Combination of DEA and ANP-QUALIFLEX Methods to determine the most Efficient Portfolio (Case study: Tehran Stock Exchange)

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ABSTRACT

The existence of an active and prosperous capital market is always recognized as one of the signs of international development in the countries. The most important issue faced by investors in these markets is the decision to choose the appropriate securities for investment and formation of optimal portfolio. The rating of companies accepted in stock exchange is a complete mirror of their status and is a measure of investment. This will increase the competitiveness, development and market efficiency.

In this research, the top 20 companies listed in Tehran Stock Exchange during the third quarter of 2015 are ranked according to financial ratios. In previous studies, optimal portfolio has been determined using data envelopment analysis models and multi-criteria decision making techniques, but the present study combines these two techniques to evaluate and determine the most efficient portfolio. Accordingly, the performance scores of each model are obtained using one of the data envelopment analysis model and then, the weight of each index is obtained using the network analysis process through multi-criteria decision-making techniques.

Keywords:

Ranking, Optimal Stock Portfolio, Data Envelopment Analysis, Multi-criteria Decision Making, Network Analysis Process.

1. Introduction

The existence of an active and prosperous capital market is always recognized as one of the signs of international development in the countries. In developed countries, most investments are made through financial markets. The active participation of people in the stock market ensures the life of the capital market and sustainable development of the country. The most important issue faced by investors in these markets is the decision to choose the appropriate securities for investment and formation of optimal portfolio. Therefore optimal portfolio selection is one of the most significant issues in finance. The investment process in a coherent state,

It involves an analysis of the main nature of investment decisions. In this case, activities related to the decision-making process are decomposed and important factors in the field of activity of investors that affect their decisions are examined. The rating of companies accepted in stock exchange is a complete mirror of their status and is a measure of investment. This will increase the competitiveness, development and market efficiency.

Given the developments that have taken place in the world today, Countries, especially developing countries facing numerous threats, need to find suitable solutions for solving their economic problems in order to better utilize their Goddess facilities and wealth. In this regard, one of the important ways to expand investment. It should be said, Deciding on buying a share is complicated because several variables such as rate of return on capital, earnings per share, the ratio of the price to profit of each share and other factors should be taken into account. Since a set of variables is considered for decision making, a multi-criteria decision making method should be used. The data envelopment analysis method, which is one of the multi-criteria decision-making methods, makes this possible. Based on this method, the best options can be specified. The main purpose of portfolio management is to help investors in selecting the optimal portfolio. In this regard, analyzing the current and past affairs of companies and identifying the most efficient companies, according to some criteria, will be of great help to investors.

The selection of optimal portfolios is one of the most important issues discussed in the past and present, and with the research done in this field, there are some models for determining portfolios that their deficiencies have been detected over time and have been replaced by other models. One of the main problems of the presented models is the ignorance of multiple indicators and dimensions for the final evaluation of stock portfolios, which in turn undermines the validity of the results of the evaluation. In this research, it is tried to identify financial factors affecting decision making on optimal portfolio selection and combine data envelopment analysis (DEA) and multi-criteria decision making (MCDM) for evaluating and selecting the optimal portfolios of shares of companies accepted in Tehran Stock Exchange in order to eliminate the deficiencies mentioned above (Khajavi et al., 2005).

2. Literature Review

The theory of portfolio selection was created by Markowitz in 1952. Markowitz established the basis of the aforementioned theory on the basis of optimizing the risk and return of a portfolio of several financial assets. The main task of the portfolio selection model was to allocate cash between different portfolios in such a way that risk and return on the portfolio would be optimized (Aoni, 2009).

Markovitz assumes in his choice of portfolios that all investors make their choices based on two criteria of risk and return. However, many studies have criticized all of the other investors' preferences in the Markowitz model. Considering the above mentioned issues about the problems in choosing the optimal portfolio, the present study attempts to take into account stock returns, earnings per share, price / profit ratio and return on assets in the optimal portfolio selection process will be examined.

