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Research Paper

Optimizing the Cryptocurrency Investment Portfolio in Conditions of Uncertainty Using the Method of Data Envelopment Analysis - Robust Programming[1]

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INTRODUCTION

Financial market investors are looking for stocks and portfolios that outperform others in an uncertain economic and social environment. As a result, the selection of a stock portfolio, with the judgment of decision-makers, is often uncertain and explained by imprecise numerical values. To address this, uncertainty theories such as fuzzy theories and stochastic approaches have been developed to improve confidence levels based on uncertain intervals and the lack of accurate data (Bosufian et al; 1991). The primary objective of these models is to choose a financial portfolio with an optimal degree of confidence that aligns with the expectations of the investor or falls within a reliable interval. Furthermore, when choosing a financial portfolio, it is crucial to combine stocks and identify opportunities to evaluate and align them with the goals and structure of an optimal portfolio. Therefore, it is necessary to design a process that selects a suitable set of stocks capable of overcoming uncertainty and accommodating different decision-making approaches (Li and Teo, 2021). One powerful method for measuring and evaluating productivity under uncertainty is data envelopment analysis (DEA) models, along with robust programming. These models can be designed with flexible constraints to account for uncertain parameters in the problem space (Wei,

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2001). DEA is a non-parametric method widely used in operations and economics research to measure or estimate the performance efficiency of production units. Consequently, more complex and operationally realistic models are developed to consider efficient goals and limitations in financial markets. Additionally, due to the uncertainty associated with predicting financial parameters such as yield and risk, which play a crucial role in investment, there is a need for advanced techniques that incorporate uncertainty into these issues (Peykani et al; 2021).

MATERIALS AND METHODS

The primary objective of current research in portfolio management is to develop a decision-making tool that enables investors to select optimal assets in uncertain conditions. To achieve this, a model was introduced that analyzes the efficiency of stocks and incorporates hybrid modeling to address uncertainty. The research process consists of several stages. In the first stage, the performance of all investable stocks is evaluated and measured using the data coverage analysis model. The selected stocks then undergo an investment filter and are identified as potential candidates for entry. Next, the model determines the allocation of investment for each eligible selected share. In this step, the average semi-variance of the growth rate (MSVG) and the average absolute deviation of the growth rate (MADG) models are utilized. It is important to note that the uncertainty of parameters is accounted for using the robust optimization method at each phase. Finally, the proposed research approach is implemented in a real case study involving digital currencies. The entire research process is depicted in Figure 1.

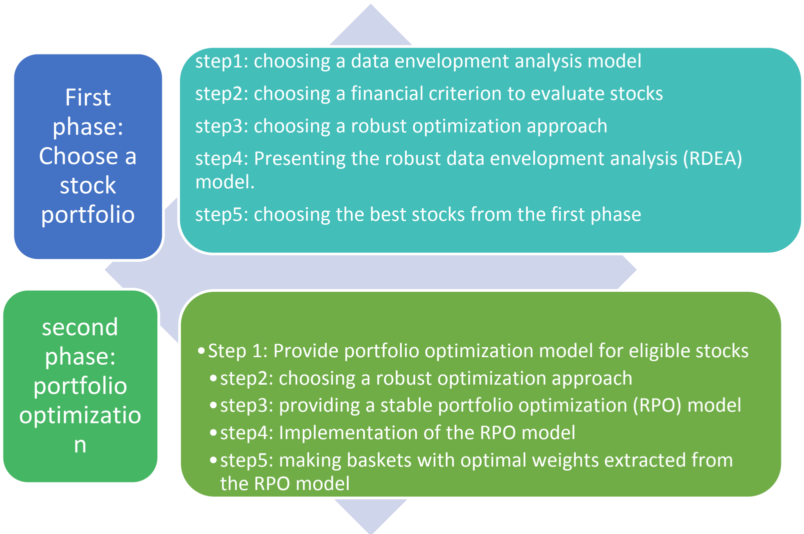

Figure 1. The process of implementing the present research

- The main advantages of the proposed approach in this study compared to recent similar research can be summarized as follows:
- The implementation of the method is based on a new and popular case study (digital currency market), which is comprehensively evaluated from various financial aspects and criteria.
- The model can be dynamically modeled by several objective functions based on six robust data envelopment analysis (RDEA) models that are popular in the field of DEA.
- Inclusion of cost in the objective function, which is less considered in similar research
- Securing responses in the most adverse conditions.

NUMERICAL RESULTS AND DISCUSSION

RATING OF ALL STOCKS

First, the variables of the model are selected using the Delphi method and financial criteria to evaluate stocks from different perspectives; which include return, risk, profitability, growth rate, leverage, valuation, and growth. The efficiency of all investable stocks for selection is evaluated and measured based on the number of inputs and outputs, which among the items listed in the reliable sites are 37 of the 50 cryptocurrencies that are popular and also have the largest volume of transactions allocated to them. It has been used from 2020 to 2021. After data collection, according to the desired confidence level of 90% in order to satisfy the limitations in DEA and the level of conservatism equal to 3.56, 3.86, and 4.84 for the limitations of non-deterministic parameters, as well as setting disturbance to 0.05 of all models RCCR-IO, RCCR-OO, RBCC-IO, RBCC-OO, RADD-CRS, and RADD-VRS are implemented. Finally, the stocks selected from RDEA models in the first period are Bitcoin, Ethereum, Solana, Terra, Algorand, Axie Infinity, Filecoin, Hedera, Helium, and Gala.

