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Risk, Return, and Portfolio of Selective Industries in Tehran Stock Exchange

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ABSTRACT

Portfolio selection and choosing the proper risk measure is one of the pivotal argument in finance literature and working in the empirical environment. This paper aims to evaluate a portfolio selection with two methods including mean-variance and mean-CVaR to find proper risk measure in Tehran Stock Exchange. So that, nine sectors consisted of the construction, telecom, oil, banking, insurance, leasing, transportation, investment companies, and metal were investigated by using daily data from 2013 to 2018. The results showed that the share of each sector was different in the portfolio by two methods. The mean-CVaR method proposed construction sector in the first rank and mean-variance method ranked telecom sector at the first. Also, the correlation between the two risk measures and returns indicated that CVaR had a high correlation with returns about 0.93 and the correlation between returns and variance was 0.23. So, CVaR was a better than variance as a risk measure from the standpoint of correlation in Tehran stock exchange.

Keywords: Risk, Return, Portfolio, CVaR, Tehran Stock Exchange

Introduction

The goal of an investor is portfolio selection that allocates her/his wealth between different assets in a way that maximizes return and minimizes risk. There are several theories that present a framework for the best allocate of assets. Each theory has its assumptions about risk and return like mean-variance, mean-semivariance [1], mean absolute deviation risk [2], Value-at-Risk model [3], Conditional Value-at-Risk models [4], mean-semivariance-CVaR model [5] etc.

Markowitz [1] for the first time presented the modern portfolio theory (MPT) which was based on mean-variance to maximize return. This theory proposed the variance as the risk measure. Then, Markowitz (1959) introduced semivariance as a risk measure. He argues that this risk measure is better than variance to optimize portfolio [6]. Latter, Konno and Yamazaki [2] demonstrated mean absolute deviation risk as a risk measure for a portfolio optimization model that claimed it could remove difficulties of MPT. Jorin (1996) and Linsmeier and Pearson [3] proposed value at risk (VAR) as a risk measure that measures the amount of risk in given probability. Next, CVaR as a risk measure was used to optimize portfolio by Mansini et al. [7] that considers the expected loss beyond VaR breakpoint. Finally, Najafi and Mushakhian [5] presented a portfolio optimization based on three parameters include the expected value, semivariance, and CVaR at a specified confidence level.

Although there are many theories and methods designed to determine the optimal asset allocation, MPT remains one of the most popular. This study aims to compare two models, one based on mean-variance and the other mean-CVaR in Tehran Stock Exchange. Also, it wants to answer this question that is there a difference between the two portfolios?

The rest of the paper has been structured as the following. Next section presented the literature review and explained different risk measures. Then, the third section included the methodology that described the method to optimize the portfolio. The findings have been explained in the fourth section. Finally, the conclusion has been presented in the fifth section that consisted of results and recommendations.

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Literature

This section has two subsections, the first subsection has reviewed the different risk measures in framework of portfolio selection. Then, the second reviewed different portfolio with a specific risk measure.

Different Risk Measures

Markowitz [1] has presented a portfolio optimization model in modern portfolio theory (MPT). Although there are many theories and methods designed to determine the optimal asset allocation, this model remains one of the most popular. This theory considers the efficient frontier in two states. First, it illustrates combinations of maximum portfolio return given each level of risk. Second, it considers minimum portfolio risk respect to each return level. So, there are two ways to optimize the combinations of risk and return.

Markowitz (1959) introduced semivariance as a risk measure that was better than the variance in some cases. He argued that semivariance led to better portfolios than ones based on variance. Also, he stated that this risk measure is more plausible and because of investors' worry about underperformance rather than overperformance, it is more proper risk measure. Although semivariance has some advantages respect to variance, some features of variance cause that researchers use variance to optimize portfolios. Variance has some advantages respect to cost, convenience, and familiarity [6].

Konno and Yamazaki [2] presented mean absolute deviation risk to optimize the portfolio. Using as a risk measure led to a linear program instead of a quadratic program, so this measure can reduce the number of calculations. The result of this study didn't show any difference with Markowitz's model. In other words, the obtained portfolios were completely same.