In previous studies, using the data envelopment analysis techniques (Khojavi and Moghaddam, 2012) and multi-criteria decision-making techniques (Amiri et al., 2010), the optimal portfolio was determined, but in the present study, by combining these two techniques into evaluation And determining the most efficient stock portfolios. Using the combined technique of VIKOR and DEA, Foroughi et al, could rank international airports in Iran. Thus, each of the effective factors was assigned a certain weight using VIKOR, then, by combining the input and output factors and solving each of the models individually, the effects of the factors on the efficiency of the airports were analyzed (Foroughi et al., 2012).

In the research, Lee and Zhou first measured the technical efficiency of Chinese coal companies using the data envelopment analysis technique, and then examined the relationship between the efficiency and capital structure of the companies. The researchers showed that there is a relationship between the capital structure and the technical efficiency. They also showed that the investigated companies should create a certain debt ratio, so that if the debt ratio is higher than that, the technical efficiency will be reduced. (Li and Zhou, 2011)

Lee et al, studied the performance evaluation of airports using the DEA-AR-AHP combination technique, and by providing a questionnaire and expert opinions, identified factors affecting the efficiency of airports, and attributed weights to each of the factors using the AHP technique. Then, using weights, the upper and lower limits were considered for each DMU and they ranked airports as a constraint using the BCC model (Lee et al., 2015).

3. Methodology
3.1. Data Envelopment Analysis

Data Envelopment Analysis is a technique used to assess the efficiency of homogeneous organizational units with multiple inputs and multiple outputs referred to as decision-making units (Cooper et al., 2000). However this technique is a powerful managerial technique that provides managers with a device so that they could test the function of their companies against their competitors, and make decision for the better future based on the results (Jafarian-Moghaddam et al., 2011).

3.1.1. Free Disposal Hull (FDH) Model

The FDH model is another form of data envelopment analysis model. Its main characteristic is the non-existence of the principle of convexity in the set of production possibilities. This model is also known as the VRS variable model among DEA models and is represented by a integer planning problem . The FDH model will be as follows

$\text{Min } \theta_0$

(1)

s. t.

$$\sum_{j=1}^{n} \lambda_j x_{ij} \leq \theta_0 x_{i0}$$

$$\sum_{j=1}^{n} \lambda_j y_{rj} \leq y_{r0}$$

$$\sum_{j=1}^{n} \lambda_j = 1$$

$r=1,\dots,S$

$j=1,\dots,n$

$i=1,\dots,m$

$\lambda_j \in \{0,1\}$

3.2. Multi-Criteria Decision Making

Decision process can be defined as a set of actions and methods dynamically organized. Although the decision-making problem could be constructed as more than one hierarchy with different criteria. The minds of researchers from recent decades (1970) have focused on multi-criteria decision models (MCDMs) for complex decisions. In these decisions, instead of using an optimality measure, several criteria are used. In fact in multi-criteria decision problems our interest is in selecting from some set of alternatives the one that best satisfies the criteria.

3.2.1. Analytical Network Process Analysis (ANP)

The ANP method is the generalization of AHP method, but does not require a hierarchical structure. With AHP, a problem is modeled as a hierarchy, in which the nodes of each level may represent factors or decision alternatives. Accordingly ANP represents more complex relationships between different decision levels in the form of a network and considers interactions and feedback between the criteria and the alternatives.
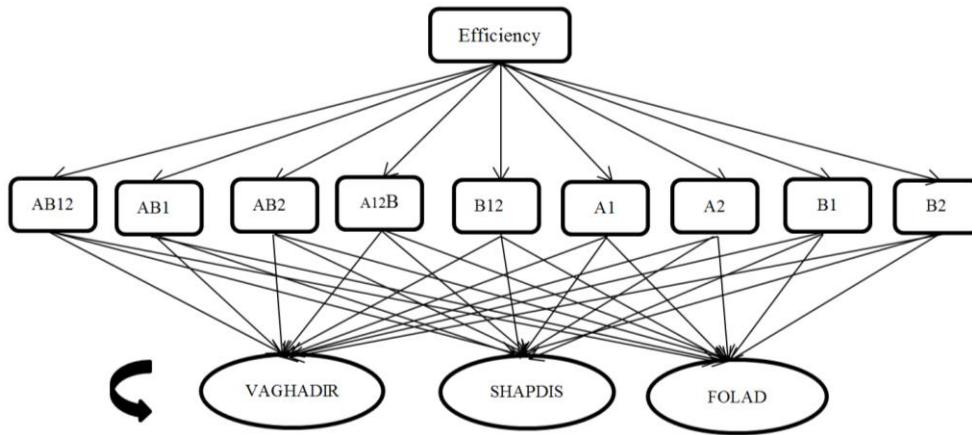
Fig 1. Network Process analysis

