Journal of Business, Economicsand Finance - (JBEF), ISSN: 2146 – 7943, , http://www.pressacademia.org/journals/jbef

PressAcademia

Journal of Business, Economics and Finance

Year: 2017 Volume: 6 Issue: 3

EFFICIENCY RESEARCH WITH TOTAL FACTOR PRODUCTIVITY AND DETERMINATION OF IMPROVEMENT TARGETS

DOI: 10.17261/Pressacademia.2017.684
JBEF- V.6-ISS.3-2017(5)-p.246-253

Murat Taha Bilisik [1], Gulizar Ozkaya Elibol[2]
[1]Istanbul Kültür University, Faculty of Economics and Administrative Sciences, Istanbul, Turkey. m.bilisik@iku.edu.tr
[2]Istanbul Kültür University, Faculty of Economics and Administrative Sciences, Istanbul, Turkey. guelizar.oezkaya@googlemail.com

ABSTRACT

Purpose - In today's competitive world, when financial crises and economic stagnation are experienced, the effective and efficient use of resources has become an important and necessary condition for companies and country economies. The iron-steel industry, which provides a great deal to the country's economies, also provides raw materials to a large number of industries. In the iron-steel industry, where our country has limited resources and high dependency on external sources, it is necessary to determine whether the resources are used correctly to evaluate the efficiency and productivity and to determine the appropriate improvement targets.

Methodology – In this study, the activities of 9 iron and steel companies listed in Istanbul stock market and operating in the Turkish iron and steel industry have been examined using output oriented Data Envelopment Analysis (DEA) which is a non-parametric approach and Malmquist productivity index (MPI). In the study, 3 input factors have been number of employees, fixed assets and current assets. On the other hand, 2 output factors have been revenue and gross profit . The required data sets were obtained from 2014 and 2015 financial statements of the relevant companies.

Findings – Technical efficiencies, pure efficiencies, scale efficiencies and Malmquist indexes for each company have been found. According to the results obtained, decision making units which are efficient and inefficient were determined. By the way, the reasons for Malmquist Productivity Index, in terms of technical change and technological cahange have been explained.

Conclusion – Iron-steel companies determined to be unproductive may use these results to find out the detailed reasons preventing them to be productive. Since activities are directly proportional to the use of resources, organizations need to reduce input or take measures to increase their output. Increasing the production of high value added products or increasing the production can increase the income. Especially in view of stainless steel, special steel and seamless pipe products, which are insufficient in Turkey, an increase should have been in export and imports. With plans and strategies to be implemented in this way, both the cost of inputs can be reduced and the output can be increased.

Keywords: Iron-steel industry, data envelopment analysis (DEA), malmquist productivity index (MPI), efficiency, productivity
JEL Codes: C81, C61, C67

1. INTRODUCTION

Nowadays, due to the competitive conditions and competition on the global market, effective and efficient use of resources has a great importance for companies. The shrinkage in market shares has forced firms to respond to different production plans, productivity surveys and technological developments. Performance and efficiency studies have made it possible for managers to make advanced plans for resources and increase productivity. Outside managers, efficiency analysis helps investors to think rationally about information and investment decisions. Therefore, analysis of the effectiveness of the activities; Investors, companies, executives and the sector make it almost mandatory. In this study, 9 iron and steel companies listed in Stock Exchange Istanbul were examined by data envelopment analysis and Malmquist total factor productivity. Analysis and necessary improvements were determined. In the first section of the study, information about the iron and steel sector was analysed as a comparison between our country and the global market. The main part includes the concepts of efficiency, data envelopment analysis and approaches in the literature about total factor productivity. Based on this information, optimization solutions have been made and the results of the companies are evaluated and the necessary potential improvement ratios and targets are presented.

Iron and steel industry; Iron ore or slag is melted in oven and made according to the desired chemical and physical structure. The iron and steel industry, which supplies raw materials to many other industries is one of the most important industries. Today, there are two basic methods used in steel production. These are the production of pig iron in blast furnaces in integrated plants and production of steel in basic furnaces. Another method is steel production by melting scrap steel in electric arc furnaces. An integrated plant uses iron ore as raw material, while electric arc furnaces uses scrap iron in production. Electric arc furnace plants constitute 74% of steel production in Turkey according to the records from 2012. The remaining 25.9% are produced in integrated plants. The reasons for Turkey's orientation to electric arc furnaces are that electric arc furnaces require lower financing for plant installation than integrated furnaces. Further reasons are difficulties in ore mine investments, the absence of mineral deposits and high cost of transportation are required.

