Compare Ability of Markowitz, Single Index Model of Sharp, Data Envelopment Analysis and Value at Risk Models in Selecting Optimum Portfolio of Stocks in Accepted Companies of Tehran Stock Exchange

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ABSTRACT
This study compares ability of Markowitz, Single Index Model of Sharp, Data Envelopment Analysis (DEA) and value-at-risk (VAR) models in selecting optimum portfolio of stocks in accepted companies of Tehran Stock Exchange. This study uses referential statistics with applied goals. Statistical population includes all accepted companies in Tehran Stock Exchange. Regarding study restriction, 85 companies from 2004-2013 were selected. To reach portfolios of Markowitz model, VAR, single index model of Sharp, MATLAB software and to asses DEA, DEA SOLVER software was used. After identifying portfolios and calculating return and risk, hypotheses were tested using SPSS Software.
Findings of this study showed that all three models of Markowitz, VAR, and Sharp can form optimum portfolios but collective pattern in DEA model doesn't have the ability of forming optimum portfolios in Tehran Stock Exchange. The ability of VAR is higher than Markowitz and Sharp in selecting optimum portfolios.

KEYWORDS: Risk, Return, Optimal Portfolio, Markowitz Model, Value at Risk Model, Single Index Model of Sharp, Data Envelopment Analysis

INTRODUCTION

Investment is a hot issue in financial management. Basically, investment in stock market necessitates risk. Risk and return are two distinct factors in investment decision. These two factors are theoretically proven to having a tight linear or positive relationship (Zakaria, 2013).
Proper selection of assets helps investors to get maximum return in an acceptable risk level. But, for investment, security is required; so, risk should be minimized or controlled.

One way of controlling investment risk is forming portfolio and diversifying assets. Efficient portfolio refers to a desirable combination of securities in a way that risk of that portfolio is minimized for gaining a good return. A wisdom investment works so that the highest probable and expected return is reached by accepting a given level of risk. The assumed or given return is one of the investment methods which might lower the risk and implement the diversification strategy of the portfolio (Mir Mohammadi Sadrabadi,2013).

Reasonable investors look for an efficient portfolio. Because, such portfolios maximize expected returns for a definite level of risk or minimum risk for a definite expected return (Radpour, 2009). Today the stock market performance of developed countries as a measure to evaluate the policies and decisions of economic, financial and trade of these countries used to be. Continue to operate as a stock exchange in any country's economic growth and development is a continuous process this is only for investors who are attracted to different tastes and preferences (Fakher Aein, 2013).
Mean-variance model of Markowitz, Single Index Model of Sharp, Data Envelopment Analysis and VAR of Waterston models are known models in this regard. In 1950, Markowitz offered a basic portfolio model, introducing diversification officially. Efficient portfolios are the ones which have the highest expected return at expense of a definite risk level or the lowest risk at expense of a definite expected return (Eghbalnia, 2006). Regarding considerable costs and

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requirements of Markowitz model, Waterston followed Markowitz works and offered VAR. VAR index offers maximum probable portfolio loss in a time span with quantitative statements. With the aim of improving Markowitz model, William Sharp (1961) offered sharp model which connects return of every security to the return of joint stock index, requiring lower calculation than Markowitz model. Attempts for improving stock analysis methods lead to creating new methods which aim to find a response for earnings maximization in financial markets. A new solution for evaluating corporate efficiency is DEA which is a multivariate method for decision-making and measuring corporate performance. This techniques is rarely used in Iran Stock Exchange, hence it is expected that applying this modeles causes a new horizon to be captured for the selection of optimum portfolio in Iran's capital market and consequently enhancing the investment culture. Utilization of this methods contributes managing the investment risk and selecting an optimal portfolio (Mir Mohammadi Sadrabadi,2013).

This study aims to form an optimum stock portfolio in Tehran Security Exchange using VAR, Sharp, and DEA in comparison with Markowitz model. Since these 4 models have not been compared before, this study aims to find which model has higher ability in forming optimum stock portfolio.