3.2.2. QUALIFLEX Method

In this method, first, different permutations of options are formed. In the next step, the options are ranked according to the indexes so that if the option is better than the rest in terms of one of the indices is ranked first and so are the other options. The dominant and non-dominant values are obtained by comparing permutations and rankings.

The obtained results are placed in a matrix having the information of indices and permutations, and the sum of the values for each permutation is calculated, which represents the priority of the permutations.

Model Features: This method is similar to the permutation method on the boundary between compensatory and non-reciprocal methods. In this way, the indicators should be independent and there is no need to convert the quality indices into quantitative ones.

Description of the model: Possible permutations are made up of the existing m option, for example,

if m = 3, then
$$m! = 3! = 6 \qquad (2)$$

Therefore, with the assumption of 3 options, the permutation options are as follows:

$$per_1 = \{A_1, A_2, A_3\} \qquad (3)$$
$$per_2 = \{A_1, A_3, A_2\}$$
$$per_3 = \{A_2, A_1, A_3\}$$

$$per_4 = \{A_2, A_3, A_1\}$$
$$per_5 = \{A_3, A_2, A_1\}$$
$$per_6 = \{A_3, A_1, A_2\}$$

Ranking of options based on indicators: At this stage, the decision matrix given by the decision maker. Based on the strengths, the ranking is better than the other one, and the other options are ranked. Calculation of dominant and recessive values: If the permutation matches the values of the value, then the value of 1 and if it does not match, the value of -1 and the time when the two options are equal in one index is assigned zero. for example, Suppose, in the first index and the hypothetical permutation we have the following values:

$$g_1 = \{A_1, A_2 = A_3\}, per = \{A_1 > A_2 > A_3\} \qquad (4)$$
$$A2 < A1 \rightarrow -1$$
$$A2 = A3 \rightarrow 0$$
$$A3 < A1 \rightarrow 1$$

In permutation, A2> A1, in the ranking of the first index A2 <A1, and since this value does not match the ranking of the indices, it takes -1. Also, A2 = A3, and therefore takes the value of zero, and finally, in the prompt A3 <A1, and in the index of the first index, A3 <A1, which is also consistent and therefore takes +1.

Formation of permutation Matrix and Indicators: The calculated values in the previous step are summed

up and broken down into all the permutation and indicators and entered into the table.

Calculate the amount of permutation options and select a superior option: then the amount of permutation of each indicator is multiplied by weight and combined, and is introduced as a permutation, the highest of which will represent the superior option. Chart of the proposed method
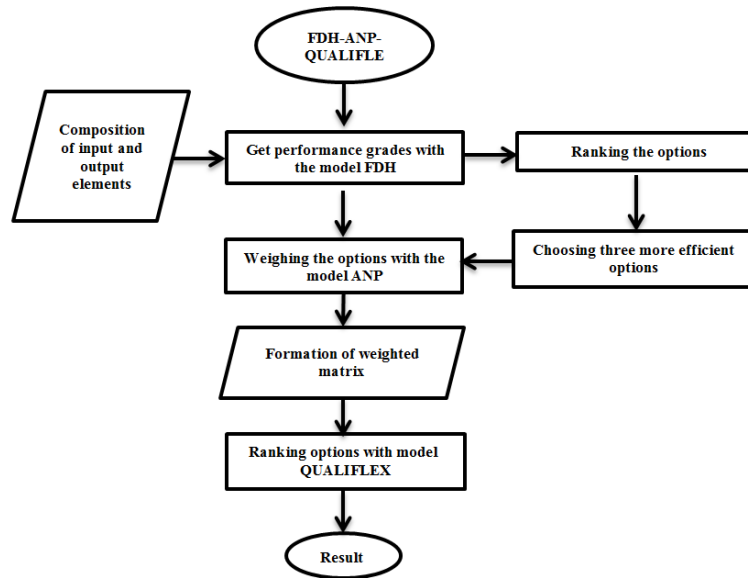