Value at risk (VaR) has more background compared with the other risk measures. Linsmeier and Pearson [3] defined VaR as the number of losses in the normal condition of market. Losses bigger than of VaR have a small probability to occur. They have presented three methods to measure VaR including Monte Carlo or stochastic simulation, the variance-covariance, and historical simulation. As a useful feature, VaR can be reported easily in a single number to the boardroom, regulators, and other beneficiaries.

On the other hand, VaR has some weak points, for example, it is unstable numerically when the distribution of losses is not normal. Generally, loss distribution shows the fat fails and or empirical discreteness. Also, VaR doesn't consider to threshold amount which is unable to distinguish between two situations with different risks to this extent [4].

Conditional value at risk (CVaR) or tail VaR introduced by Rockafellar and Uryasev [4] as an alternative measure due to the weak points of VaR. They stated that CVaR considers to the losses in the tail and have some advantages respect to VaR. For instance, CVaR can be expressed by a remarkable formula which is easily used by optimization problems. According to Acerbi and Tasche [8], it is a coherent risk measure. So, CVaR can be defined as an overstep of VaR that measures the maximum risk in confidence level.

Najafi and Mushakhian [5] used a combination of two risk measures consisted of CVaR and semivariance to optimize the return (expected value). They called their proposed model the multi-stage stochastic mean–semivariance–CVaR model. Also, a hybrid of Genetic Algorithm (GA) and particle swarm optimization algorithm were designed to solve the model. Due to the proper choice of parameters, they applied Taguchi (1986) experimental design method.

Different Portfolio with a Specific Risk Measure

There are several studies that tries to enhance modern portfolio theory (MPT) based on mean-variance such as Grubel [9] by using dynamic mean-variance, Levy and Sarnat [10] that have used a locus of efficient portfolios between mean returns and their variances, Merton [11] by introduced Inter-temporal CAPM model, Mayers and Rice [12] that applied security market line benchmark in a CAPM model, and Pastor and Stambaugh [13] that used Bayesian approaches among two risk-based models and characteristic-based model. In an empirical study, Driessen and Laeven [14] used MPT for 52 countries. Findings demonstrated that investors in developing countries allocated their capital outside of country's region and gained from international diversification.

The other studies have used VaR as a risk measure to optimize the portfolio in different ways. For example, Barberis [15] used a VAR model to evaluate the NYSE stock and Treasury bills return by using monthly data from 1952 to 1995. The results of this study showed that investors with 10-year-horizon invest more than those with 1-year-horizon. Other studies tried to developed portfolio selection in VaR framework like Ahn et al. [16], Basak and Shapiro [17], Campbell et al. [18], Alexander and Baptista [19], Chen and Yu [20], and Al Janabi [21]. Campbell et al. [18] developed a portfolio selection model that maximized expected return consider to the value at risk limits that determines by the risk manager. Alexander and Baptista [19] related VaR to mean-variance and used mean-VaR to optimize the portfolio. They concluded that VaR, as a risk measure, is not a perfect risk measure respect to variance.

Finally, some studies used CVaR as risk measure to optimize the portfolio. Mulvey and Erkan [22] evaluated CVaR as a risk measure for decentralized risk management in financial companies. They used a stochastic optimization model and developed the decentralized approach by CVaR and indicated the

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advantages of it over the other risk measures like VaR. Allen and Powell [23] examined the relationship between two risk measures including VaR and CVaR in different sectors in Australia during Global financial crisis. The findings showed that was not correlation between VaR and CVaR outomes. Wang and Huang [24] investigated optimal contract with VaR and CVaR. Findings showed that CVaR didn't change the contractual form and increase minimum insurance premium, but VaR led to change it to double deductible insurance.

Methodology

Data

The database of Tehran Stock Exchange was used to collect data. Data were extracted in daily form and during 2013 to 2018. Nine sectors were selected to optimize portfolio including telecommunications, oil, construction, banking, insurance, leasing, investment companies, transportation, and metal.

