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Designation and Explanation of Performance Evaluation Model Metals Producers Companies in Iran Stock Exchange with an Approach to Data Envelopment Analysis

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Abstract *Monitoring and evaluation are concepts that has long been considered as one of the main tasks of management and economics, thus the performance evaluation of subject is not an issue that is pointed out today. But what is certain is the attitudinal change that has been made in this regard which it is regarded as a means of improving performance. To gain and maintain competitive advantages, companies should seriously evaluate their performance as well as pay attention to their financial and non-financial aspects of performance. The use of new tools as well as a more precise evaluation of the performance is concerned by many organizations and data envelopment analysis (DEA) is one of these tools. Data envelopment analysis as an efficient tool in the evaluation of decision making units' function similarly has found great applications. This tool uses a series of tangible organizational inputs and outputs to assess organizational performance. Data envelopment analysis is a mathematical technique that assesses the relative efficiency of a group of decision making units. Now the steel and metals industry is considered as an important and strategic industry in the country and comparative advantages in the production of goods, including the rich mines scattered around the major cities, give special importance to the industry as one of the main engines of the country's industrial growth. Steel and metals industry are one of the industrial products which plays an important role in the development and prosperity of the country and allocated the world's first industrial production among industrial productions. At present there are about 16 companies in the Stock Exchange. Although Iran is the largest steel producer and metals in the Middle East and their production in the country has increased in the past few years, the plants' efficiency has not been grown for many reasons and using new methods of performance evaluation in this regard and calculating the efficiency of companies and comparing them together is very important. The researcher of this study is to explain the model and performance evaluation of Manufacturers Metals Exchange.*

Key words SEC, DEA, evaluates performance, steel production companies

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1. Introduction

Obviously rational function and rational behavior life coincided with them from the beginning of human. Therefore, the productivity and efficiency in its extensive concept has long been of interest to humans. In one hand, human wants and desires are unlimited and on the other, the power, features and tools of his life are limited. The idea of efficient use of resources is inevitably tied to human life and the productivity and efficiency in its broad sense has long been of interest to humans (Ghafournian, 2004).

Of very important and valuable industry in the community which has an important role in economic development and infrastructure in other industries in the country can be named steel and metals industry, because important economic and infrastructural growth in many parts of the country depends on the growth of this sector of the economy and industry. Therefore, evaluating the performance of companies in this industry and measuring its efficiency is very important. Evaluating active companies in steel industry is done for this reason to be informed of the quality and their performance and can compare them and thereby take steps to continuously improve their performance.

Using basic and advanced techniques in order to achieve better performance can be a very important tool to improve the performance. Using these techniques make it possible that an organization change its direction in changing circumstances, accelerate its growth in some areas and decelerate in other areas to deal with future threats with appropriate responses and makes the maximum advantage from the obtained opportunities. Using these principled methods, organizations will be able to take steps to improve weaknesses and move organization's purposes to the best directions using the maximum use of the capabilities and strengths (Ghafourian, 2004).

It has been tried in the present study to recognize and analyze performance evaluation measures (factors effective in efficiency) of steels and metals companies active in the Stock Exchange, a suitable model for evaluating the performance of the company using one of the techniques of operations research (DEA) is designed and their performance is compared with each other.

2. Research Basics

2.1. Performance evaluation concept

Quality and effectiveness of performance management system is a vital factor in the research, development and prosperity of nations. High costs of organization and financing of the costs from common resources are increasingly limited and low efficiency of these organizations put this thinking in nations' minds that realizing organization's purposes should be considered. Paying attention to the results and goals of research, continuous improvement of services quality and products that provide organizations and citizen satisfaction necessitate paying attention to management and evaluation of its performance (Agharafie, 2004).