Fig 2. Chart of the proposed method

3.3. Introduction of Performance Measurement Criteria

In the efficient market, stock prices are determined in the stock market. In other words, when the seller's supply crosses the buyer's request, there are no definite rules that characterize the behavior of stock prices, but there are several factors that influence the stock prices' upward or downward movement. These factors fall into three general categories of fundamental variables, technical variables, and emotional variables.

3.3.1. Fundamental Variables

EPS and P / E: In an efficient market, stock prices are primarily determined by the fundamental factors that are derived from the combination of the two basic variables of earning per share (EPS) and price to earnings ratio (P / E) per share.

ROE: Among the fundamental parameters, one of the most important ratios is the return on equity (ROE), which indicates the management of the company in the efficient use of investors' money. ROE

indicates that the management of the company was able to increase the company's value as acceptable or not, which is calculated as follows:

$$(5)$$
$$\text{Return on Equity} = \frac{(\text{Net Annual Income})}{(\text{Total Equity of the Company})}$$

ROA: Return on assets is an indicator of how profitability of the company relies on its total assets. One of the ratios that shows management efficiency is the return on assets, which reflects the profit earned per unit of the company's assets. Assets include cash, accounts receivable, property, machinery and inventory. ROA is calculated as follows:

$$\text{Return on Asset} = \frac{(\text{Net Annual Income})}{(\text{Total Assets})} \quad (6)$$

3.3.2. Technical Variables

Technical variables are in fact a combination of external conditions that affect stock supply and demand. Some of these factors indirectly affect the

fundamental factors (for example, the growth of the economy is effective in corporate income growth). Technical variables are as follows: inflation, situation of the industry, alternative markets, age, and liquidity.

3.3.3. Emotional Variables

Emotional variables examine the psychological conditions of stock market activists (individual and collective). In sum, short-term investors usually use the technical variables to select the stock, while long-term investors benefit from fundamental variables for decision making. Of course, these investors may use technical variables along with a fundamental variable (Stock Exchange organization, 2015).

4. Results

In this section, the information gathered from the statistical population is analyzed using the FDH-QUALIFLEX combined technique. The time domain of the study is a three-month period, which begins in September 2015 and ends on December 2015 (the third quarter of 2015).

4.1. Introducing the List of 20 More Active Companies in Tehran Stock Exchange

First, data envelopment analysis is used to rank the options. The following table is the top 20 companies in Tehran Stock Exchange, extracted from the Tehran Stock Exchange organization.

4.2. Calculating Input and Output Elements of the FDH Model

After introducing the top twenty companies by the stock exchange organization, these companies are re-ranked using the FDH model. First, the input elements and output elements are determined.

The first two components (P, P / E) are considered as inputs and the next two components (ROE, ROA) as output. Inputs are named A and B, and outputs are named 1 and 2, respectively. The inputs are extracted from the Tehran Stock Exchange website and outputs are obtained according to the financial statements presented on the Tehran Stock Exchange website using the presented formulas. For example, the Fars symbol that is related to Persian Gulf Petrochemical Company is examined.