Variables

• Risk

This study considered two risk measures consisted of variance and CVaR so that comparing two methods of mean-variance and mean-CVaR. CVaR was preferred to VaR because of its advantages rather than VaR. based on CVaR features, it can show the extreme risk of the distribution. There are two methods to calculate CVaR including parametric method and historical method. Normal distribution is assumed for assets' return when CVaR calculates by the parametric method. But in historical method, returns ranged in ascending order from the minimum value to maximum one at a given confidence level. The historical method will calculate risk better than parametric method if a stock has fat tail distribution. So this study used the historical method to calculate CVaR as the risk measure.

• Return

Return was calculated for each sector by log returns' average for each year from 2013 to 2018.

• Optimization

Markowitz [1] has presented a portfolio optimization model in modern portfolio theory (MPT). Although there are many theories and methods designed to determine the optimal asset allocation, this model remains one of the most popular. This theory considers the efficient frontier in two states. First, it illustrates combinations of maximum portfolio return given each level of risk. Second, it considers minimum portfolio risk respect to each return level. So, there are two ways to optimize the combinations of risk and return. If the minimization objective is considered with variance as a risk measure, the model will be as follows [25]:

$$\min \sum_{i=1}^{n} \sum_{k=1}^{n} \sigma_{i,k} x_i x_k \qquad (1)$$

Respect to:

$$\sum_{i=1}^{n} x_i = 1 \qquad (2)$$

$$\sum_{i=1}^{n} r_i x_i = r_p \qquad (3)$$

$$0 \le x_i \quad i = 1, 2, ..., n$$

Where the covariance between returns on assets i and k, is asset weights, is the assets' rate of return. Weights of assets cannot be negative and the sum of them is 100 percent, is a given level that equals the weighted average expected return of the portfolio.
Markowitz [1] has used variance as a risk measure but this paper used CVaR instead of the variance. CVaR considers the actual losses beyond VaR and as such forms a different optimal combination of assets than the variance-return framework [23]. In other words, CVaR is the average of the worst losses which is higher or the same of VaR. but VaR is only percentage quantile of losses [24]. The CVaR-return efficient frontier is obtained by minimizing CVaR at a selected level of returns:

$$\min CVaR(x), \sum_{i=1}^{n} r_i x_i \ge r_p \qquad (1)$$

Results

Daily average return is presented for each sector from 2013 to 2018 in Table 1.

Table 1
Daily average return of each sector

Construction	Metal	Banking	Transporting	Oil	Telecom	Industry	Leasing	Investment
-0.02%	0.03%	-0.01%	-0.23%	-0.03%	0.08%	0.01%	0.02%	0.03%

As can be seen from Table 1, the maximum value of daily return belongs to the telecom sector with 0.08% and the minimum value belongs to transporting sector with -0.23%. The average of daily return is -0.01%.

Markowitz's portfolio model was calculated to minimize risk based on the above returns. The weights of stocks presented in Table 2.

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Table 2
The weights of stocks for each sector

Construction	Metal	Banking	Transporting	Oil	Telecom	Insurance	Leasing	Investment
19.72%	0.00%	13.47%	0.00%	1.24%	53.93%	7.90%	0.00%	3.73%

As shown in Table 2, the maximum share belonged to Telecom sector with 53.93% and second rank Construction sector with 19.72%. The least share was zero that involved three shares including Leasing, Transporting, and Metal. In fact, Table 2 shows the portfolio based on mean-variance method.

In the following, CVaR as the risk measure was calculated. Next, the portfolio based on mean-CVaR method has been optimized. CVaR of each sector is presented in Table 3.

Table 3
Average CVaR for each sector

Construction	Metal	Banking	Transporting	Oil	Telecom	Insurance	Leasing	Investment
2.29%	6.21%	6.28%	93.23%	4.97%	32.75%	2.71%	4.34%	2.93%

Estimated CVaR measures showed that transportation and telecom sectors had maximum value with 92.23% and 32.75% respectively. Also, the construction sector had the minimum value of CVaR measure with 2.29%. Next, the portfolio optimized based on CVaR as the risk measure. The results indicated in Table 4.

