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Presenting a combined econometric model to optimize the stock portfolio in the stock exchange

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ABSTRACT

Purpose: Portfolio optimization is one of the important issues in the field of financial sciences and investment, which has many applications in financial planners and decisions. By choosing a suitable stock portfolio, it is possible to greatly increase the efficiency of investment (in terms of increasing returns and reducing risk).

Methodology: In this paper, by presenting a model of liquidity risk, using the concept of diversification in the form of Shannon's entropy and econometric approach, an optimal portfolio of investment with the lowest risk and the highest return has been presented in the form of a portfolio. To calculate the liquidity risk, using multivariable methods, the variance-covariance matrix of price index returns and price gap was calculated and used in the presented model, and finally, the optimal weight was used using the optimization method and meta-heuristic algorithm of non-dominant ranking of the second version., calculated for selected industries.

Findings: The output results of the model show that the optimal weight of the groups that have less variance in the optimal portfolio is higher.

Originality/Value: Besides, the effect of removing the concept of liquidity from the model leads to an increase in the weight of industries that have less liquidity, and along with the increase in risk, the return of the optimal portfolio also increases in this case.

1. Introduction

Portfolio optimization is one of the important issues in the field of financial and investment issues and has many applications in the field of capital management. Stock selection is done in different ways for everyone. Some choose their shares according to the past of the share, and some consider the liquidity and cash profit of the share. Besides these, the role of analysis is very prominent and people buy stocks using technical and fundamental analysis [1] . After the stock portfolio is formed, it can be optimized

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through methods and get the highest return, this is what is called stock optimization. Achieving long-term and continuous growth in the economy of a country requires the preparation and optimal allocation of resources at the macroeconomic level of that country, and this is not possible without the help of financial markets, especially the extensive and efficient capital market. In a healthy economy, the existence of an efficient financial system plays an essential role in the proper distribution of capital and financial resources. Financial markets are usually defined as a system composed of individuals and institutions, tools and procedures that gather savers and borrowers in one place. One of the most important financial markets is the stock market [2]. In today's financial world, in order to invest in stocks, acquiring knowledge, reducing costs, choosing superior and more profitable stocks and optimal use of capital are an integral part of investors' actions and activities.

Therefore, the most important goal that countries and societies are trying to achieve is investing in the direction of economic growth and development. The necessity of investment for the economic growth and development of any country is also undeniable [3]. Not only a country needs different investments to achieve progress, but also the people of the society should invest in different dimensions to achieve more benefits than what they have now. In order to benefit as quickly as possible from the benefits of investment at any level, the investment should be as effective and optimal as possible. In order to achieve the category of optimal investment, a variety of investment fields (assets) must be created, which is called a portfolio (portfolio) or asset basket. One of the important issues in financial management is optimal investment and diversification of assets in the investment portfolio, which reduces investment risk. Reducing investment risk can affect investment returns, and therefore since the introduction of Markowitz's theory and even before that, the concept of optimal investment as a balance between risk and return was taken into consideration [4]. During these several decades, new standards, interpretations and concepts of risk have been proposed; While with the expansion and progress of other fields of knowledge, new approaches have been invented in the field of calculations related to the concept of risk. On the other hand, one of the results obtained from the financial crises was to pay attention to the issue of liquidity of assets, and therefore, from this point of view, introducing the concept of liquidity to The title is one of the risk indicators and criteria that can be justified [5].

This research examines the selection of an optimal portfolio using the liquidity criteria for a portfolio and while presenting a model that includes the concept of liquidity based on value at risk, it tries to answer the basic question that the weight and amount of stocks that are They have less liquidity, how is it in the optimal portfolio?

In this research, an attempt has been made to provide a model for achieving the optimal portfolio by using Markowitz's general approach and including the liquidity criterion, as well as paying attention to the concept of portfolio diversification; Also, due to the existence of heterogeneity of variance in financial data, econometrics, and multivariate methods have been used to calculate conditional variance-covariance matrices in the model.

2. Literature Review

Today, environmental uncertainty and intense competition have made organizations face many challenges. For the effective management of these challenges, new management approaches have been recommended. Risk identification and management is one of the most important approaches that is used to strengthen and improve the effectiveness of organizations in this field [6].

