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The selection and optimization of Stock portfolio using genetic algorithm based on mean-Semi variance model

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***Abstract*—the selection of stock portfolio is the allocation of capital among different stock options in a way that this investment provides its stockholder with the most interest. The purpose of this study is to select and optimize the stock portfolio based on Semi variance risk criterion. To do so, the genetic algorithm has been designed and the mean-Semi variance has been considered then some of the real world limitations have been added to the model. The software MATLAB 7.1 has been used to design the algorithm. The sample is 146 companies at Tehran Stack Exchange and the stock data from the beginning of year (1380; i.e. April 2001) to the end of 1387 (March 2008) have been used. The findings indicate the optimum and high stability of genetic algorithm in different frequencies.**

Key words: the selection of stock portfolio; semi variance; risk and return; genetic algorithm

I. INTRODUCTION

According to scholars, one of the reasons behind being on developed of developing countries is the low amount of fixed investment in these countries. The lack of convenient structure for individual and organization investment is one of the major problems of the third world countries. Meanwhile, the active participation of investors in the Stock Exchange is so significant that the existence of Stock Exchange depends on people's investment. [4]

In the last century, there have been great attempts to direct the investors to invest appropriately and plenty of models have been proposed. The concepts of the optimization of stock portfolio and variety giving have been considered as tools to develop and communicate with financial markets and decisions. The publication of the choice theory of stock portfolio by Harry Markowitz in the most major success in this regard. [10]

Markowitz' model made great contribution to people's perspective in investment and stock portfolio and regarded as an efficient tool in optimizing the stock portfolio. [14]

But Markowitz' theory just gave a solution regarding the allocation of investment. The investment capital that is composed of hundreds of various investment with different quality made the choice for difficult for the investors.

Using math planning models, Markowitz' model can be solved. But when the real world limitations such as high number of investments, the stock weight limitations and others make it more complicated that makes using the math models impossible. Consequently, the innovate algorithms such as genetic algorithms, neural networks, Murchegan algorithm and soon have been of great help.

II. REVIEW OF LITERATURE

Xia Lau Yang (2006) made use of the genetic algorithm along with a dynamic portfolio optimized system to improve the efficiency of the stock portfolio. In addition to G-A & M-V model, he help a third method called Bayesian perspective. The research findings showed that the genetic algorithm is of higher return compared to the other two methods and simultaneously of less risk. Besides, the analyses proved that the selected portfolio based on both models of GA in comparison to those of M-V & Bayesian methods, are of less fluctuations. [19]

Lin & Gen (2007), making use of Markowitz model as a basic math model, looked for maximizing the return and minimizing the investing risk. Their finding proved the reliability and efficiency of the genetic algorithm in optimizing the stock portfolio. [10]

Lin and Liu (2008) also modelized Markowitz models in three ways considering the limitation of the least purchase amount. They indicated that the genetic algorithms could gain the close point to optimization in little time for those models [15].

Aranda & Iba (2009) introduced a tree genetic algorithm that was used for the optimization of the stock portfolio. The smaller stock portfolios were obtained here. [6]

Hao and Liu (2009) showed new samples of mean-Semi variance models to do so. In the end, they introduced two numerical samples to prove the efficiency of the introduced methods. [12]

A. Markowitz Mean-Semi Variance Model

Harry Markowitz (1952) proposed his popular model [18].

This model has been based on the expected return indexes, the security risk and the varietization of security portfolio that basically is a theoretical framework to analyze the risk and return options [2].

But the point that received scant attention is that since the beginning, Markowitz was also interested in suggesting another definition of risk known as Semi Variance as he states "It seems that analysis based on S semi variance creates better portfolios compared to V variance basis." [8]

Considering this criterion, just the random returns that are smaller than return mean can be used to measure the risk. In facts, the rate of variance from the expected return is dangerous when it leads to less of the investor. Otherwise, it can't lead to any risk. Therefore, to measure the risk when the random return is bigger than the expected one, the value o (zero) replaces the difference between them [13]. Thus, Semi variance formula is as follows [11]. First formula

