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Research Article

THE SELECTION AND OPTIMIZATION OF STOCK PORTFOLIO BY MEANS OF MONTE CARLO'S SIMULATION METHOD AND ARTIFICIAL NEURAL NETWORK (ANN)

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ABSTRACT
The governing climate over the economic activities is always followed by several threats. The present investigation is intended to select the optimal stock portfolio from the investment companies , which have been admitted by Tehran Security and Exchange Organization (TSEO), by means of Monte Carlo's simulation method and Artificial Neural Network (ANN). This study is of applied type based on its goal and its methodology is of descriptive- correlation type . 30 investment companies have been examined by means of sampling deletion method during the time period from 2007 through 2011 . The modeling of this survey was done by means of MATLAB software and hypotheses were tested by R- software. After modeling for both of two models , the stock weights and efficient frontier have been identified for 10-stock and 20- stock portfolios in these two models. Finally, with respect to the derived results, it was characterized that there is no significant difference in using each of these two models.

***Keywords**: Artificial Neural Network, Monte Carlo's Method, Optimization, Risk, return*

INTRODUCTION
Risk and return (efficiency) are deemed as two major elements in stock investment, today (Raei & Fallahpour, 2007). Every investor seeks for increasing financial return on the one hand and reduction of risk on the other hand. But anyone, who seeks for more return (efficiency), should tolerate more risk as well. Such confidence is possible by diversification and stock portfolio (Raee, 1988). Portfolio is a group of stocks in which each of the existing stocks has specific rate of return and risk. With respect to type and quantity of the existing stock, portfolio has also certain return and risk. Portfolio of one investor differs from another investor's since there is some difference in motives as well as personality characteristics of any investor compared to other investors . Selection of those tools and techniques, which can form the appropriate portfolio, is a wish in world of investment (Raei, 1988) .

Importance of research subject
Sometimes, some sudden shocks from capital market and fall of prices have caused some investors to exit this market and at the same time some groups to enter in capital market. On many occasions, these fluctuations have also led to inappropriate allocation of financial resources. Allocation of resources correctly requires suitable grounds for investment and the presence of appropriate analytical tools and techniques in capital market (Raei, 2002).

Research history and Theoretical background
Subject of selecting portfolio
If stocks and securities are risky the major issue for any investor is to determine a group of securities and stocks, which have the maximum utility. This issue is the same as selection of optimal portfolio out of possible group of portfolios, which is called subject of selecting portfolio. (Raei & Pooyanfar, 2012).
Optimization of portfolio

Optimization of portfolio is to select the best composition of financial assets in such a way that to maximize return of investment portfolio and to minimize risk of this portfolio (Raei & Alibeigi, 2010).

Genetic Algorithm (GA)

Genetic Algorithm (GA) is a technique of searching in computer sciences to find the approximated solution for optimization and searching problems. Genetic algorithm is a type of evolution algorithms, which use biological transformational techniques like inheritance and mutation.

Artificial Neural Networks (ANNs)

Artificial Neural Networks (ANNs) are a model for data processing that has been built with imitating from biologic neural networks like human's brain. The key element in this model is the new structure of its data processing system and it is made up great number of elements (neurons) with strong internal connections, which operate harmonically together to solve the special problems (Menhaj, 2013).

Monte Carlo's Method

Monte Carlo's method was purposed for the first time in the movie titled as "Phelim O. Boyle" and published in an essay under title of "The option of contract" based on the viewpoint from Monte Carlo. (Farid et al, 2010).

Empirical background

A review on domestic researches

In their survey, Farid et al (2010) have utilized Monte Carlo's simulation technique in selection of optimal portfolio. They initially calculated the value-at-risk (Var) for this stock and then they obtained stock weight according to the presented model. In a study, Raei (1988) has designed a model for appropriate investment in stock portfolio by means of Artificial Intelligence (AI). The results of this survey show this point that behavior of stock return is not only random but it has a certain trend. In a research titled as formation of stock portfolio for risky investor (joint venture) (comparison of neural network and Markowitz's model), Raei (2002) compares these two model both in static and dynamic statuses. At the end, he concluded that neural network model is preferred to Markowitz's model in both static and dynamic modes. In their investigation, Alem Tabriz et al (2003) have used Artificial Neural Network (ANN, ARIMA, and Markowitz's model to select the optimal stock portfolio. The results indicated this point that Artificial Neural Network (ANN) has been characterized as the best model to select the optimal stock portfolio.