table1. top 20 companies in Tehran Stock Exchange in 2015

Row	Company Name	Symbol	Activity indicator
1	Persian Gulf Petrochemical Industries	FARS	14.710
2	Investment in GHADIR (holding)	VAGHADIR	9.191
3	Mellat Bank	VABEMELT	7.388
4	Mobile communication company	HAMRAH	6.976
5	SADERAT BANK OF IRAN	VABSADER	6.796
6	Steel Mobarakeh Isfahan	FOLD	6.220
7	Iran Telecommunication	AKHABER	5.914
8	Oil and gas and petrochemical supplies	TAPICO	5.876
9	Expansion of oil and gas	PARSAN	5.552
10	Mapna Group (Public Joint Stock Company)	RAMPNA	5.402
11	Mobin Petrochemical Co.	MOBEN	5.329
12	Purification of Bandar Abbas Oil	SHABANDAR	5.221
13	Shipping of the Republic of Iran	HKESHTI	4.767
14	National Copper Industry of Iran	FAMLI	4.661
15	Isfahan oil refining	SHAPNA	4.228
16	Pasargad bank	VAPASAR	4.162
17	Iran Khodro	KHODRO	4.009
18	Pardis petrochemicals	SHAPDIS	3.985
19	Jam Petrochemical	JAM	3.709
20	Bahman Group	KHBAHMAN	3.590

2.1. Calculating Input Values

Calculating P & P / E: Input values are available on the Tehran Stock Exchange. For Fars, these values are P = 929 and P / E = 6.36

Calculating ROE: Return on equity assesses the performance of a company in creating net profits for shareholders

$$ROE = \frac{Net\ Income}{Shareholder\ Equity}$$

Table 2. Calculating ROE FOR "FARS

Symbol	ROE	Shareholder Equity	Net Income	DPS	P/E	P
FARS	0.4826706	105,118,822	50,737,761	500	6.360	929

$$ROE = \frac{50,737,761}{105,118,822} \rightarrow ROE = 0.4826706 \qquad (8)$$

Calculating ROA: The return on assets is an indicator of how profitability of a company depends on the total assets of that company

$$ROA = \frac{Net\ Income}{Average\ Total\ Assets} \qquad (9$$

Table 3. Calculating ROA FOR "FARS"

Symbol	ROA	Average Total Assets	Net Income	DPS	P/E	P
FARS	0.2671456	189,925,512	50,737,761	500	6.360	929

$$ROA = \frac{50,737,761}{189,925,512} \rightarrow \qquad ROA=02671456$$
(10)

The results of input and output calculations for other companies are as Table 4.

Table 4. The results of input and output calculations for 20 companies

symbol	P	P/E	Net Income	Shareholder Equity	Average Total Assets	ROE	ROA
FARS	929.00	6.36	50737761.00	105118822.00	189925512.00	0.48	0.27
VAGHADIR	460.00	5.48	44718981.00	95259641.00	101294356.00	0.47	0.44
VABEMELT	475.00	4.67	18303455.00	73180609.00	1444636607.00	0.25	0.01
HAMRAH	6808.00	4.92	25245668.00	29649562.00	114063131.00	0.85	0.22
VABSADER	145.00	7.43	7360570.00	93105332.00	1098189888.00	0.08	0.01
FOLD	126.00	9.83	23760731.00	180164197.00	84165560.00	0.13	0.28
AKHABER	559.00	5.08	20967033.00	113057940.00	79178037.00	0.19	0.26
TAPICO	550.00	4.58	25543220.00	72614829.00	121857038.00	0.35	0.21
PARSAN	481.00	5.87	21466756.00	83135643.00	58650649.00	0.26	0.37
RAMPNA	622.00	15.24	6029898.00	31732155.00	142544304.00	0.19	0.04
MOBEN	705.00	5.21	7320279.00	34545892.00	22186610.00	0.21	0.33
SHABANDAR	220.00	15.73	6899884.00	29660323.00	79503030.00	0.23	0.09
HKESHTI	145.00	40.68	2583460.00	19707526.00	57262697.00	0.13	0.05
FAMLI	141.00	10.89	11342347.00	111716668.00	65705314.00	0.10	0.17
SHAPNA	420.00	7.01	6871764.00	29842643.00	49657893.00	0.23	0.14
VAPASAR	285.00	4.67	12642696.00	67528074.00	444243740.00	0.19	0.03
KHODRO	40.00	60.83	6022865.00	14776042.00	95808547.00	0.41	0.06
SHAPDIS	1661.00	5.76	9943278.00	16732710.00	25025748.00	0.59	0.40
JAM	1578.00	6.33	14928926.00	27345323.00	42073258.00	0.55	0.35
KHBAHMAN	296.00	7.63	2053365.00	13178670.00	18669877.00	0.16	0.11

