzy (uncertain) approach.

In fields such as capital markets, the mathematical approaches used to solve these models require large-scale computations and extensive planning, because stock market behavior does not follow linear patterns. Therefore, simple linear methods cannot adequately describe such behavior and are often ineffective. Portfolio optimization, however, makes it possible to attract more investors, as the formation of a sound investment process helps channel free capital in society into investments. When selecting an optimal portfolio, the primary focus is on correctly determining the volumes of asset purchases and sales while taking budget constraints into account. Currently, due to the low efficiency of financial markets, many studies recommend applying new approaches to investment rather than relying on traditional methods based solely on historical data[1].

In today’s globalized world, traditional approaches may no longer be effective; instead, it has become necessary to adopt more creative approaches in order to manage investment portfolios efficiently and maximize expected returns. These methods include modern approaches such as artificial intelligence, big data, and robo-advisors. Portfolio optimization models can be seen in the following table.

[1] Majid Zanjirdar Overview of Portfolio Optimization Models, Advances in mathematical finance & applications 5(4), (2020), 419-435 pages

Table 1: Investment portfolio optimization models[2]

Optimal portfolio models	
Heuristic models	**Mathematical models**
Particle swarm optimization	Markowitz model
Genetic algorithm	Value at Risk (VaR)
Artificial neural networks	Conditional Value at Risk (CVaR)
Simulated annealing	Fuzzy (uncertain) approach

The difference between heuristic models and mathematical models is that mathematical models are based more on precise calculations, taking into account the average returns of assets and their covariances to determine the optimal portfolio structure. For example, a linear programming model is used to identify the most optimal portfolio solution in situations where constraints such as returns, liquidity, taxes, and others exist. Game Theory, on the other hand, is applied to develop the most optimal strategies when multiple participants are competing in the market. This model is particularly important for adjusting portfolio decisions according to the potential actions of other investors. Meta-heuristic models, unlike formula-based approaches, help find optimal solutions for investment portfolios. They are mainly used to solve complex, multi-criteria problems involving large volumes of assets. For instance, Artificial Neural Networks (ANNs) provide forecasts by analyzing market data and studying complex interconnections between assets. In our view, technologies such as AI (artificial intelligence) are expected to be used in the future for effective management of investment portfolios. This is because such technologies can quickly analyze very large volumes of market data and make rapid decisions. In turn, this can significantly increase the expected returns from portfolios. Artificial intelligence (AI) is revolutionizing the management of investment portfolios, moving from traditional, human-managed strategies to more complex, data-driven approaches. In today's fast-paced and constantly changing financial environment, where speed and accuracy are crucial, AI has become an indispensable tool for managing portfolio risk through advanced analytics and data-based insights. According to a recent report by PwC, global assets under management (AuM) are projected to grow from $84.9 trillion in 2016 to $145.4 trillion by 2025. This indicates a growing demand for advanced investment strategies.

References

1. Majid Zanjirdar Overview of Portfolio Optimization Models, Advances in mathematical finance & applications 5(4), (2020), 419-435 pages.

[2] Prepared independently by the author