A review on Foreign researches

Yan Chen and Shingo Mabu and Kotaro Hirasawa et al (2011) have used Genetic Relation Algorithm (GRA) and guided mutation for optimization of assets at large scale. The findings of this study show that GRA technique succeeds to optimize assets. Fernandez and Gomez (2007) have carried out a study under title of "Selection of stock portfolio by means of neural network". The results of this investigation signify the preference of this model in selection of stock portfolio. Andreas Steiner (2011) has done optimization of portfolio in drawdown-at-risk mode by Monte Carlo's method. In his study, he expresses that the scientific value of Monte Carlo's optimization is identified basically by its relative performance in contrast to other methods. William T. Shaw (2012) have optimized portfolio for goals of risk, return for general investor and distribution of arbitrary efficiency by Monte Carlo's method. In this study, optimization of risk quartile functions, efficiency, value-at-risk, and conditional value-at-risk including variability ratios such as omega and Sortino and mathematical constructions like the expected returns and behavioral finance extensions have solved and explored. Alexei A. Gaivoronski and George Pflug (2005) have investigated the computational features and methods of value-at-risk in optimization of portfolio. In this research, the computational technique gives a portfolio that at least several expected efficiencies among these methods which may be followed the minimum value-at-risk.

Research hypotheses

First hypothesis: There is a significant difference among rate of efficiency of investment in the selected and optimized stock portfolios based on Monte Carlo's technique and mean efficiency of investment in

the selected and optimized portfolios according to neural network and by means of genetic algorithm. Second hypothesis: There is a significant difference among variance of investment in the selected and optimized stock portfolios based on Monte Carlo's technique and by genetic algorithm with variance of investment in the selected and optimized portfolios according to neural network model and by genetic algorithm.

These hypotheses also apply to 10 stock and 20- stock portfolios. Any hypothesis is divided into two parts: Null hypothesis (lack of significant difference) and the opposite hypothesis (significant difference).

METHODOLOGY

This study is classified as applied researchers based on research goals and it is of descriptive and correlation type in terms nature and method.

Statistical population

The statistical population in this survey includes all the admitted investment companies in Tehran Security and Exchange Organization (TSEO) during time ranged from 20/03/2008 through 19/03/2013.

Statistical sample

It comprises of 30 investment companies, which have been admitted in Tehran Security and Exchange Organization (TSEO).

Sampling method

The systematic deletion technique has been used for preparation of statistical sample in this study.

Research tools

Data analysis tools

MATLAB software (v. 7.11.0) has been employed as tool for both the given models and Excel software has been utilized to calculate skewness, kurtosis, and standard deviation of efficiencies. Likewise, R-software was used to test the hypotheses.

Data collection methods

The method of existing data and information has been adapted in this study. Similarly, the related websites with corporative stocks such as SEO and Code-all-network were investigated.

Data analysis methods

Analysis of efficient system done by Markowitz is one of the foremost analysis techniques of investment in stock portfolio. In this analysis, the relationship among stock in a system and their interaction with each other is highly important. The following model is a non-linear programming model that has been purposed by Markowitz:

$$\text{Minz} = \sigma_P^2$$

S.T

$$E(r_p) = \sum_{j=1}^{M} X_j E(r_j)$$

$$\sum_{j=1}^{M} X_j = 1,\ X_j \geq 0$$

The above model is implemented both in neural network and in Monte Carlo's technique.

Solution of Artificial Neural Network (ANN)

Network training: Levenberg- Marquardt algorithm will be used for training of network that has been designed.

Like all traditional training algorithms in this algorithm, gradient algorithm and Hessian's matrices are employed to achieve the optimal weights for the network. Jacobian determinant is used in the present algorithm.