4.3. Solving the Models Using the FDH Method

Then, by combining inputs and outputs, the following nine models are solved with the FDH model. Models include:

AB12-AB1-AB2-A12-B12-A1-A2-B1-B2

To calculate the number of models, the following equation is used

$$\sum_{i=1}^{n} \sum_{j=1}^{m} \binom{n}{i} \binom{m}{j}$$

$$\sum_{1}^{2} \sum_{1}^{2} \binom{2}{i} \binom{2}{j} = \binom{2}{1} \binom{2}{1} + \binom{2}{1} \binom{2}{2} + \binom{2}{2} \binom{2}{1} + \binom{2}{2} \binom{2}{2} = 9$$

For example, if there are three inputs and two outputs, the number of models is 21

$$\sum_{1}^{3} \sum_{1}^{2} \binom{3}{i} \binom{2}{j} = \binom{3}{1} \binom{2}{1} + \binom{3}{1} \binom{2}{2} + \binom{3}{2} \binom{2}{1} + \binom{3}{2} \binom{2}{2} + \binom{3}{3} \binom{2}{1} + \binom{3}{3} \binom{2}{2} = 21$$

The results of solving all models to obtain the performance scores of twelve DMUs are as follows.

In the next step, all the performance scores of each row are summed up and finally, the three highest summed sores are obtained.

Table 5. The results of solving all 20 models

DMU	AB12	AB1	AB2	A12	B12	A1	A2	B1	B2	SUM
FARS	0.89	0.89	0.52	0.18	0.74	0.05	0.13	0.44	0.52	4.35
VAGHADIR	1.00	1.00	1.00	0.61	1.00	0.10	0.43	0.49	1.00	6.63
VABEMELT	0.63	0.63	0.03	0.05	0.31	0.05	0.01	0.31	0.03	2.05
HAMRAH	1.00	1.00	0.56	0.02	1.00	0.01	0.01	1.00	0.56	5.16
VABSADER	0.53	0.53	0.03	0.05	0.06	0.05	0.02	0.06	0.01	1.36
FOLD	1.00	0.84	1.00	1.00	0.36	0.10	1.00	0.08	0.36	5.73
AKHABER	0.65	0.43	0.65	0.30	0.65	0.03	0.21	0.21	0.65	3.77
TAPICO	0.90	0.90	0.57	0.24	0.74	0.06	0.17	0.44	0.57	4.59
PARSAN	0.79	0.53	0.07	0.48	0.55	0.05	0.07	0.25	0.05	2.85
RAMPNA	0.30	0.30	0.07	0.04	0.07	0.03	0.03	0.07	0.03	0.95
MOBEN	0.79	0.47	0.79	0.29	0.79	0.03	0.21	0.24	0.79	4.38
SHABANDAR	1.00	1.00	0.19	0.25	0.12	0.10	0.18	0.09	0.07	3.00
HKESHTI	0.85	0.48	0.14	0.20	0.02	0.09	0.14	0.02	0.01	1.96
FAMLI	0.69	0.68	0.55	0.69	0.20	0.07	0.55	0.05	0.20	3.68
SHAPNA	0.54	0.54	0.34	0.21	0.32	0.05	0.15	0.19	0.25	2.58
VAPASAR	0.64	0.64	0.10	0.06	0.23	0.06	0.04	0.23	0.08	2.10
KHODRO	1.02	1.02	0.17	0.08	0.50	0.08	0.06	0.50	0.17	3.61
SHAPDIS	1.00	1.00	0.86	0.15	1.00	0.04	0.11	0.60	0.86	5.60
JAM	0.97	0.97	0.70	0.14	0.84	0.03	0.10	0.50	0.70	4.94
KHBAHMAN	0.52	0.52	0.39	0.24	0.21	0.05	0.17	0.12	0.18	2.38