Table 4
The weights of stocks for each sector based on CVaR

Construction	Metal	Banking	Transporting	Oil	Telecom	Insurence	Leasing	Investment
79.14%	0.00%	0.00%	0.00%	3.56%	11.53%	0.00%	0.00%	5.78%

As can be seen from Table 4, the share of five stocks has become zero at the optimized level including banking, transporting, metal, insurance and leasing as the minimum value in the portfolio. Furthermore, the construction sector is 79.14% as the maximum value in the portfolio. Obtained weights are different in two methods. The maximum value of weights in mean-CVaR is the construction sector while the maximum one is the telecom sector in mean-variance. Five sectors' share has zero value with the mean-CVaR method, but there are three ones with zero share with the mean-variance method. Three sectors with zero share in two methods are the same consisting of leasing, metal, and transporting. Correlation has been calculated between return and two risk measures in order to better comparing between the two risk measures for Tehran Stock exchange. Graph 1-4 indicates the relationship between return and the two risk measures.

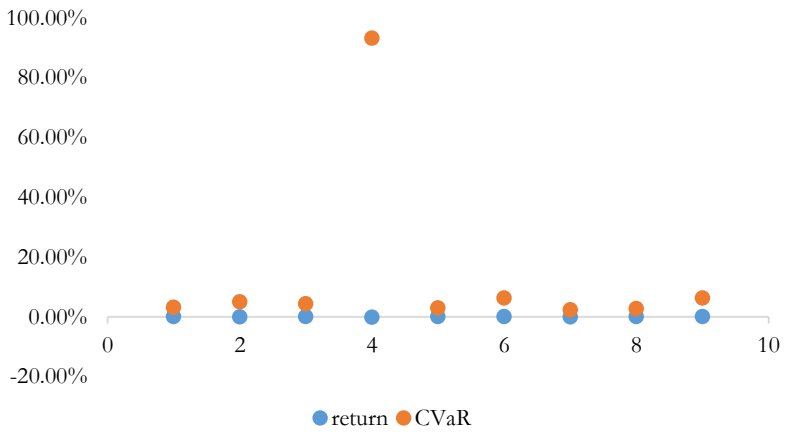

Figure 1. CVaR and return in Tehran stock exchange

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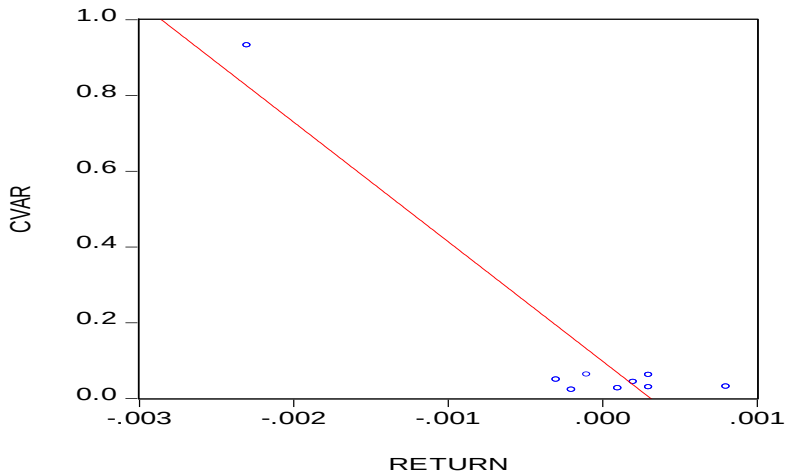