Solution of Monte Carlo's simulation methods

The simulation in Monte Carlo's method comprises of three main steps: The first step is creation of scenario. We can use a number of various attitudes to create a distribution of future assumed scenarios. Any scenario is complied with possible status (in real world). The second step is evaluation of portfolio. We compute one value for stock portfolio in every scenario and the third step is related to presentation of report. Namely, we purpose the results of simulation either as distribution of portfolio or a certain risk criterion.

RESULTS

To test hypotheses in this part, we need to weights of 10-stock and 20-stock portfolios in both models and mean efficiency and variance are compared based on these weights, which have been already optimized by genetic algorithm.

Table 1: Weights of 10-stock portfolios in Artificial Neural Network

Title of enterprise	Weight percentage (weightage)
Omid investment company	0.0139
Iran Khodro Industrial Group	0.2784
Bu-Ali investment Inc	0.0139
National development company	0.2784
Tooka Steel Co	0.0266
Rena investment Co	0.0140
Sepah investment Co	0.0139
Industry & mines investment Inc	0.2784
Ghadir investment Co	0.0139
Behshahr industrial Group Investment Co	0.0726

Table 2: Weights of 10-stock portfolios in Monte Carlo's method

Title of enterprise	Weight percentage (weightage)
Iranian Credit investment company	0.0208
Iran Khodro Industrial Group	0.0212
Iranian industrial development investment Inc	0.0208
Tooka Steel Co	0.0209
SAIPA Group investment Co	0.4164
Retirement Fund Investment Co	0.0208
Industry & mines investment Inc	0.04164
Ghadir investment Co	0.0209
Behshahr industrial Group Investment Co	0.0208
National Iranian Investment Co	0.0208

Table 3: Weights of 20-stock portfolios in Artificial Neural Network

Title of enterprise	Weight percentage
Atiyeh Damavand investment Co	0.0130
Omid investment company	0.0130
Iran Khodro Industrial Group	0.2594
Bu-Ali investment Inc	0.0130
Petrochemical industries investment Inc	0.0130
Toos Gostar Co	0.0131
Azerbaijan industrial development investment Co	0.0130
National development investment Inc	0.2594
Tooka steel investment Co	0.0130
Rena investment	0.0130
Iran construction investment Co	0.0134
Sepah investment Co	0.0130
Shahed investment Co	0.0130
Retirement fund investment Co	0.0130
Insurance industry investment Co	0.0130
Industry & mines investment Co	0.2594
Ghadir investment Co	0.0130
Behshahr industrial Group Investment Co	0.0133
National Iranian investment Co	0.0130
Energy investment Inc	0.0130

Table 4: Weights of 20-stock portfolios in Monte Carlo's method

Title of enterprise	Weight percentage
Atiyeh Damavand investment Co	0.0130
Iranian credit investment company	0.0130
Alborz investment Inc	0.0130
Iran Khodro Group investment Inc	0.0130
Petrochemical industries investment Inc	0.0130
Toos Gostar Co	0.0130
Azerbaijan industrial development investment Co	0.0130
National development investment Inc	0.0130
Tooka steel investment Co	0.0132
Rena investment	0.0130
SAIPA Group investment Co	0.2595
Retirement fund investment Co	0.0130
Insurance industry investment Co	0.0130
Industry & Mines investment Co	0.2595
Ghadir investment Co	0.0130
Behshahr industrial Group Investment Co	0.2595
National group investment Co	0.0134
Mellat investment Co	0.0130
National Iranian investment Co	0.0130
Energy investment Inc	0.0130

After optimization of stock portfolios, now it is the time to select the optimal stock portfolio that is done by efficient frontier.

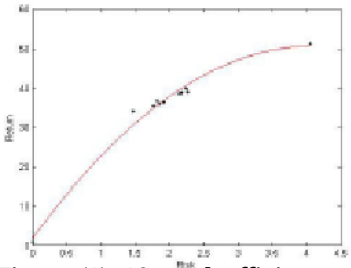

Figure (1): 10-stock efficient frontier in Monte Carlo model.