There are different definitions of performance assessment, which some of them are mentioned below:

- Performance evaluation is process that all organizations should do it. They may do it as quickly or as completely systematic or specifically. However, companies need to improve their performance evaluation form (Parker, 2000).
- Performance appraisal process is a process that gives the organization the opportunity to identify problems and do the appropriate action before they become big problems (Kouing, 2000).
- Performance evaluation is a continuous process, which is measured by the achievement of goals. In this measurement, efficiency and effectiveness of resources used and working processes, product quality (output) and implementing programs are studied (Gholami and Nouralizadeh, 2003).
- Performance evaluation is a process that measures the activity of the organization in such a way that the organization reduces costs thanks to the improvement of activities and improves how to implement operations in the organization as well as support the organization's mission (Sheri and Jebelameli, 2005).
- Performance evaluation is assessing the success of employer in his/her work, especially the kind of evaluation that is made as part of an organizational approach.
- Manner in which the assessment is done on a continuous basis, assessment records and data are kept and some measures are done for performance improvement is often referred to briefly as evaluation (Saebi, 1371).
- Performance evaluation is defined as effectiveness and efficiency quantification process (Aoulia, 2005).

We can see that in all definitions, performance assessment was considered as activities to improve and the evaluation will be done not only in the staff but also in the entire organization level. Performance evaluation is important to the extent that Kanji (2002) regards it as the first condition of progress and development, and ultimately the pursuit of excellence in developing and maintaining a system for evaluating the performance.

2.2. Past and present of performance evaluation

Evaluation history goes back to the far past. Studies have shown that phenomena of labor division exist among tribal members as well as performance evaluation in preliminary form in the formation of human communities as tribes so that people were able to gain rewards and possible promotion. Formal system of performance assessment at individual and organizational level was introduced in 1800 by Robert Owen in Scotland in the textile industry for the first time so that produced goods were categorized with the use of

wood in different colors that this work has actually been an assessment of the organization's quality or output.

By institutionalizing a performance appraisal system, many changes have been done to date on this system so that we can evaluate the evaluation system throughout history in both traditional and modern methods. Previously, performance evaluation was concentrated on financial measures such as return on investment, sales, profits, liabilities and capital income. Traditional measures (financial) are not fully compatible with competences and skills of companies that require being faced with today's workplace. Therefore, financial measures have an old and obsolete center view. In addition, these traditional measures tend to focus on the person or performance, not the processes that are in the center of management. Furthermore, traditional measures of performance provide short-term perspective because of shortage of center and strategy focus. They have one-way monitoring. This means that they make people more cornered rather than improve them (Kanji, 2002). So many criticisms were made on traditional performance of measurement systems which consequently leads to the creation of new systems for performance evaluation. These new systems such as the balanced evaluation, Baldrige method, performance excellence model, data envelopment analysis technique, etc. would overcome the weaknesses of traditional systems.

2.3. Performance Evaluation Theories

Theories related to performance evaluation can be divided into two main sections:

- Theories related to performance measures
- Theories and issues related to system design and performance assessment framework

The first set of these theories emphasize on performance criteria and a true selection of these criteria, while the second category focuses more on theories which focus on the design and development of performance measurement systems (Folan and Brown, 2005). Performance assessment frameworks have been introduced in the next section. Performance criteria are studied in Section 2-10.

2.4. Performance assessment frameworks

Performance assessment frameworks by specifying the boundaries and dimensions of performance evaluation, as well as providing initial intuition about the relationship between these dimensions make it easier to evaluate the performance of systems (Rose and Patril, 2003). Performance assessment frameworks can be divided into two categories: Structural frameworks and procedural frameworks.

Structural frameworks identify performance measurement typology and procedural framework identifies step by step process and development of performance measurement system as well. Almost every organization has a performance evaluation system which it is expected to meet the needs of major goals in the field of human capital management. Objectives mentioned often include motivating individuals to optimal performance, helping people to develop skills, building a culture of performance, determine who is eligible for promotion, decisions about people who have weak performance and assist in the implementation of business strategies. There is no doubt that the performance evaluation system, which can obtain these objectives, can have an important contribution to the organization effectiveness (Rahmani, 2005).

Performance evaluation objectives can be pointed out in the overall six general frameworks (Oulia, 2005):

- The direction of strategies and activities;
- Operation control;
- Management and Interaction with stakeholders;
- Knowledge of the reasons for the improvement or decline of quality;
- Motivating and rewarding employees;
- Responsibility.