2.THEORETICAL AND LITERATURE REVIEW

2.1 Theoretical Concepts Review

2.1.1. Markowitz model

In 1950, Markowitz offered a portfolio formation basis, known as the foundation of modern theory of portfolio. Investors were familiar with investment, risk and return concepts before Markowitz; but, they couldn't measure it. But Markowitz (2006) was the one who introduced portfolio and diversification formally. Attention to investment, not only based on standard deviation but also according to the risk of investment, was the most significant feature of Markowitz model (Raei and Talangi, 2008). Efficient portfolios are the ones which have the highest expected return at expense of a definite risk level or the lowest risk at expense of a definite expected return. While, optimum portfolios are the most reliable efficient portfolios from investors' views based on the following assumptions: 1.Investors consider each investment alternative as being presented by a probability distribution of expected returns over some holding period. 2. Investors minimize one-period expected utility, and their utility curves demonstrate diminishing marginal utility of wealth. 3. Investors estimate the risk of the portfolio on the basis of the variability of expected returns.4. Investors base decisions solely on expected return and risk, so their utility curves are a function of expected return and the expected variance (or standard deviation) of returns only. 5. For a given risk level, investors prefer higher returns to lower returns. Similarly, for a given level of expected returns, investors prefer less risk to more risk (Talangi, 2008).

2.1.2. VAR model

VAR is maximum loss in a way that decrease of portfolio value for a definite holding in future with a definite coefficient doesn't exceed that. In other words, VAR measures the worst expected loss under common market conditions and a definite holding period at a definite confidence level. Application of this model in risk management is a measure for risk and needed capital of an organization for operations (Talebnia and Nezamabadi, 2010). VAR doesn't have many restrictions of traditional risk management methods like normality of return distribution, the lack of considering time span, or cashability of financial assets. This measure is responsive to the complexities of financial tools, summarizing different risks in a number. Thus, senior managers don't face a sum of risk calculations. By VAR, risk can be purposeful and planned (Hanifi, 2003). VAR summarizes risk of portfolio in a number. It is a framework for measuring and analyzing risk that can be equally used about different assets. Thus, using VAR, a portfolio made of securities with formed portfolio from comparable stocks can be compared.

2.1.3. Single Index Model of Sharp

Sharp (1961) offered Sharp model suggesting beta as risk factor. The advantage of Sharp model is simplicity and data reduction for selecting portfolio and offering a new risk measure for investment. Besides, Sharp model is a statistical model for estimating derivation of stock return. The basic concept in this model is that all securities are affected by general volatility of the market because similar future economic forces of companies are affected per se. In Sharp model, it is assumed that market index is not correlated with error amount and securities are affected by their reaction to return, meaning that error of security i is not correlated with error of security j (Jones 2008).

2.1.4. Data Envelopment Analysis Model

DEA uses mathematic planning that can use many variables and relations and doesn't have limitation of few inputs and outputs like other methods. Simplicity

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in calculation and evaluation and the lack of restriction in selecting factors provides the possibility of handling more complicated problems in managerial and policy-making areas. Moreover, strong theory of mathematic planning provides the possibility of better analysis and interpretation (Charnes et al., 1987).This model uses all gathered observations for measuring efficiency. Despite regression method, DEA optimizes each observation in comparison with efficient border (Mehrgan, 2004).