Figure 2. CVaR and return in Tehran stock exchange with regression line

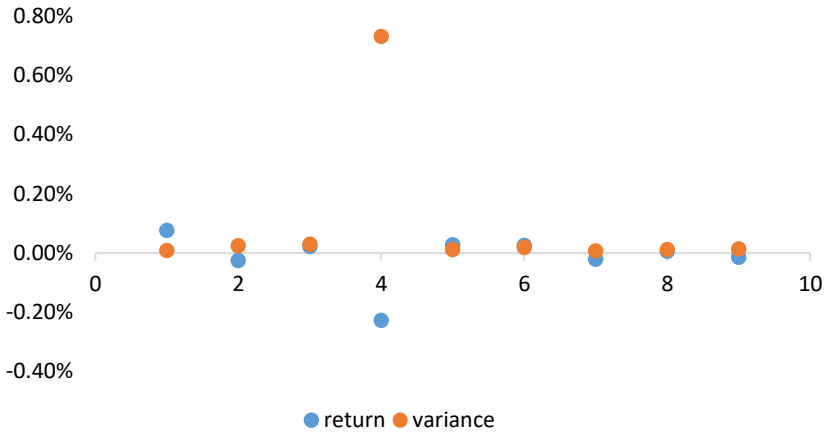

Figure 3. Variance and return in Tehran stock exchange

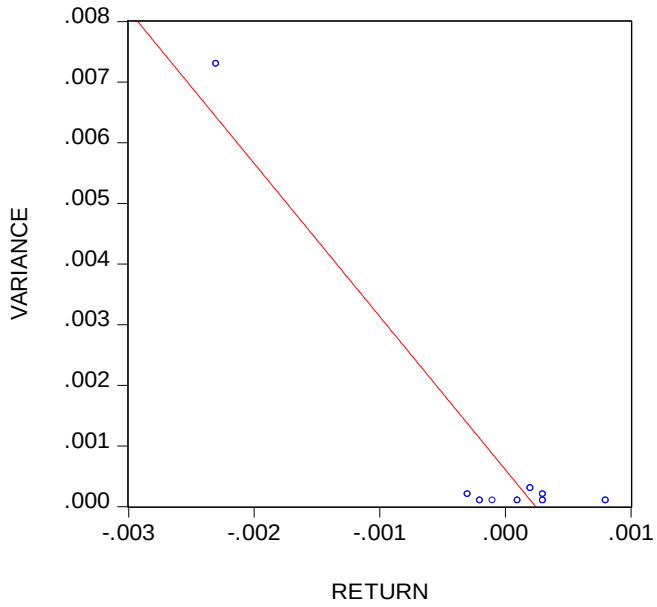

Figure 4. Variance and return in Tehran stock exchange with regression line

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As can be seen from figures 1-4, the relationship between CVaR and return is better correlated than the variance and return because CVaR as a risk measure considers the observations in fat tail of a distribution.

Table 5
Correlation between the two risk measure and return

	CVaR	Variance
Return	0.93	0.23

As shown in Table 5, the correlation between CVar and return is very high and the returns have a relationship with CVaR as the extreme risk. In other words, the returns are sensitive to extreme risk not to volatility that to be represented by variance.

Conclusion

One of the pivotal arguments in finance literature is the portfolio selection and the relationship between risk and return. This paper aimed to investigate selecting a proper risk measure between CVaR and variance to optimize a portfolio consisted of nine sectors in Tehran Stock Exchange. So that, daily data from 2013 to 2018 was used to optimize the portfolio based on the two risk measures. Then, the correlation between the two risk measures and return was calculated.

The results showed that the share of each sector in the portfolio based on the mean-variance and mean-CVaR was different. The share of five sectors was zero in mean-CVaR method and the maximum share belonged to the construction sector. On the other hand, the share of three sectors was zero in mean-variance method and the telecom sector had the most share in the portfolio. Also, the obtained correlation between two risk measures and return indicated that was a high correlation between CVaR and return about 0.93. The value of correlation between the variance and return was 0.23 in Tehran Stock Exchange. In fact, the results showed that CVaR was a better than variance as a risk measure from the standpoint of correlation in Tehran stock exchange.

Findings confirmed the finance literature and suggested the CVaR because it had a high correlation with return and the investors should consider the CVaR other than variance as a risk measure. In addition, the study considered the nine sectors to optimize portfolio by two methods, further studies can compare other risk measures and in companies of a single sector. The other suggestion is comparing risk measures in different markets or assets like gold, foreign exchange.

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