$$semi\,\mathrm{var} = \frac{1}{n-1}\sum_{i=1}^{n}(\min[(r_i - \bar{r}),0])^2$$

B. The Research Conceptual Framework

Markowitz mean-variance model is one of the most common models to select the stock portfolio. In this study, using Semi variance instead of variance in Markowitz model, the researchers come to a new model. This research aims at moving the model closer to the real market and more applied and also directing the investors to select more reliable options. Entering λ in the target function, it was attempted to include both criteria of risk and return in target function and while quantifying the risk, maximizing the return should be dealt with. In fact, λ is only a weighting parameter whose value fluctuates (0, 1) that is used to show the rate of value given by the investor to risk or return. In other words, when λ increases, the purpose of return increases and at the same time since the value (1- λ) decreases, the weight of the quantifying risk decreases. Finally, the proposed model of this research to select and optimize the stock portfolio is as follows:

$$\text{Max } \lambda\sum_{i=1}^{n}\omega_i\mu_i - (1-\lambda)\sum_{i=1}^{n}\sum_{j=1}^{n}\omega_i\omega_j\, semi\ \mathrm{cov}\,i,j$$

Subject to:

$$\sum_{i=1}^{n}\omega_i = 1$$

$$semi\mathrm{cov}_{i,j} = \frac{1}{T}[\sum_{t=1}^{T}\min\{(r_{i,t} - \bar{r}_i),0\} * \sum_{t=1}^{T}\min\{(r_{j,t} - \bar{r}_j),0\}]$$

$$\omega_i \geq 0 \quad i=1,2,3,....,N$$

$$t=1,2,3,....T$$

The genetic algorithm here is a one-step algorithm. The selection technique here is that of Rolette Cycle. The stable jump actioner of 0.5 is used. The junction actioner of 1 used in this study is middle one. There are 2000 generations and each population is 20. This algorithm is written using MATLAB 7.1 Software.

III. METHOD & SUBJECTS

This research is applied in purpose and descriptive in method. The subjects include all those accepted companies in Tehran Stock Exchange (146 companies).

IV. THE PRODUCERE OF CONVERGENCE OF THE GENETIC ALGORITHM

To design the genetic algorithm, the accurate selection of some of the parameters is of great importance in the procedure of convergence of the algorithm. The member of generation frequency is one of those parameters that are considered 2000 in this study though 1000 could have been enough. The findings are shown in diagrams 1-3.

V. THE ANALYSIS OF THE STABLE RATE OF THE ALGORITHM:

It is one of the most important tests. It is tested to see whether any time run of the algorithm can bring almost the same result and the uniqueness of the optimized result can be obtained or not.

So doing, one of the algorithms is taken into consideration and is applied a few times. Then, the resulted results are compares with each others. The selected stock portfolio of 10 stocks was considered. The results of the algorithm frequency can be seen in the table 1 and diagram 4.

Total Mean	Target operation	Target operation	Target operation	Target operation	Purpose of opeartion
0/02078	0/0218	0/0217	0/0223	0/0219	0/0193
Variance	Target operation	Target operation	Target operation	Target operation	Purpose of opeartion
0/000003	0/0201	0/0198	0/0168	0/0218	0/0223

VI. THE RESULT OF GENETIC ALGORITHM:

After running the genetic algorithm and assurance of convergence of the algorithm, the algorithm pertaining to each portfolio was run. Since the genetic algorithm is blind, it selected the various companies regardless of their natures and the kind of companies' activities has no effect on this algorithm. Instead, it selects the optimized stock portfolio based on risk and the return of various stocks and their effects on the target function.

VII. THE EFFECT OF THE STOCK PORTFOLIO SIZE ON THE VALUES OF TARGET FUNCTION, THE RETURN AVERAGE AND THE PORTFOLIO VARIANCE

As illustrated in table 2, the applied genetic algorithm can optimize the stock portfolios in various size and the change in the size can change the target function little. The portfolio size has negative relationship with the risk and return.

30تـا یـی	20تـا یـی	10تـا یـی	Size of basket
0/0203	0/0207	0/0196	Size of Target Function
0/0065	0/0089	0/008006	Basket variance
0/0016	0/0025	0/047492	Basket return

VIII. THE RESEARCH FINDINGS

Generally, the findings prove the high efficiency of the genetic algorithm in sowing the optimization of the stock portfolio. This algorithm could solve the issue in various levels of stock numbers. The purpose of the research, i.e. proposing a model of optimize the stock portfolio, then was obtained.

Besides, the limitation of the correct number as one of the added limitations to the traditional model could help the investors to make the model closer to the reality**.** Investors can have different stock portfolio *using the identified stock number and the* model efficiency.

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