2.2. Background

In a study titled "the relationship between risk and return in Singapore Stock Exchange", Tang and Shoom (2004) studied firms from 1986-1988. They concluded that although the relationship between risk and return is unconditional, but its explanatory power is weak. Such relationship is not observed in some periods. Also, the relationship between risk and return is non-linear. Unsystematic risk and total risk have final and significant role in pricing securities of Singapore. Anyway, when a conditional framework based on market in growth or recession states is introduced, explanatory power increases 100 times and by the time, excessive return of the market is positive, there will be a positive and significant correlation between risk and return. But, when excessive return is negative, this correlation is negative. When conditional relationship between risk and return is considered, there will be a significant correlation in the market in growth state and a negative correlation in recession state. In a study titled "comparing Fama and French model with VAR in selecting efficient stock portfolio", Duri and Afentakis (2008) concluded that VAR has higher prediction power than Fama and French model. They hypothesized that both models have power of predicting optimal portfolios. Using daily stock index of London in 5 years, they found that VAR has power of predicting optimal portfolios but Fama and French model can't predict that. In a study titled" selecting an optimal portfolio using VAR and CAPM models in Bahrain, Egypt, Jordan, Morocco, Oman, Saudi Arabia, and Turkey", Moghireh et al. (2010) used non-parametric method for their study. They studied firms from 2008-2010. They concluded that using VAR leads to better results. In his study titled"comparing VAR in Egypt, Jordan, Morocco, and Turkey", Asef (2011) used variance, covariance, historical simulation, and Ferin Value Theory. He concluded that historical simulation underestimates VAR. In this study in which time span was from 2008-2010, the researcher found that calculation accuracy between variance-covariance method and Ferin value theory are close but different in 4 countries. Lechner and Evarat (2010) conducted a study titled "investigating VAR and techniques of return estimation" and used 4 methods for estimating model parameters. They found that other approaches such as final value theory focus on final values for estimating normal distributions. Advantages and restrictions of ARCH models and final value theory showed that one model can't be suggested for calculating VAR. In his study titled "investigating the effect of VAR in merged markets", Snosi and Alarooei (2012) aimed to identify the most effective measures of merged market for market risk. The other question was "if risk measurement tools change, what effects they will have on VAR?" . They found that market development is a function of efficient measures of VAR. Measurement models for liquidity and asymmetric information were accepted by a conducted test. Buhdalo and Benito (2012) conducted a study titled "detailed comparison of VAR DEA and CAPM in international stock transactions". They concluded that VAR is a good method for selecting an optimum portfolio for its simplicity and not having restrictions of two other models. Researchers used different methods (e.g. parametric, historical simulation, Monte Carlo simulation, and boundary value theory) for calculating VAR, showing that parametric method is the simplest and the most reliable estimation measure for VAR. Genchi et al. (2012) conducted a study titled "comparison of ARCH and Ferin Value Theory in Indonesia, Malaysia, South Korea, and Japan". They concluded that ARCH method has better performance than Ferin Value Theory in estimating VAR. For estimating VAR using Ferin Value Theory, non-parametric and parametric method, Hill estimator, and maximum likelihood function were used. Despite the differences of development of Asian countries, equal features for index return of these countries were found. Authors found that index return distribution of Asian countries has a wide tail and regarding estimated parameters for that looks like international or American index return distribution. Janson (2008) simplified portfolio optimization process via Sharp model. In this study, sharp model was used as a simplification method for estimating the optimum portfolio. Results of achieved portfolios were compared with industrial standard return of Dow Jones. They showed that Sharp model estimates inputs of Markowitz model, comparing returns of Markowitz model and Dow Jones index. Shahriar and Ahmadi (2008) conducted a study titled "identifying optimum investment in Tehran Stock Exchange with VAR

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approach". They found that investors should allocate maximum investment weight to a company with less risk likelihood and the lowest weight, not to the risky companies. Since this study aims to offer VAR approach for measuring risk and optimum investment division into 3 portfolios, parametric methods such as variance-covariance methods based on autoregression conditional variance and extended auto regression conditional variance for estimating VAR, stock portfolio of 4 companies, and optimum investment weights in stocks of 4 companies in Tehran Stock Exchange were also used. Khalili (2008) estimated market risk of an investment portfolio based on VAR. He found that VAR is better than previous formula for optimizing portfolios. Asghari Aghmashhadi (2009) examined the ability of DEA in selecting efficient portfolio. He compares results of DEA with results of Markowitz model. Based on the results, collective pattern in DEA doesn't have the ability of forming an efficient portfolio in Tehran Stock Exchange. Talebnia and Fathi (2010) conducted a study titled "comparative evaluation of optimum stock portfolio selection in Tehran Stock Exchange via Markowitz and VAR models ". They found that selecting optimum stock portfolio has the same function using both Markowitz and VAR models. Based on their results, investors can use both models. Talebnia and Nezamabadi (2010) conducted a study titled "investigating prediction power of 3-factor model of Fama and French and VAR in selecting optimum portfolio of accepted firms in Tehran Stock Exchange". They found that Fama and French 3-factor model has better prediction power of optimum portfolio than VAR. So, both models have prediction power of optimum portfolio. Judi (2010) conducted a study titled "identifying optimum portfolio of foreign exchange in Tejarat Bank using VAR". He found higher efficiency of variance-covariance method for measuring VAR. Using observations of foreign exchange portfolio of Tejarat Bank including 14 foreign exchange prices, 3 methods of variance-covariance, historical simulation, and Monte Carlo simulation for VAR were utilized. After optimization operations, efficient portfolios were identified, using their risk and return. Khiabani and Sarooghi (2011) conducted a study titled "valuing VAR estimations based on ARCH models". Using parametric simulations, prediction power of ARCH family patterns for VAR in Tehran Stock Exchange was examined. They found that among VAR estimators, ARCH model and student-t have higher efficiency than TARCH and EARCH in estimating one-day risk of Tehran Stock Exchange. Abdi et al. (2011) conducted a study titled "calculating parametric VAR using conditional variance heteroscedasticity models in Tehran Stock Exchange". They found that predicting one-day and ten-day VAR values using leptokurtic distributions has higher precision and performance. Also, selecting different sample sizes affects number and results of the models that correctly estimate VAR. They estimated VAR about portfolio of Tehran Stock Exchange with 50 firms regarding their high cashability from 2008-2010. Using GARCH model in estimating VAR, Mirzaei and Ajami (2012) concluded that in all samples and all distributions in two confidence levels, GARCH models have better performances. Leptokurtic distributions are better estimators for VAR because they have better performance in estimating values of VAR at lower levels. Using several volatility estimators on 3 different distributions (normal distributions, Leptokurtic distribution, and student-t) and considering 4 different sample sizes, one-day VAR was examined using 5 market indexes at 95% and 99% confidence levels. Mollaei et al. (2011) conducted a study titled "optimizing management patterns of Markowitz risk, VAR, and parametric VAR using local and global algorithms in Tehran Stock Exchange". They concluded that there is no difference in using Markowitz patterns, VAR, and parametric VAR. Their efficiency borders overlap. Optimum portfolio coefficients are the same, offering similar results. Also, it is recommended that for optimizing management patterns, global risk become used along with local risk. In case investors' goal is optimization at minimum time, local methods should be used for gaining optimum weights. Abiri (2012) conducted a study titled "selecting optimum stock portfolio using DEA and VAR". He found that like Markowitz model, VAR has the ability of forming optimum portfolio. Regarding non-linear behavior of investors, Markowitz model was used for comparison. Forming a portfolio using 3 models, the researcher compares them with the mean of market portfolio return. Based on the results, VAR yields a better optimum portfolio.