In 1925, depended on the Directorate of Military Factories, the first iron and steel industry established in order to meet the steel requirement of the industry. The factory with 50.000 tons of production capacity was built in year 1928. Another step was taken in the name of the iron and steel industry is the launching of the analysis by the Ministry of Economics whether the industry can be established in 1925. Inspections were conducted in Germany, Belgium and Luxembourg, but the work was not resumed. Finally, the second iron and steel company which called Kardemir was established in Karabük at 1932. Kardemir started steel production with a capacity of 150 thousand tons in 1939 and there was no significant improvement in production until 1960's. Between 1970 and 1977, five electric arc furnace plants were established in Turkey. In 1980, the raw steel production capacity reached 4 million 200 thousand tons. The free trade agreement was signed in 1996 and in 1999 steel production reached over 14 million tons. This value accounted for 1.9% of world raw steel production. With this free trade agreement, Turkey's raw steel production has been steadily increased and makes it one of the world's largest steel producers. Turkey has reached 14 million tons of steel production after the free trade agreement. Within last 10 years, Turkey has caught countries such as Italy, Brazil and Ukraine which have 2-fold levels more production quantities than Turkeys and even passed them .Turkey shows continuous improvement in raw steel production and produces more than enough to meet its own needs but they are experiences serious problems in market balance and in the supply of resources. High levels of dependency of scrap for steel production and continuously increase of scrap prices, reduce the competitive power of Turkey. Turkey has a significant market presence in steel exports. In spite of, it is easily affected by steel price, market and market conditions, competitive power and interest rates. In 2014, 17.5 million tons of exports and 13.2 billion dollars of value-based exports were realized. The product group in which Turkey is strongest in steel exports is long products. The main countries in which Turkey exports iron and steel exports are the Middle East, the EU, North African countries and North America. 65% of the raw material used in production is covered by imports. This shows that the minimum share of imports in production has to be 65%. With the increase in scrap prices, Turkey seems to be oriented towards production rather than scrap, which has the largest share in imports. In 2015, 19.06 million tons and 12.32 billion dollars of value-based imports were realized. In recent years Turkey's imports have been more than exports. As a result, Turkey is a net importer. In such an environment, Turkey experience resource constraints and its market share decreases. It is necessary to use its resources efficient and effective in such an environment.

2. LITERATURE REVIEW

Debnath and Sebastian (2014) assessed the technical and scale efficiency of the Indian steelmaking industry in their work. The study measured the activities of 22 companies producing pig iron, steel and sponge iron over 50 million tons per year, with output-based on fixed return on scale and assumption of variable return on scale. Gross fixed assets, current assets and total energy cost were included in the number of employees as input, while output; profit before interest and tax, interest and profit after tax were used as the data set. According to the fixed income assumption, 10 companies and according to the variable return assumption by scale 13 companies were shown as effective.

Kara and Aydın (2011) calculated the activities of selected firms in the sample set of iron and steel producers operating in Turkey with Data Envelopment Analysis (DEA) and Malmquist total factor productivity index. As a result, the industry they have dealt with has determined that there is an incremental increase in scale. They analyzed technical efficiency levels and sources of inefficiency with Tobit model. As a result, the ratio of private sector credit to gross domestic product, the rate of growth of the industrial sector and the number of investment incentives have been influential in explaining the sources of inefficiency.

Kaya, Öztürk and Özer (2010) considered 4 periods of 2008 with the data envelopment analysis of 25 firms listed in Istanbul Stock Exchange which operates in metal goods, machinery and materials manufacturing sector. While 5 firms were efficient in 4 periods, 20 firms were inefficient. For companies that are ineffective, they propose by calculating potential improvement ratios.

Ertuğrul and T. Işık (2008) measured the efficiency through output-based CCR (Charnes, Cooper and Rhodes) models with 2 inputs and 2 outputs based on the financial statements of 2003-2007 periods of 13 companies operating in the metal industry sector. Results for 2007, inefficient firms have identified potential improvement ratios to be efficient.

Chen (1999) analysed the activities of the 35 largest steelmakers in China with data envelopment analysis. Especially in reducing the number of workers and improving the technical efficiency of firms, it is necessary to increase the output of China's steel industry.

3. DATA AND METHODOLOGY

Data Envelopment Analysis (DEA), which is used for efficiency measurement, is named; due to the fact that the activity boundary passes through at least one point in the set of production possibilities and that all other remaining points maintain below or above this frontier (Cooper; Seiford; Tone, 2000). The foundation of DEA based on a study by Debreu (1951) in the work of Farrell in (1957). In Farrell's "The Measurement of Productive Efficiency" study, linear programming was used in efficiency measurement by examining the activities of decision-making units, which are multi-inputs and single outputs for evaluating productivity. The first data envelopment analysis model is a work done by Charnes, Cooper and Rhodes in 1978. Under Cooper's advice, Rhodes evaluated the "Program Follow Through", a training program for disadvantaged students based on the assumption of fixed income on a scale basis in his doctoral dissertation. DEA proportional formulation was born with the desire to project the activities of the schools with multiple inputs and outputs, aimed at this program applied in public schools. DEA, a nonlinear and nonparametric method based on linear programs, provides relative efficiency measures for businesses or companies responsible for transforming input factors into output. The mentioned companies are called decision making units (DMU's). The data envelopment analysis determines the weights of multiple inputs and outputs according to their significance levels, and defines the efficiency frontier, so that we can compare whether the decision-making units are efficient or not. The efficiency frontier is a set of all the facilities used in production. If all of the facilities are used, the efficiency score is defined as 1. Efficiency scores of firms that do not use all of the facilities are below 1 and are considered inefficient. With DEA, activity analysis has been done about many institutions and organizations. In data envelopment analysis, the efficiency criterion is the ratio of total weighted output to total weighted input is shown in figure (1). The methods used in data envelopment analysis can be solved either as input-directed approach or as output-based approach; the same result will be achieved. In the input-directed approach, the output quantity is fixed, the input quantity aim to minimize and the output-based approach, the input quantity is fixed, the output quantity aim to maximize.