2.5. Different Causes of Performance Evaluation

Different reasons are presented for performance evaluation. Parker (2000) stated causes of performance evaluation as follows:

- Identifying situations;

• Performance evaluation indicates that where the problem is and where there is need for improvement;

• Performance evaluation helps the organization to better understand its processes and to identify what they know and what they do not know;

• Ensuring that decisions are based on facts rather than assumptions and guesswork;

Halechmy (2002) has also presented a comprehensive list of causes of performance evaluation:

• Lack of job evaluation leads to a lack of understanding of the work;

• Lack of understanding of the work makes the job difficult to control;

• If the work cannot be controlled, it can be improved;

• Lack of measurement makes it difficult to detect success from failure;

• Lack of knowledge leads to lack of offering rewards;

• An organization's failure to reward makes it to fail in rewarding;

• Lack of success recognition makes it that cannot be supported and continued;

• Failure to identify success or failure causes lack of learning;

• Lack of diagnosing failures caused repeated errors and wasting resources;

• Lack of results communication with the resources used will lead to a lack of understanding of the actual costs;

• Lack of understanding the real costs makes it difficult to decide the resources of the cost;

• Failure to identify the total cost causes not to receive the best value from that money;

• Failure to completely clear the results declines the ability of managers to dialogue and prove organization with stakeholders and customers and thus organization cannot be supported from the public.

3. Literature review

In most studies, data envelopment analysis approach was used to evaluate the performance of various organizations although in many cases this approach has been used in service organizations. Some studies in this area are as follows:

1. Simultaneous analysis of production and investment in the Canadian health and life insurance companies by using data envelopment analysis: in this study, a new model of DEA to provide valuable management information when evaluating the effects of dual management strategies and business operations for life and health insurance companies in Canada have been introduced. The new DEA models that is task-oriented and different from classical models, is able simultaneously to independently assess the performance of production involved.

2. Determination efficiency and returns to scale in the Indian life insurance companies using data envelopment analysis: in this research, DEA is used to evaluate the performance of Indian life insurance companies. To select the outputs in the research, value used perspective is used. This perspective considers the criteria as output which creates significant added value using the costs.

3. Performance Evaluation of Insurance Company: in his MA thesis, Ali Aghrafaie evaluates the performance the chambers of Iran Insurance Company using a data envelopment analysis approach.

4. Evaluation of operation performance from irrigation networks in data envelopment analysis: also Ebrahim Salehi Taleshi in his thesis in the agricultural fields used data envelopment analysis to evaluate the operating performance of the irrigation systems.

5. Evaluating the effectiveness of after-sales service (Iran Khodro Company authorized representative): in his thesis in the field of industrial management, Khalil Mirkhani has evaluated authorized Iran Khodro agencies efficiencies and compared those using data envelopment analysis technique.

6. Designing and explaining performance evaluation model Dana Insurance branches using data envelopment analysis: in her thesis, Maryam Daneshvar compared several models of DEA among its several models and selected input-oriented BCC model to evaluate the performance of the Dana branches. In this study, she considered general and administrative costs, skilled manpower and geographical representation as input and the number of issued insurance policies, amount of insurance policies issued, number of paid damages and the amount of paid losses are considered as outputs.

7. Hashimoto and Ishikawa used DEA in order to measure the desirability of living in 47 areas of Japan and by using multiple social indicators. They replaced both positive and negative social indicators in order to replace the inputs and outputs in DEA.

8. Banistro and Stalp used DEA in measuring the regional performance of the manufacturing sector in Mexico and examined the relationship between industrial concentration and regional performance and regional scale and although a small number of Mexico areas had industry focus, they found positive relationship between regional scale, urban economies and technical efficiency, respectively.

9. Siphordo Zo used DEA to estimate the productivity of Chinese industry from 1953 to 1990. Their aim was to maximize the productivity of Chinese industry, focusing on the overall performance, industrial development and yield performance using different sets of inputs and outputs. They also use a weighted additive model of DEA and constant returns to scale as well as areas of assurance, Delphi and AHP techniques to include value judgments in DEA models.

10. Atanasopolos and Karakazis used DEA method for evaluating the effectiveness of public investment in specific infrastructure sectors and giving special investment grading to attract private sector investment in southern Greece. They identified areas that are well managed through special facilities and infrastructure to attract private sector investment.

11. Macmillan used DEA method for ranking the regions (from an economic point of view). He suggested using the DEA to evaluate efficiency of cities in China. In addition, he fulfilled the possibility of using DEA results as a basis for investigating the non-efficient behavior.