3. MATERIALS AND METHODS

3.1. Community sample

Statistical population of this study includes all accepted companies in Tehran Stock Exchange from 2004-2012. The companies with the following conditions were accepted as the sample:

1. Their stocks' transaction doesn't have any long stop (i.e. over 4 months).

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2. Investment, financial services, and mediation companies are excluded from sample companies
3. Needed information for calculating research variables of under-study firms are available.
4. They are accepted in Tehran Stock Exchange before 2001 and have not exit it till the end of fiscal year of 2013.
5. Their fiscal year ends in last month of winter.

3.2. Hypothesis

1. VAR has the ability of forming optimum portfolio in Tehran Stock Exchange.
2. DEA has the ability of forming optimum portfolio in Tehran Stock Exchange.
3. Sharp model has the ability of forming optimum portfolio in Tehran Stock Exchange.
4. Results of VAR are conformed to Markowitz model.
5. Results of DEA are conformed to Markowitz model.
6. Results of Sharp model are conformed to Markowitz model.

3.3. Methodology

This study uses referential statistics with applied goals. Results of this study on analysis and investigation of different optimum portfolios can be used by decision-makers.

3.4. Measurements

3.4.1. Input variables of Markowitz model

For estimating Markowitz model, variables of expected return of stocks, expected return of portfolio, without-risk return rate, return rate of market investment collection, beta coefficient (index of systematic risk), portfolio and covariance risk (among return of stocks) were used.

3.4.2. Input variables of VAR

The most common calculation method for VAR is parametric method, calculated by assuming normality of asset return distribution as follows (Hanifi, 2004):

Equation 1.

$VAR_i=Pi\times Z\times Sdi$

Where,

VAR_i: VAR of asset i

Pi:price of asset i(market value of asset i)

Z : standard normal statistics related to confidence level

Sdi: price volatility of asset i

3.4.3. Estimating optimum portfolio of Sharp Model

The most common parameter estimation method in one factor model is using historical return rates. Rules of stock selection in combining optimum portfolio is as follows: first, the ratio of excess return to beta is calculated and ranked from maximum to minimum. Optimum portfolio includes investment on all securities whose excess return to beta ratios are above Cut-Off Ratio of C*. Cut-Off Ratio is a point of economic importance. After calculating Cut-Off Ratios, securities are ranked. First C* value is identified using all features of extant securities in optimum portfolio. Let's assume Ci the candidate of being selected as C*. Ci value is identified when a stock belongs to the optimum portfolio. Values of Ci variable are identified in a way that stocks with first priority are posited in the combination of optimum portfolio. Then, stocks with first and second priority are identified. Then, stocks with first, second and third priority are determined in the combination of the optimum portfolio. When the stocks of a desirable portfolio were identified, the percent of investment on each share was calculated.

3.4.4. Calculating optimum portfolio of DEA

DEA has different models. Used model in this study is the model of return to input-centered constant scale. Regarding research literature, ratio of price to income, beta and sigma coefficients as the input and return and income rate of each share entered DEA model as outputs.