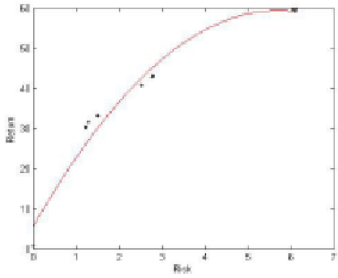

Figure (2): 20-stock efficient frontier in Monte Carlo model.

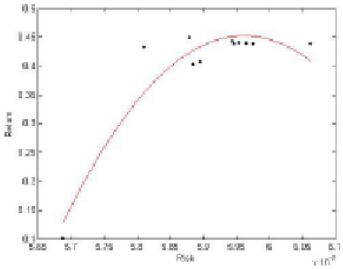

Figure (3): 10-stock efficient frontier in Neural Network.

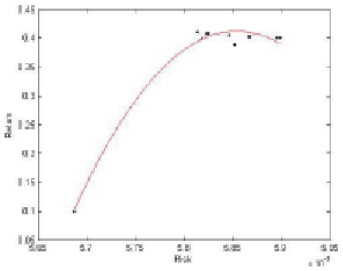

Figure (4): 20-stock efficient frontier in Neural Network.

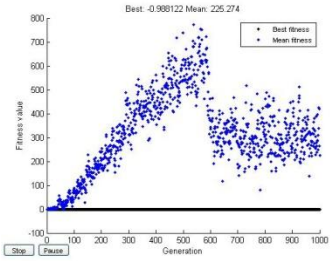

Figure (5): . Convergence of in 10-stock portfolios in a neural network

Figure 5-8 shows convergence of all four stock portfolios via genetic algorithm

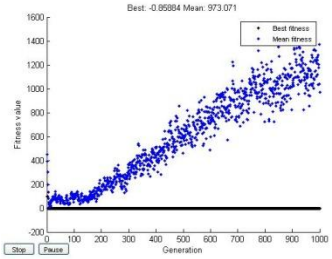

Figure (6): . Convergence of in 10-stock portfolios in a neural network

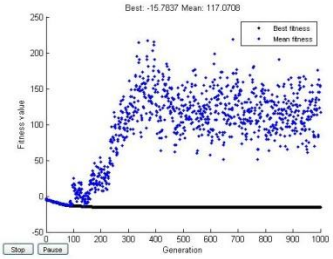

Figure (7): . Convergence of in 10-stock portfolios in a neural network

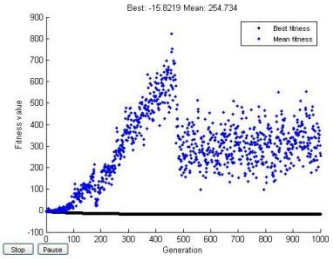

Figure (8): . Convergence of in 10-stock portfolios in a neural network

Similarly, the outputs of first and second hypotheses have been computed for 10- stock and 20- stock portfolios by R- software.

Variable	Resources of portfolios	Quantity	Mean	Covariance test			Comparison test of efficiency in two portfolios			
					F	Significance level	t-test statistic	Significance level	95% confidence level	
									Lower boundary	Upper boundary
Mean efficiency	Neural network	10	0.02040992	Equality of variance	0.0029	5.192e-10	-0.943	0.37	-1.181	0.485
	Monte Carlo	10	0.36834036	Inequality of variance						

Table (6): The comparison of mean efficiency for 20-stock portfolios

Variable	Resources of portfolios	Quantity	Mean	Covariance test			Comparison test of efficiency in two portfolios			
					F	Significance level	t-test statistic	Significance level	95% confidence level	
									Lower boundary	Upper boundary
Mean efficiency	Neural network	20	0.005908065	Equality of variance	0.9685	0.9452	0.0017	0.9987	-0.01655762	0.0165851
	Monte Carlo	20	0.005894312	Inequality of variance						

Table (7): The comparison of variance for 10-stock portfolios

Variable	Resources of portfolios	Quantity	Mean	Covariance test			Comparison test of efficiency in two portfolios			
					F	Significance level	t-test statistic	Significance level	95% confidence level	
									Lower boundary	Upper boundary
Mean efficiency	Neural network	10	0.000703198	Equality of variance	4.1825	0.0444	0.8883	0.390	-0.00006	0.001
	Monte Carlo	10	0.000238964	Inequality of variance						