4. Research Questions

Given the nature of the problem in this research, research questions include:

• *What are the entrance criteria of performance evaluation of metal producing companies in Tehran Stock Exchange?*

• *What are the exclusion criteria to evaluate the performance of companies of producing metals on the Stock Exchange?*

• *Which of data envelopment analysis models are more consistent for evaluating the performance of companies in the Stock Exchange's metals producers?*

• *Which of the metals producing companies are efficient in the Stock Exchange?*

5. Research Objectives

The primary objective of this study was to design a model to evaluate the performance of metal producing companies in the Stock Exchange of Iran. Other objectives of the study are as follows:

• Determining measures of performance evaluation of metals production companies in the Stock Exchange;

• Performance measurement in metal producing companies in the Stock Exchange and determining the efficient and inefficient firms;

• assisting the optimization of metal producing companies in the Stock Exchange.

6. Research Scope

Thematic scope: this study seeks to identify measures of performance evaluation of metals producing companies in Iran Stock Exchange and designing mathematical models of these companies.

Spatial scope: To test the model, the metal producing companies on the stock exchange has been selected. Thus, the spatial scope of the study includes all metal producing companies in the Stock Exchange of Iran.

Temporal scope: information on the implementation of the model is limited to the year of 2013 in cement producing companies in the Stock Exchange of Tehran.

7. Research Applications

The implications of this study are as follows:

• Performance evaluation of metal producing companies in Iran Stock Exchange;

- Performance evaluation of metal producing companies managers in Iran Stock Exchange;
- Help Shareholders in the Portfolio Planning in the metals industry, particularly steel;
- Application in designing organizational changing programs of thee corporates.

8. Features and capabilities of data envelopment analysis models

Data envelopment analysis in recent years has been proposed with different models and several capabilities in the scientific and research in applied mathematics and management science. Some of the features and capabilities of the mentioned models that are important in the implementation and application are summarized below (Motameni, 2002):

- Simultaneous evaluation of factors;
- Realistic assessment;
- No need to pre-determined weights;
- Compensatory feature;
- Evaluating the boundary orientation rather than central tendencies;
- showing the best functional status instead of desired status;
- Standardization;
- Ranking of decision making units;
- Presentation of the model and strategies to improve performance;
- Providing units with the highest level of productivity and the estimation of returns to scale;
- determining the density and its amount in inputs;
- Presenting development strategy includes expansion and contraction of units;
- Optimal allocation of resources;
- Identifying functional potential (practical);
- Sensitivity analysis of inputs and outputs.

9. Data Analysis

In this section, we analyze the data and provide a model for evaluating the performance of steel companies in the Stock Exchange. The study population includes all steel companies in the Iran Stock Exchange. Before proceeding to the data analysis, decision making units and selected input and output to evaluate the performance of the companies is introduced. The models used in this study which consists of two main models for output-oriented BCC and CCR has been studied. Then using the software outputs, etc., efficiency of decision units described above have been obtained and by detailed introducing of related objective function to two units of decision-making units along with related restrictions, DEA technique has been introduced. Finally, the sensitivity analysis results are discussed.

9.1. Definition of decision-making units (DMU)

DMUs is an entity that transforms inputs into outputs. DMU are units that have the same kind of work done and have the same goals and aspirations. DMUs used in DEA should be homogenous and have the same inputs and outputs. There are two basic guidelines for choosing DMUs: A) Each DMU should be defined as an entity that is responsible for the inputs used and outputs produced. B) To provide a degree of sufficient freedom, the number of DMU should be large enough to the number of inputs and outputs used in the study (Ray, 2004).

9.2. Introducing inputs and outputs

In this section, the inputs and outputs that are used to implement the DEA technique was introduced.

9.2.1. Inputs

1. Property, machinery and equipment
2. Total assets
3. Capital
4. The sum of equity

9.2.2. Outputs

1. Aggregates
2. Profit (loss) after tax deduction
3. Return
4. Production volume

9.3. Output-oriented CCR model results

Table 1 shows the efficiency of active steel companies in the Stock Exchange along with model companies in 2013. These efficiencies are obtained by using the CCR model. This model which has constant returns to scale, four companies has performance i.e. they have CCR efficiency. Of inefficient firms, Aloumorad Corporations with 0/463 efficiency has the lowest performance.