Despite the simplicity and intuitive revision of the investment portfolio structure that uses modern portfolio theory, it will take many years for portfolio managers to use portfolio optimization for real money management. In the real world, there are many concerns regarding its use and portfolio optimization; Because many users find it impractical to use. The dimensions and scope of the concept

of risk have expanded over several decades so since the introduction of the portfolio theory by Markowitz, different criteria for risk have been proposed. Some of these risk criteria are under the title and concept of adverse risk, which, although it was the focus of researchers and financial thinkers for many years, later became the basis of the post-modern portfolio theory. In the subset of this category of risk criteria, there is the criterion of value at risk and value at risk of liquidity, which these two criteria received a lot of attention after the financial crisis [7]. The main characteristic of financial crises is the record in the markets and the impossibility or low liquidity of assets in this era, and this feature is very important for an investor. An investor is looking for this feature of the market and property to convert his invested assets into cash at the appropriate time with the minimum cost and the minimum possible time. Therefore, liquidity risk and the number of assets that are at risk due to this risk are important for investors [8].

Value at risk is a conventional approach to risk calculation. Incorrect estimates of the value at risk of asset portfolios can lead companies to maintain insufficient capital reserves to cover their risks. Asset liquidity is the ability to quickly trade a large number of securities with low cost and low price impact. The effect of low price means that the price of the asset does not change much between the order and the purchase.

The risk related to market liquidity can be divided into exogenous liquidity and endogenous liquidity. In both categories, risk or illiquidity is related to the price gap, but a fundamental difference in the formation of the price gap in the markets differentiates between these two categories. Today, most of the countries in the world, including the United States, the European Union, and many Asian countries use a risk-based financial monitoring system, and the proper creation and implementation of such a system require the identification and appropriate modeling of various risks. Basically, the topic of stock portfolio optimization is a highly researched topic with many dimensions. Many researches have been done on the general topic of stock portfolio optimization, but in terms of using the issue of liquidity in this research, it has tried to examine the history of research that includes this feature in the past few decades [9].

In the issue of using the liquidity criterion as one of the portfolio selection criteria, some researchers conducted research titled "Portfolio selection using the three criteria of average return, the standard deviation of return and liquidity in Tehran Stock Exchange". In this research, it has been stated that: Among the criticisms that were made to the Markowitz model, it was that in this model, only two criteria, the average and the standard deviation of returns, are considered. This is while investors actually pay attention to various criteria when forming a portfolio [10]. Liquidity is one of the most important criteria investors pay attention to when forming a portfolio. This research aims to use the liquidity criterion in the model proposed by Markowitz using two approaches of filtering and liquidity limitation in the Iranian capital market and finally reach a model that, by using it, investors can form a portfolio that is Efficiency, risk, and liquidity should be optimal. The results of the research show that liquidity at high levels is effective on investors' decisions and therefore affects the efficient frontiers [11].

Other researchers also investigated the optimization of the investment portfolio of selected industries in the stock exchange. In this research, four industries of petroleum products, automobiles, parts manufacturing, electrical machinery and metal mineral extraction were selected. In order to investigate the issue, the researchers first estimated the time-varying conditional covariance matrix based on heterogeneous multivariate models. Then portfolio optimization was done with the risk minimization approach of the stock investment portfolio based on Markowitz's portfolio theory and the optimal weights of selected multiple industries were determined over time. The results of the optimization have shown that in all three mentioned models, more weight in the investment portfolio has been allocated

to industries that have less fluctuations in the stock returns of those industries. Also, the optimal weight has been decreasing over time for industries whose efficiency fluctuations have increased, and on the contrary, if the fluctuations in efficiency have decreased over time, the optimal share of the portfolio has increased [12].

Some other researchers focused on the optimization of the investment portfolio using the multivariable Markowitz and multivariate model. They show that whenever there is less risk in any of the industries, their share in the investment portfolio is higher. In addition, among these four industries, the highest share is related to the non-metallic mineral extraction industry, and the metal mineral extraction industries, multi-disciplinary companies, and the chemical materials and products industry are in the next positions, respectively [13].