Table (8): The comparison of variance for 20-stock portfolios

Variable	Resources of portfolios	Quantity	Mean	Covariance test			Comparison test of efficiency in two portfolios			
					F	Significance level	t-test statistic	Significance level	95% confidence level	
									Lower boundary	Upper boundary
Mean efficiency	Neural network	20	0.000303818	Equality of variance	1.1026	0.8336	0.0676	0.9465	-0.0005	0.00060
	Monte Carlo	20	0.000284172	Inequality of variance						

DISCUSSION

As it observed in testing the first hypothesis, to examine mean efficiency for 10- stock portfolio (Table-5), firstly the covariance test is studied among two groups where F-statistic and significance level for them were calculated 0.0029 and 5.192e-10 respectively. Whereas significance level is smaller than ($\alpha = 0.05$) thus variance is not equal in two groups while the significance level has been acquired as 0.855 for comparison test of mean efficiency among two groups and this signifies lack of significant difference among both groups in terms of mean efficiency. In other words, this verifies null hypothesis and or we have not adequate reason to reject it. Similarly for 20- stock portfolio, the covariance test has been initially examined among two groups where F-statistic and its significance level were derived 0.9685 and 0.9452 respectively. Since significance level is greater than ($\alpha = 0.05$) therefore variance is equal in both groups while the significance level has been obtained as 0.9987 in comparison test among mean efficiency of two groups and this suggests the lack of significant difference among two groups in terms of mean efficiency. Namely, this confirms null hypothesis and or we have not the reason enough to reject it. In the second hypothesis, covariance values of stock portfolios are compared. Primarily, the covariance test is examined among two groups in which F-statistic and its significance level are obtained 4.1825 and 0.04444 respectively. Since the significance level is smaller than ($\alpha = 0.05$) therefore variance is not the same in two groups while to conduct comparison test of variance in both groups, the significance level was acquired 0.3905 and this signifies the lack of significant difference among two groups in terms of variance. Regarding 20- stock portfolios, firstly covariance test was examined among two groups where F-statistic and its significance level were derived 1.1026 and 0.8336 respectively. Whereas the significance level is greater than ($\alpha = 0.05$) thus variance is equal in both groups while the value of significance level has been obtained 0.9465 for variance comparison test in both groups and this expresses lack of significant difference among two groups in terms of variance.

CONCLUSION

The governing climate over the economic activities is always followed by several threats . Risk and return (efficiency) are deemed as two major elements in stock investment, today . One of the important objectives of this study is to contribute mainly to investors in their financial decision making and selection of stock portfolio .

In Monte Carlo's simulation methods Firstly, derived data from the enterprises with the same monthly return of corporative stocks will enter in the computer and return of stocks is computed according to skewness formula and rate of skewness of return for stocks. Then simulation is done to produce random figures with 1000 scenarios. Simultaneously, simulation is conducted on mean-variance model to

minimize this model. Fitness function should become minimized and along with weights can appear. In Artificial Neural Network Initially, data enter in neural network and the neural networks predict period of upcoming year with minimizing mean-variance model. The promoter networks are used in neural networks. Multi-layer perceptron is employed in promoter networks. Similarly, error-back propagation network is utilized for network-to- network training . After modeling for both of two models, the stock weights and efficient frontier have been identified for 10-stock and 20- stock portfolios in these two models. Finally, with respect to the derived results, it was characterized that there is no significant difference in using each of these two models.

SUGGESTIONS

1- It is suggested to managers of stock portfolios in investment companies to use both neural network model and Monte Carlo's technique in evaluation of performance and to select each of them based on their preferences and utility that suitable for them.
2- It is suggested to researchers and academic students to optimize all stocks in active enterprises in Bourse (TSEO) by means of these two optimizations models so that the managers and shareholders of companies to be able to predict the future for corporative stocks at high level of confidence.
3- It is suggested to include other factors like inflation rate, housing, oil etc in order to form more appropriate and efficient stock portfolio.

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