Table 1. Efficiency of corporates in the output-oriented CCR model

Column	Name of Company	Efficiency	Parent company
1	Kalisimin	1	-
2	National Copper Industries	1	-
3	Tubes and machinery	1	-
4	Bahonar Copper	1	-
5	Iran Aluminum	0.932	-
6	National Lead and Zinc	0.912	-
7	Isfahan Mobarakeh Steel	0.879	-
8	Khuzestan Steel	0.818	-
9	Iran Alloy Steel	0.761	-
10	Rolled steel	0.714	-
11	Khorasan Steel	0.682	-
12	Development of minerals and metals	0.615	-
13	Kashan Amirkabir steel	0.613	-
14	Kavian Steel	0.559	-
15	Mineral Processing	0.548	-
16	Aloumorad	0.463	-

9.4. Output-oriented BCC model results

Table 2 shows the efficiency of steel producing companies in the Stock Exchange along with Model Company. These efficiencies are obtained using BCC model. In this model which has variable returns to scale, 9 companies have efficiency i.e. it has BCC efficiency. Of inefficient firms, Alomorad Company with 0.644 efficiency has the least efficiency.

Table 2. Efficiency of steel producing companies in the Stock Exchange along with Model Company

Column	Name of Company	Efficiency	Parent company
1	Isfahan Mobarakeh Steel	1	-
2	Khouzestan Steel	1	-
3	Kavian Steel	1	-
4	Khorasan Steel	1	-
5	Development of Mines and Metals	1	-
6	Kashan Amirkabir Steel	1	-
7	Bahonar Copper	1	-
8	Rolled steel	1	-
9	National Lead and Zinc	1	-
10	National Copper Industries	0.992	-
11	Iran Aluminum	0.990	-
12	Mineral Processing	0.963	-

Column	Name of Company	Efficiency	Parent company
13	Tube and machinery	0.958	-
14	Iran alloy steel	0.914	-
15	Kalsimin	0.898	-
16	Aloumorad	0.644	-

9.5. Comparing the results of the CCR and BCC models

In this section, we compare the performance of CCR and BCC models (Table 3), a suitable model for evaluating the performance of steel companies active in Iran's Stock Exchange will be presented.

Table 3. Comparison between performance of CCR and BCC models

Column	Name of Company	Efficiency	Parent company
1	Kalisimin	1	0.891
2	National Copper Industries	1	0.992
3	Tubes and machinery	1	0.958
4	Bahonar Copper	1	1
5	Iran Aluminum	0.932	0.990
6	National Lead and Zinc	0.912	1
7	Isfahan Mobarakeh Steel	0.879	1
8	Khuzestan Steel	0.818	0.914
9	Iran Alloy Steel	0.761	0.963
10	Rolled steel	0.714	1
11	Khorasan Steel	0.682	1
12	Development of minerals and metals	0.615	1
13	Kashan Amirkabir steel	0.613	0.644
14	Kavian Steel	0.559	1
15	Mineral Processing	0.548	1
16	Aloumorad	0.463	1

A comparison of output-oriented CCR and BCC models indicated that the results of these models are somewhat different. This indicates that companies do not act in optimal scale. As a result, there are constant returns to scale and to gain companies' efficiencies; output models to constant scale cannot be used. As a result, the output-oriented BCC model is the model for this investigation.

9.6. Presenting the model

Introducing model variables:
I_1 :Property, machinery and equipment
I_2 : Total Assets
I_3: Capital
I_4: Total enacted equity (the Ordinary)
O_1 : Total incomes
O_2: Profit after tax reduction
O_3: Output
O_4: Production volume
V_1: First input weight
V_2 : Second input weight
V_3 : Third input weight
V_4 : Fourth input weight
W_1 : First output weight
W_2 : Second output weight
W_3 : Third output weight
W_4 : Fourth output weight

The general BBC output-oriented model for this study is given as follows:

$$j=1,2,\cdots,24 \qquad \mathrm{Max}\, Z=\sum_{r=1}^{3} W_3 O_{rj} + W + O_{tj}^{-b} + W$$

St :

$$j=1,2,\cdots,24 \quad \sum_{i=1}^{3} V_i I_{jj} = 1$$

$$j=1,2,\cdots,24 \quad \sum_{r=i}^{3} W_r O_{rj}^{j} + W + O_{tj}^{-b} - \sum_{i=1}^{t} V_i I_{ij} + W \le 0$$