3. Research Methodology

The main goal of this research is to achieve an optimal portfolio through the following model. The feature of this model is to include the liquidity criterion for an optimal portfolio. In fact, this model is a three-objective function, which includes minimizing liquidity risk, maximizing portfolio returns, and increasing diversification using Shannon's entropy criterion.

$$\begin{cases} Min(LVaR_p) = z_\alpha \sqrt{W^T H_r W} - W^T \overline{R} + \frac{1}{2}(W^T \overline{R}_S + z_\alpha \sqrt{W^T H_s W} \\ Max\ R_p = \sum_{i=1}^{N} w_i R_i \\ Max\ E_s = -\sum_{i=1}^{N} w_i \log(w_i) \\ \quad Subject\ to: \\ \quad \sum_{i=1}^{N} w_i = 1\ ,\ w_i \geq 0 \end{cases} \quad (1)$$

$LVaR_p$	The amount of value exposed to the liquidity risk of the portfolio
N	Number of assets
W	Portfolio weight vector and W^T transpose vector W
H_r	Variance-covariance matrix between industry efficiency i and j
H_s	The variance-covariance matrix of the price gap of buying and selling industry i and j industry
$\overline{R}$	The mean vector of the expected price return of industry i
$\overline{R}_s$	Average return vector of the expected price gap of industry i
z_α	confidence yield ($confidence\ Level$) in standard normal distribution
$\overline{R}_p$	Expected portfolio return
E_s	Shannon entropy index value

To optimize the portfolio using the above model, given that the data has variance heterogeneity, multivariable models are used to estimate the variance-covariance matrix. For this purpose, EViews software was used to estimate multivariable equations and the best estimation method was selected according to the information criteria of the variance-covariance matrix for modeling.

4. Research findings

For classification and ease in naming *EViews* software files and subsequent references, the four groups of selected industries have been named as follows. Also, *pir* suffix is used for price index data and *sir* suffix is used for price gap data.

Table 1: Symbolization of groups

Groups	Group 1	Group 2	Group 3	Group 4
symbol	Fa	B	Fn	Kf

In the study of descriptive statistics and the trend of price index and price gap data changes in the selected groups, it can be seen that the value of skewness and elasticity of all four data series has a significant difference from the corresponding values in normal data, where the value of zero is for skewness and the value of three is for elasticity. The statistic clearly shows that the null hypothesis of normality of the data of all four data series in both categories of price index and price gap is rejected with a high percentage of confidence.

Table 2: Statistical description of price index data

	FA-PIR	B-PIR	FN-PIR	KF-PIR
Mean	0.002574	0.001754	0.002478	0.002657
Median	0.0011255	-0.00014	0.000453	0.000012
Maximum	0.059872	0.05863	0.084542	0.077525
Minimum	-0.5124151	-0.04571	-0.624712	-0.514212
Std.Dev	0.017854	0.01542	0.031241	0.018452
Skewness	0.055421	0.25412	-0.541231	0.307725
Kurtosis	3.254123	4.98452	2.987412	3.557412
Jarque-Bera	38.74212	122.54123	6.992122	58.12415
Prob	0.00000	0.000000	0.012221	0.00000
Sum	3.612145	2.213252	3.042158	2.992514
Sum sq. Dev	0.398475	0.325471	0.553524	0.498745
Observations	1184	1184	1184	1184

Figure 1: Chart of price index data

Table 3: Statistical description of price gap data

	FA-SIR	B- SIR	FN-SIR	KF- SIR
Mean	-6.32425	-5.652141	-6.12415	-6.15847
Median	-5.42158	-5.63254	-6.02145	-6.25417
Maximum	-5-0368	-3.25142	-4.21251	-4.21541
Minimum	-8.26541	-9.12514	-11.4854	-8.32541
Std.Dev	0.58416	1.352141	0.97215	0.82541
Skewness	-0.45841	-0.54122	-0.79421	0.45741
Kurtosis	2.32514	1.987451	4.21452	2.77841
Jarque-Bera	18.6532	72.6542	218.990	45.3254
Prob	0.00011	0.00000	0.0000	0.0000
Sum	-8160.52	-8254.54	-6854.52	-8001.136
Sum sq. Dev	937.621	2357.524	1245.251	1174.845
Observations	1184	1184	1184	1184