IMPLEMENTAION OF PORTFOLIO OPTIMIZATION MODEL FOR CRYPTOCURRENCIES

To implement the portfolio optimization model, the monthly data of returns and growth rates of selected stocks are extracted from the cryptocurrency market. After selecting the stocks from the first phase, the proposed robust model related to the second phase will be implemented according to the desired confidence level and the adjustment of the degree of disturbance Δ, to satisfy the limitations in the model and the level of conservatism for a limitation with the unknown parameter K, as well as the profit growth rate of the case The expectation of the portfolio is considered constant to increase the expected return of the portfolio. In the model RMSVG The highest portfolio risk equal to 0.0493 is related to the return equal to 0.240 and the lowest risk is 0.0020 to the expected return equal to 0.06. As the expected return of the portfolio increases, the risk of the portfolio increases as measured by the semi-variance (Figure 2). In the model RMADG the stable counterpart of the portfolio with the absolute value risk measure also increases with the increase in stock returns (Figure 3). According to the desired confidence level of 90% and the level of disturbance of 0.05 and the level of conservatism for a limit with 10 unknown parameters, the model is implemented, the highest risk of the portfolio is equal to 0.2122, corresponding to the Breyer return with 0.230, and the lowest risk is 0.0639, corresponding to the expected return equal to It is 0.08.

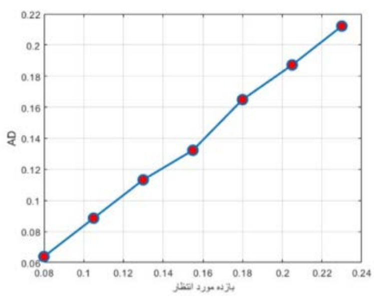

Figure 2. RMADG efficiency frontier

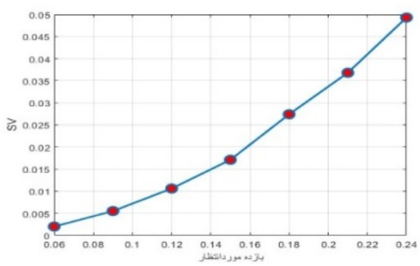

Figure 3. RMSVG efficiency frontier

In the last step, we perform sensitivity analysis for both phases of the model. The results show that the objective function worsens with the increase of conservatism from 0% to 100% and disturbance from 0.01 to 0.1.

Also, Figures 4 and 5 show the changes in the risk measures against the uncertainty of the problem parameters and the level of conservatism and the degree of disturbance of the data. By comparing these two figures, it can be recognized that the amount of risk in the semi-variance measure is lower than the risk with the absolute value measure. So, it is seen that the performance of the RMSVG model is slightly better than the RMADG model.

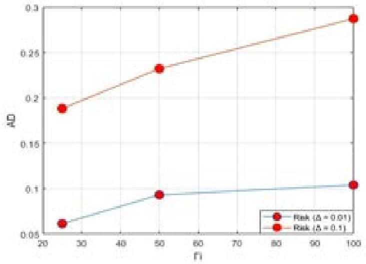

Figure 4. AD in RMADG

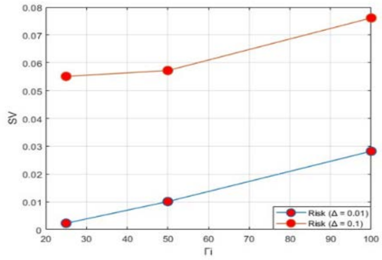

Figure 5. SV in RMSVG

CONCLUSION AND DISCUSSION

In the optimization of the stock portfolio, increasing yield and reducing risk are two things that are considered. In this research, a solid approach to the problem of creating a stock portfolio in financial markets is presented. This approach consists of two stages, and in the first stage, which is called stock selection, during six stages, the performance of all stocks that investors can invest in is evaluated and measured. At the end of this phase, only the stocks that pass the investor's filter are qualified to be investment candidates in the second phase. The next phase is the optimization of the stock portfolio, this phase with five stages, the amount of investment in each eligible stock is determined and finally, the portfolio is created In other words, at this stage, the decision-making unit decides on the weight of eligible stocks from the first stage in the basket. In the following, the robust optimization model that simultaneously uses two methods of data envelopment analysis and stable optimization on cryptocurrencies in the portfolio problem was investigated. The results showed that the proposed approach to building a portfolio of cryptocurrency stocks is effective in an environment of uncertainty. The computational complexity to consider the cardinality constraint in portfolio optimization models by applying the two-phase approach is reasonable and acceptable. In other words, this approach does not require a meta-heuristic algorithm to solve the portfolio optimization model with investment constraints under uncertainty.

Keywords: Portfolio Optimization , Data Envelopment Analysis , Robust Programming, Semi-Variance Mean , Absolute Deviation Mean.

JEL Classification: C52, C61, C67, G11.

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