W free in sign $W_r \ge 0 \qquad V_i \ge 0$

For example, if Khouzestan Steel Company is the first company, then the related model is as follows:

$$\mathrm{Max}\, Z = W_1 O_{11}^{g} + W_2 O_{21}^{g} + W_3 O_{31}^{g} + W + O_{41}^{-b} + W$$

St :

$$V_1 I_{11} + V_2 I_{21} + V_3 I_{31} + V_4 I_{41} = 1$$

$$W_1 O_{11}^{g} + W_2 O_{21}^{g} + W_3 O_{31}^{g} + W + O_{41}^{-b} - V_1 I_{11} + V_2 I_{21} + V_3 I_{31} + V_4 I_{41} + W \le 0$$

$$W_1 O_{12}^{g} + W_2 O_{22}^{g} + W_3 O_{32}^{g} + W + O_{42}^{-b} - V_1 I_{12} + V_2 I_{22} + V_3 I_{32} + V_4 I_{42} + W \le 0$$

…

$$W_1 O_{24}^{g} + W_2 O_{24}^{g} + W_3 O_{3n}^{g} + W + O_{4n}^{-b} - V_1 I_{18} + V_2 I_{28} + W \le 0$$

$W_r \ge 0 \qquad V_i \ge 0$ W free in signs

With replacement of inputs and outputs values, we have: (Please note that due to the high number of units, only writing 3 limits will suffice).

$$\mathrm{Max}\, Z = 273659 W_1 + 10/803 W_2 + 95/63494 W_3 + 76/208 W_4$$

St:

$$185081 V_1 + 346673 V_2 + V\cdots V_3 + 139682 V_4 = 1$$

$$185081 W_1 + 346673 W_2 + W\cdots V_3 + 139682 W_4 - 273659 V_1 - 101803 V_2 - 95/6349 V_3 - 761208 V_4 + W \le 0$$

$$292544 W_1 + 679416 W_2 + 233574 W_3 + 256199 W_4 - 375412 V_1 - 208988 V_2 - 111/029 V_3 - 1044244 V_4 + W \le 0$$

$$176610 W_1 + 540483 W_2 + 76000 W_3 + 120082 W_4 - 352915 V_1 - 174146 V_2 - 101/22 V_3 - 1059609 V_4 + W \le 0$$

W free in signs $W_r \ge 0 \qquad V_i \ge 0$

DEA Solver software has been used to solve this model.

The efficiency of the unit as well as input and output values of the weights and prices of other software also specified.

Efficiency rate is 0.905. Values of input and output weights are as follows:

$$V_1 = 0$$

$$W_1 = 0 \qquad V_2 = 2/14629 \times 10^{-6}$$

$$W_2 = 0$$

$$W_3 = 0/003185792 \qquad V_3 = 0$$

$$W_4 = 9/13452 \times 10^{-7} \qquad V_4 = 0$$

$$W = 0/361057133$$

Data envelopment analysis technique is determined through virtual units, performance or non-performance of a unit. Shadow price achieved for some of the limitations of this method is in fact the weight of reference units.

Given the limitations of the model 3 (related to Unit 2 Fouladkavian) limitation 10 (related to Unit 9, Iran alloy steel) and limitation 11 (related to 10 units, Shahid Bahonar Copper). These units have zero shadow prices, so these units are considered as a reference of Khuzestan Steel Company.

The shadow prices of these constraints are as follows:

$$\lambda_2 = 0.14873$$

$$\lambda_9 = 0.849241$$

$$\lambda_{10} = 0.002028$$

Thus, the virtual unit for the evaluation of this unit is made from the combination of 0.14873 OF Kavian Steel Company, 0.849241 of Iran Alloy Steel Company and 0.002028 of Shahid Bahonar Copper Company.

9.7. Sensitivity Analysis

Sensitivity analysis of results of the technique DEA is done using BCC model results. In each scenario of the sensitivity analysis, one or more input and output has been removed and performance evaluation of companies is done based on the other outputs. The following are the results of the sensitivity analysis. In this analysis, in addition to stock firms, OTC companies are also considered.