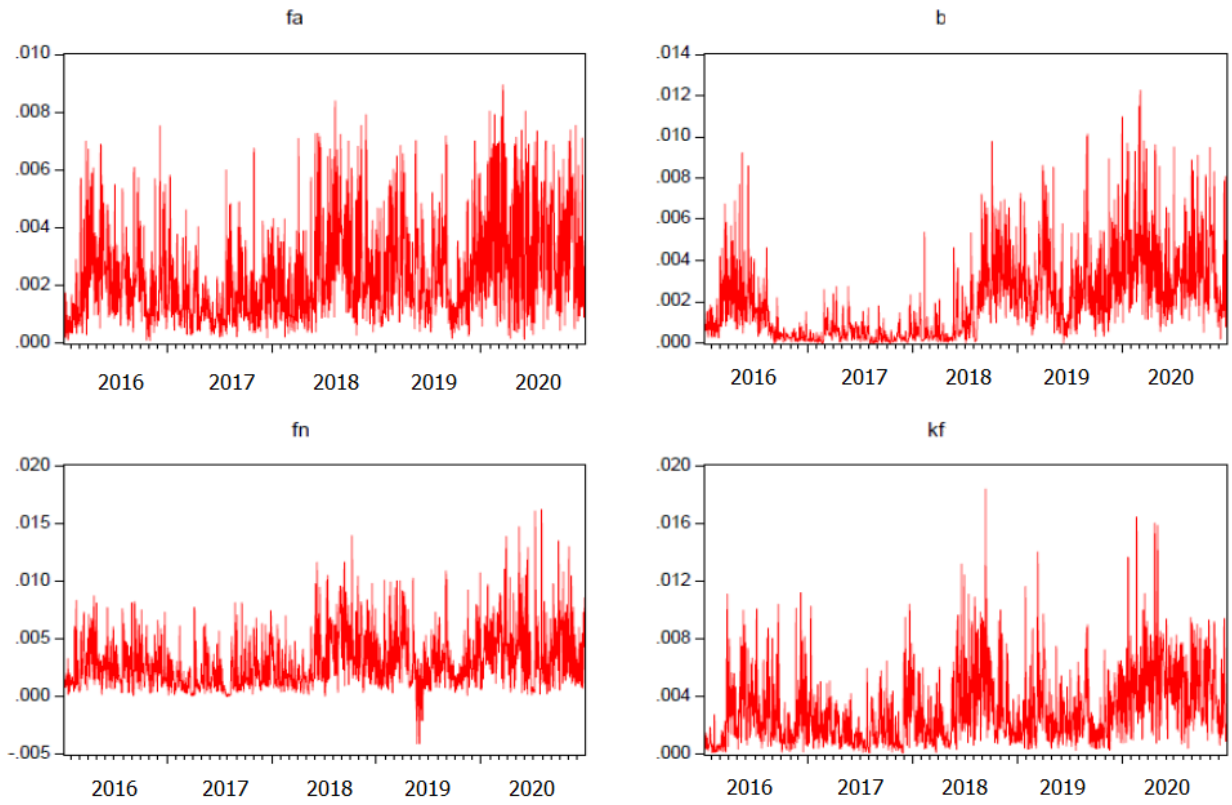

Figure 2: Chart of price gap data

Due to the heterogeneity of variance and the number of variables and the effect of these variables on each other, our modeling is based on multivariate GARCH methods. In multivariate GARCH methods, we are faced with a set of mean equations and a set of variance equations. To model the mean equations, since the effect of the variables is not based on any theory or theory about the variables, we have to use the existing data for modeling, in other words, the data itself must explain their behavior. Therefore, we use VAR models to model variables in mean equations; Meanwhile, the correlation matrix between the data time series shows that the returns of the selected industries are correlated both in the price return data and in the price gap data.