4.4. Weighing Using ANP Analysis

Weighting is done using an ANP method with the same weight of 1.3 through MATLAB software so that stocks, options and models are indicators as well. The results are as follows

The weight of the options is equal to:

Rank = 1 Alter = 1 Score = 0.36854

Rank = 2 Alter = 2 Score = 0.31907

Rank = 3 Alter = 3 Score = 0.3124

Table 6. Super Matrix

Super Matrix											
0.00000	0.00000	0.00000	0.00000	0.00000	0.00000	0.00000	0.00000	0.00000	0.15073	0.17452	0.17849
0.00000	0.00000	0.00000	0.00000	0.00000	0.00000	0.00000	0.00000	0.00000	0.15073	0.14605	0.17849
0.00000	0.00000	0.00000	0.00000	0.00000	0.00000	0.00000	0.00000	0.00000	0.15073	0.17452	0.15283
0.00000	0.00000	0.00000	0.00000	0.00000	0.00000	0.00000	0.00000	0.00000	0.09205	0.17452	0.02717
0.00000	0.00000	0.00000	0.00000	0.00000	0.00000	0.00000	0.00000	0.00000	0.15073	0.06221	0.17849
0.00000	0.00000	0.00000	0.00000	0.00000	0.00000	0.00000	0.00000	0.00000	0.01510	0.01793	0.00627
0.00000	0.00000	0.00000	0.00000	0.00000	0.00000	0.00000	0.00000	0.00000	0.06457	0.17452	0.01906
0.00000	0.00000	0.00000	0.00000	0.00000	0.00000	0.00000	0.00000	0.00000	0.07461	0.01353	0.10640
0.00000	0.00000	0.00000	0.00000	0.00000	0.00000	0.00000	0.00000	0.00000	0.15073	0.06221	0.15283
0.33333	0.35250	0.35011	0.34641	0.42436	0.42084	0.27903	0.42356	0.45193	0.00023	0.00034	0.00029
0.33333	0.29501	0.35011	0.56725	0.15128	0.43163	0.65142	0.06634	0.16111	0.00013	0.00017	0.00015
0.33333	0.35250	0.29978	0.08634	0.42436	0.14753	0.06955	0.51010	0.38696	0.00005	0.00009	0.00004

Table 7. Final Matrix

Final Matrix											
0.00000	0.00000	0.00000	0.00000	0.00000	0.00000	0.00000	0.00000	0.00000	0.16697	0.16697	0.16697
0.00000	0.00000	0.00000	0.00000	0.00000	0.00000	0.00000	0.00000	0.00000	0.15790	0.15790	0.15790
0.00000	0.00000	0.00000	0.00000	0.00000	0.00000	0.00000	0.00000	0.00000	0.15897	0.15897	0.15897
0.00000	0.00000	0.00000	0.00000	0.00000	0.00000	0.00000	0.00000	0.00000	0.09812	0.09812	0.09812
0.00000	0.00000	0.00000	0.00000	0.00000	0.00000	0.00000	0.00000	0.00000	0.13116	0.13116	0.13116
0.00000	0.00000	0.00000	0.00000	0.00000	0.00000	0.00000	0.00000	0.00000	0.01324	0.01324	0.01324
0.00000	0.00000	0.00000	0.00000	0.00000	0.00000	0.00000	0.00000	0.00000	0.08544	0.08544	0.08544
0.00000	0.00000	0.00000	0.00000	0.00000	0.00000	0.00000	0.00000	0.00000	0.06504	0.06504	0.06504
0.00000	0.00000	0.00000	0.00000	0.00000	0.00000	0.00000	0.00000	0.00000	0.12316	0.12316	0.12316
0.36924	0.36924	0.36924	0.36924	0.36924	0.36924	0.36924	0.36924	0.36924	0.00031	0.00031	0.00031
0.31893	0.31893	0.31893	0.31893	0.31893	0.31893	0.31893	0.31893	0.31893	0.00016	0.00016	0.00016
0.31183	0.31183	0.31183	0.31183	0.31183	0.31183	0.31183	0.31183	0.31183	0.00006	0.00006	0.00006