9.7.1. Inputs sensitivity analysis

In order to analyze the sensitivity of the inputs in each scenario, the sensitivity analysis of one of the inputs are removed and evaluating the performance of companies with regard to all other inputs and outputs using the output-oriented BCC model is done. Table 4 shows the results of this sensitivity research and simultaneously compare the performance of each scenario of the sensitivity analysis with efficiency scores of the main model.

Table 4. Inputs analysis sensitivity

Column	Name of company	Main efficiency	By removing equipment	By removing total assets	By removing investment	By removing the accumulated equity
1	Foulad Mobarakeh	1	1	1	1	1
2	Bahonar Copper	1	1	1	1	1
3	Khouzestan Steel	1	1	1	1	1
4	Natioanl Copper	1	1	1	1	1
5	Tube and machinery	1	0.785	1	1	1
6	Iran Aluminum	1	1	1	1	0.963
7	Alloy Steel	1	0.807	1	1	1
8	Mineral processing	1	1	1	1	1
9	National Lead and Zinc	1	1	1	1	1
10	Rolled steel	1	1	1	1	1
11	Khorasan Copper	1	1	1	1	1
12	Kavian Copper	0.990	0.990	0.990	0.990	0.915
13	Mines and Metals development	0.958	0.958	0.939	0.958	0.958
14	Torbat Heydarieh Copper	0.905	0.905	0.837	0.905	0.905
15	Iran Manganese	0.898	0.898	0.884	0.898	0.898
16	Supplying raw materials of Sabanour Steel	0.870	0.758	0.870	0.870	0.870
17	Touka copper	0.870	0.870	0.831	0.803	0.773
18	Kalisimin	0.803	0.787	0.803	0.803	0.773
19	Amirkabir Kashan Steel	0.768	0.768	0.768	0.768	0.768
20	Zinc Mines	0.701	0.701	0.695	0.701	0.701

Column	Name of company	Main efficiency	By removing equipment	By removing total assets	By removing investment	By removing the accumulated equity
21	Iran Metal Industry	0.667	0.667	0.658	0.667	0.645
22	Milad Iron and Copper	0.650	0.557	0.650	0.648	0.650
23	Pars Industry Benchmark Steel	0.624	0.624	0.624	0.623	0.621
24	Aloumorad	0.527	0.527	0.527	0.477	0.526
The number of efficient branches		11	9	11	11	10
The percentage of efficient branches		0.458	0.375	0.458	0.458	0.417
The most inefficient branch		Aloumorad	Aloumorad	Aloumorad	Aloumorad	Aloumorad

Reflecting on the results of the sensitivity analysis, we can see the efficiency of branches will be different by removing any of the inputs. For example, by deleting the input, machinery properties and efficiency equipment in efficiency branch of Iran tube and aluminum will be reduced from 0.785 to 0.807. Also, removing input of total assets and capital do not make inefficient any of the efficient branch.

9.7.2. Outputs sensitivity analysis

In the sensitivity analysis of the outputs for each scenario, the sensitivity of one of the outputs are removed and corporate performance evaluation with regard to other outputs and all input using output-oriented BCC model is done. Table 5 shows the results of sensitivity analysis along comparing the efficiency of each scenario of sensitivity analysis with efficiency scores.

Table 5. Results of sensitivity analysis along comparing the efficiency of each scenario of sensitivity analysis with efficiency scores

Column	Name of company	Main efficiency	By removing equipment	By removing total assets	By removing investment	By removing the accumulated equity
1	Foulad Mobarakeh	1	1	1	1	1
2	Bahonar Copper	1	1	1	1	0.659
3	Khouzestan Steel	1	1	0.990	1	0.974
4	Natioanl Copper	1	1	0.622	1	1
5	Tube and machinery	1	1	1	1	1
6	Iran Aluminum	1	1	1	0.737	0.968
7	Alloy Steel	1	1	1	1	1
8	Mineral processing	1	1	1	1	1
9	National Lead and Zinc	1	1	1	1	1
10	Rolled steel	1	1	1	1	1
11	Khorasan Copper	1	1	1	0.585	1
12	Kavian Copper	0.990	0.990	0.990	0.961	0.961
13	Mines and Metals development	0.958	0.958	0.956	0.709	0.958
14	Torbat Heydarieh Copper	0.905	0.905	0.905	0.905	0.904
15	Iran Manganese	0.898	0.898	0.898	0.437	0.898
16	Supplying raw materials of Sabanour Steel	0.870	0.870	0.761	0.852	0.870
17	Touka copper	0.870	0.870	0.870	0.555	0.862
18	Kalisimin	0.803	0.803	0.803	0.648	0.803
19	Amirkabir Kashan Steel	0.768	0.768	0.768	0.532	0.768
20	Zinc Mines	0.701	0.701	0.701	0.424	0.701
21	Iran Metal Industry	0.667	0.634	0.667	0.667	0.667
22	Milad Iron and Copper	0.650	0.650	0.650	0.491	0.605
23	Pars Industry	0.624	0.624	0.624	0.368	0.624