Considering that the coefficients of this group of equations are calculated as mean equations next to the coefficients of the variance equations; For this reason, we only need to estimate the optimal interval from this group of equations, and later, along with the variance equations, the coefficients of the mean equations are extracted using multivariate GARCH methods. Based on the output taken from the software, the number of optimal intervals for modeling price index variables The selected industries are an interval, and therefore each variable of the four variables of price indices is a function of a previous interval of its own and a previous interval of other variables.

Also, based on the output from the software, the optimal number of breaks for modeling price gap variables of selected industries is three breaks, and therefore each variable of the four variables of price indices is a function of its three previous breaks and the three previous breaks of other variables.

Generalized Dickey-Fuller test is used as the most widely used unit root test to test the mean value of the yield series. In this test, the null hypothesis is the existence of a unit root (invariance) and the opposite assumption is the absence of a unit root in the time series. Therefore, if the test statistic does

not have a significant distance from zero, the null hypothesis will not be rejected, otherwise it will be rejected.

The complete implementation of the research model and the examination of the results for the average optimal weights in this case for the selected industries show that the average weight share of the industries that have less volatility in the optimal portfolio is higher. In fact, the results show that the industries that have more stability in their stock prices, or in other words, less fluctuations in their stock returns over time, have more weight in the optimal portfolio. Besides, in this case, liquidity risk is also included in the model, that is, optimal weights are chosen so that liquidity risk is less.

Table 4: The optimal weight of the selected industries in the optimal portfolio considering the complete restrictions

	fa	b	fn	kf
$Std.Dev$	0.017	0.015	0.31	0.018
$Opt.W$	0.25	0.3	0.2	0.23

The implementation of the research model in this case, that is, by removing the liquidity limit and examining the results for the optimal weights for selected industries, shows that by removing the liquidity limit, the average weight share of the oil products industry and the metal ore industry increases compared to the previous state, and this seems to mean Let it be that (considering that the liquidity limit has been removed) these two industries have less liquidity, while the average portfolio return and value at risk in this case (elimination of the liquidity limit) also increases.

Table 5: The optimal weight of selected industries in the optimal portfolio considering liquidity restrictions

	fa	b	fn	kf
$Opt.W$	0.25	0.28	0.21	0.25

The research shows that the average weight of the selected industries in the optimal portfolio changes, but this change is not very noticeable and it seems that this limitation can be ignored in the model.

5. Conclusion

In this research, an attempt has been made to present a model of liquidity risk and an econometric approach, and considering the limitations of the multivariate method, the optimal portfolio of the 4 selected groups of the Tehran Stock Exchange, which have the highest market value of the Iranian Stock Exchange; In addition, by using the Shannon entropy index as an index to diversify the stock portfolio along with the liquidity risk index, the optimal portfolio should be selected with more precautionary considerations in terms of risk.

Using the estimates made and calculating the necessary inputs for the model (using the DBEKK method estimates) and optimizing the model in the MATLAB environment using the NSGA-II multi-objective genetic algorithm, the results of the full implementation of the research model and the examination of the average results of optimal weights for industries selected, shows that the average weighted share of

industries that have lower yield fluctuations is higher in the optimal portfolio. In other words, the results show that industries that have more stability in their stock prices, or in other words, less fluctuations in their stock returns over time, are weighted in The optimal portfolio increases. In fact, in this case, the optimal weights are chosen so that the liquidity risk is lower. By removing the liquidity restriction, the average weighted share of the oil products industry and the metal ore industry increases compared to the previous state. And it seems that This means that (considering that the liquidity limit has been removed) these two industries have less liquidity, while the average return of the portfolio and the value at risk also increase in this case. Also, by removing the limitation of diversification in the form of Shannon's entropy index, the output results show that the average weight of the selected industries in the optimal portfolio changes, but this change is not very noticeable and it seems that this limitation can be ignored in the model. In future researches, with the help of the TOPSIS method, the weights obtained in each industry can be distributed among the different companies of that industry by considering the standards and referring to the opinions of the experts of that industry by compiling a suitable questionnaire. In this way, by combining a survey research with this research, the limit of the number of stocks in the portfolio can be lifted to some extent.

Conflicts of Interest

None.

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