Table 8. Final weight for 3 top DMU

ROW	DMU	AB12	AB1	AB2	A12	B12	A1	A2	B1	B2	w
2	VAGHADIR	1.00	1.00	1.00	0.61	1.00	0.10	0.43	0.49	1.00	0.37
6	FOLAD	1.00	0.84	1.00	1.00	0.36	0.10	1.00	0.08	0.36	0.32
18	SHAPDIS	1.00	1.00	0.86	0.15	1.00	0.04	0.11	0.60	0.86	0.31

4.5. Ranking the Most Efficient Stock Portfolio Using the QUALIFLEX Method

Since after weighing using the network analysis process, it is observed that the second and third options are of the similar weights, QUALIFLEX technique is used to have more resolution and choose the best option from among the second and third options.

Finally, weights obtained from QUALIFLEX technique are used to rank the stock portfolio and the following results are obtained. Then, the obtained results are multiplied in weights (we call Ghadir symbol A, the steel symbol B, and the Shepdis symbol C). Now, with the QUALIFLEX model, the best option is assigned number 1, the next is assigned 2, and the worst option is assigned 3. Finally, with the formation of six permutations, the best permutation is obtained as follows.

And thus, the top permutation is the second row. Accordingly, the largest share is to be purchased from the investment company of Ghadir (Holding) and then Pardis Petrochemical Company and finally from Mobarakeh Steel Co. of Isfahan.

Table 9. Formation of six permutations

ROW	permutations	AB12	AB1	AB2	A12	B12	A1	A2	B1	B2	SUM
1	A>B>C	3	1	1	-3	1	3	1	-1	1	7
2	A>C>B	1	3	3	-1	3	1	-1	1	3	13
3	B>A>C	1	-1	-1	-1	-1	1	3	-3	-1	-3
4	B>C>A	-1	-3	-3	1	-3	-1	1	-1	-3	-13
5	C>A>B	-1	1	1	1	1	-1	-3	3	1	3
6	C>B>A	-3	-1	-1	3	-1	-3	-1	1	-1	-7

5. Discussion and Conclusions

The results presented in this study were based only on studies on the top 20 companies listed in the Tehran Stock Exchange during the third quarter of 2015. In previous studies, optimal portfolio was determined using data envelopment analysis models (Khajavi and Moghaddam, 2012) and multi-criteria decision making techniques (Amiri et al., 2010). but the present study combined these two techniques to evaluate and determine the most efficient portfolio.

The advantage of the DEA-ANP ranking model is that ANP pair-wise comparisons have been derived mathematically from multiple input/output data by running pair-wise DEA runs. Thus, there is no subjective evaluation. The DEA and the ANP methods are commonly used in practice and, yet, both have limitations. The DEA-ANP method combines the best of both models by avoiding the pitfalls of each. ANP is designed for subjective evaluation of a set of alternates based on multiple criteria organized in a hierarchical structure. In this model, we work with given tangible inputs and outputs of units, and no subjective assessment of the decision maker's evaluation is involved. The Pareto optimum limitation of DEA is resolved by the full-ranking performed here by means of the ANP. It is important to note that DEA-ANP does not replace DEA, but rather, it provides further analysis of DEA to full ranking the units.

Therefore, the largest share should be purchased from the investment company of Ghadir (Holding) and then Pardis Petrochemical Company and finally from Mobarakeh Steel Co. of Isfahan.

Researchers can improve this study by changing indicators. For example, instead of placing nine models as indicators, they only put models that have delivered better results and reduce the size of the problem or select

the indexes by 20 stocks and weight models and select the model that weigh more in order to identify the factors affecting stock performance.

Future studies are suggested to use developed methods, such as a two-step logarithmic logical programming method, or an ideal lexicography programming method because these models can produce certain output or uncertain output with non-deterministic data, which is of greater validity and offers even more logical results.

Qualiflex method's development in the fuzzy environment can also be considered in order to use the capabilities of the method.

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