Column	Name of company	Main efficiency	By removing equipment	By removing total assets	By removing investment	By removing the accumulated equity
	Benchmark Steel					
24	Aloumorad	0.527	0.527	0.527	0.238	0.527
The number of efficient branches		11	11	9	9	8
The percentage of efficient branches		0.458	0.458	0.375	0.375	0.333
The most inefficient branch		Aloumorad	Aloumorad	Aloumorad	Aloumorad	Aloumorad

As Table 5 shows, by eliminating output net profit after tax reduction of two companies named Khuzestan Steel Company and National Iranian Copper Industries, that are considered as efficient companies, inefficient companies is changed to efficient ones to 0.990 and 0.622 efficiency, respectively. By eliminating the output volume, the number of efficient companies will be reduced from 11 companies to 8 ones and the percentage of efficient branches will be 0.333.

10. Conclusions and Suggestions

Conclusions

In this section, total results of the study have been presented in the framework of answering to the questions:

1. What are the input parameters (inputs) to evaluate the performance of steel companies in Iran Stock Exchange?

After reviewing similar research and numerous interviews, steel companies' outputs for evaluating the performance in order to survey the metals industry experts is identified as follows:

- Machinery, Equipment and Property;
- Total Assets;
- Investment;
- Approved stock Equities (in ordinary assembly).

After reviewing similar studies and surveys conducted according to industry experts, the output criteria for evaluating the performance of Steel companies in the Stock Exchange were determined by the following:

- Total incomes.
- Net profit after tax reduction.
- Returns.
- Production volume.

2. Which of data envelopment analysis models is more consistent for evaluating the performance of steel companies active in Iran Stock Exchange?

In order to select an appropriate model to assess the performance of steel companies in the Stock Exchange, the performance scores for all companies using the output-oriented CCR and BCC models are calculated. Comparing the results of these models indicate that the efficiency scores of the two models somewhat differ with each other. This difference suggests that the assumption of returns to constant scale is not true in the case of steel companies and CCR model cannot be used. As a result, suggested model for this research is output-oriented BCC model. This model is described in detail in Chapter IV.

3. Which of the steel company's active in the Iranian stock exchange are efficient?

Results of output-oriented BCC model shows that out of 16 companies under review, the company returns with one performance rating is efficient. Efficient firms are shown in table 6.

Table 6. Efficient firms

Column	Name of Company
1	Isfahan Foulad Mobarakeh
2	Khuzestan Steel
3	Kavian Steel
4	Khorasan Steel
5	Development of minerals and metals

Column	Name of Company
6	Amirkabir Kashan Steel
7	Shahid Bahonar Copper
8	Rolled steel
9	National Iranian Lead and Zinc

Suggestions

1. Executive proposals

Companies can introduce the model to each of the inefficient firms to increase efficiency and optimize the performance of inefficient firms in such a way that optimal values for inefficient firms is exactly specified and these units can be achieved full efficiency if they change their inputs and outputs exactly according to determined value.

Inefficient firms is like Siman Khazar Co.

2. Research Proposals

1. Given the importance of output to companies scale to select a DEA suitable model, a study should have done regarding the type of returns to scale of steel companies and choose the right model based on the type of returns to scale.

2. DEA determines the special weight to input and output weights in such a way that of the single efficiency is maximized under evaluation. Due to the different coefficients of the importance of each data and outputs, it is better the limits of input and output weight is specified by manager opinion through polling from the experts and evaluation with DEA model with limited features of weights is done.

3. The inputs and outputs of units under different conditions may not be fixed and certain. Thus, the use of Fuzzy DEA approach to reflect the actual condition of the data and outputs is recommended to evaluate performance.

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