3.5. Model results

Gathering data and information of study companies, they were classified in Excel software. To analyze data of Markowitz, VAR, and sharp models, MATLAB and DEA SOLVER software were used. After portfolio formation and calculating return, risk, and their variation coefficient, it was concluded that VAR has the best situation (it must be mentioned that in this regard, high return is desirable but about the risk and its variation coefficients, lower values are desirable).

3.6. Hypothesis test

Table 1. Results of Markowitz model-minimum risk and VAR model

model	Rank mean	Rank sum	sig
Markowitz model-	0.901	9.01	**0.147**

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minimum risk			
VAR model	0.701	7.01	

Table 2. Results of Markowitz model-minimum risk and DEA model

model	Rank mean	Rank sum	sig
Markowitz model-minimum risk	0.901	9.01	**0.194**
DEA model	1.54	15.40	

Table 3. Results of Markowitz model-minimum risk and Sharp model

model	Rank mean	Rank sum	sig
Markowitz model-minimum risk	0.901	9.01	**0.177**
Sharp model	0.864	8.64	

Table 4. Results of Markowitz model-maximum risk and VAR model

model	Rank mean	Rank sum	sig
Markowitz model-maximum risk	0.894	8.94	**0.168**
VAR model	0.701	7.01	

Table 5. Results of Markowitz model-maximum risk and DEA model

model	Rank mean	Rank sum	sig
Markowitz model-maximum risk	0.894	8.94	**0.182**
DEA model	1.54	15.40	

Table 6. Results of Markowitz model-maximum risk and Sharp model

model	Rank mean	Rank sum	sig
Markowitz model-maximum risk	0.894	8.94	**0.186**
Sharp model	0.864	8.64	

Table 7. Results of Kruskal Wallis

Model	Rank mean
Markowitz model- minimum risk	0.901
Markowitz model- maximum risk	0.894
VAR model	0.701

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Sharp Model	0.864
DEA Model	1.54

This study used qualitative analysis of variation coefficients besides Kruskal Wallis and Mann-Whitney tests for analyzing and ranking portfolios. For examining ranks of five models, Friedman test was used. Results of model comparisons showed that regarding cover surface of Asymp.Sig Test which is 0.147 and above 5%, coordination claim of two models in 10 years is confirmed. Examining portfolio results (return, risk, and variation coefficient) coordination of Markowitz-minimum risk and VAR becomes clear since variation coefficient of VAR in 10 years is very close to Markowitz-minimum risk model. It implies low risk of every return unit. Regarding other results, coordination of VAR and Markowitz-maximum return model and coordinating Sharp and Markowitz-minimum risk model and Markowitz-maximum return results. Results of portfolio (return, risk, and variation coefficient) showed that return and risk of DEA model is significantly different from basic model. Thus, CCR pattern can't be used for selecting an optimum portfolio. For testing reliability of results, Kruskal Wallis test was used and 3 models were ranked based on their selected portfolio. Based on Kruskal Wallis ranking for ten years, results of VAR, Sharp, Markowitz- maximum return, and Markowitz-minimum risk, and DEA models gained the ranks from the highest to the lowest respectively. Thus, VAR and Sharp models are coordinated with Markowitz model in selecting the optimum portfolio. But, DEA model doesn't have the ability of forming the optimum portfolio. Based on Friedman test results whose significance is below 5%, there is a significant difference between the effects of dimensions.

RESULTS

Results of hypotheses tests showed that VAR and Sharp models have the ability of forming the optimum portfolio. During these years, portfolios of these models had higher return and lower risk than Markowitz model. This result agrees with Akgiray and Faf (1998). Tse Yang and Yu (2001). Alexander and Papitsa (2001), Chang (2005), Pocharlef and Plask (2000), Henderix (1996), Angelbert (2003). Badr (1996), Mosavizade (2007), and Karimi (2007) and Khalili (2009) showed positive effect of VAR in ranking stocks and decision-making in selecting the optimum portfolio. Talebnia and Fathi (2010) showed that selecting the optimum portfolio in capital market of Iran is the same via VAR and Markowitz models. Fazlzade et al. (2012) concluded that Sharp model has the ability of forming the optimum portfolio while DEA doesn't have such ability. Jansen (2008) found that one-index model estimates inputs of Markowitz model but DEA doesn't have the ability of forming the optimum portfolio. Since managers want to make sure about maximum loss which they bear and maximum gains that they earn from their investments, the best suggested model based on the findings of this study is VAR model. Financial analysts, stock brokers, and intermediaries are recommended to form different portfolios using mentioned models in this study and analyze their continuance in relation with the ability of gaining return.

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