$$\frac{u_1y_1 + u_2y_2 + \cdots \ldots + u_sy_s}{v_1x_1 + v_2x_2 + \cdots \ldots + v_mx_m} \quad (1)$$

s: number of outputs; m: number of inputs ;u_s: weighted output
y_s: amount of outputs; v_m: weighted input; x_m: amount of inputs

3.1. CCR Model and Definition

Charnes, Cooper and Rhodes (CCR) established the CCR ratio definition of efficiency (1978a, 1979). This interpretation of efficiency determines the single output to single input classical engineering science ratio definition without requiring reassigned weights to multiple outputs and inputs. This method is based on a constant return assumption to scale. This section contains the basic features of the CCR model. The fractional representation of the output-based CCR model is expressed in following figure (2).

$$\min\theta \frac{\sum_{i=1}^{m} v_i x_{ik}}{\sum_{r=1}^{s} u_r y_{rk}} \quad (2)$$

subject to:

$$\min\theta \frac{\sum_{i=1}^{m} v_i x_{ij}}{\sum_{r=1}^{s} u_r y_{rj}} \geq 1$$

$;u_r, v_i \geq 0$

s: number of outputs; m: number of inputs; u_r: weighted output; y: represent output data for decision making unit; v_i: weighted input; x: represent input data for decision making unit

The models of the linear program generated by the fractional model (2) will be shown in figure (3) (Charnes; Cooper; Rhodes, 1978)

$$\text{Enk} \sum_{i=1}^{m} v_i x_{ik} \quad (3)$$

subject to:

$$\sum_{i=1}^{m} v_i x_{ij} - \sum_{r=1}^{s} u_r y_{rj} \geq 0 \qquad \sum_{r=1}^{s} \mathbf{u_r y_{rk}} = \mathbf{1}$$

$;u_r, v_i \geq 0$

3.2. BCC Model and Definition

The BCC model is based on the variable return assumption to scale developed by Banker, Charnes and Cooper (1984). In the CCR model, the assumption of constant return to scale assumes that all companies function at the optimum scale. This method is used to measure the performance of companies with varying returns to scale, as factors such as market conditions and competitive environment prevent them from operating at optimum scale, see figure (4). The difference between the BCC method and the CCR method is that the µk variable is added to the objective function, and the $\sum_{j=1}^{m} \lambda j = 1$ constraint is different from the CCR in the constraints of the formula (Charnes et al., 1994).

The solution of the formula shows:

$\mu_k = 0 \Rightarrow$ constant returns to scale; $\mu_k > 0 \Rightarrow$ Decreasing returns to scale; $\mu_k < 0 \Rightarrow$ increasing returns to scale

$\sum_{j=1}^{m} \lambda j = 1$ constraint allows the definition of relative efficiency to achieve a more flexible structure (Banker; Charnes; Cooper, 1984)

subject to:

$$\min\theta \sum_{r=1}^{m} v_i x_{ik} - \mu_k \quad (4) \qquad \sum_{r=1}^{s} u_r y_{rk} = 1 \qquad \sum_{r=1}^{s} u_r y_{rj} - \sum_{i=1}^{m} v_i x_{ij} \leq 0$$

$u_r \geq \mathcal{E} > 0$; $v_i \geq \mathcal{E} > 0$; μ_k: unconstrained

BCC score is higher than the CCR score; the reason for this is the variable return assumption to scale. The BCC score provides pure technical efficiency.

3.3. Malmquist Productivity Index (MPI)

Total factor productivity is the total output obtained by a manufacturing efficiency is defined as the ratio of the production factors used to obtain the output. Malmquist index (MPI), calculates the ratio of the difference of the two data points based on a common technology, which is a measure of change between data points in total factor productivity. The distance function is used to calculate this measure. Sten Malmquist (1953), who introduced the idea of establishing an index with the help of distance functions, was given this name as Malmquist. The distance function is used to describe multiple inputs and output production technologies without specifying targets such as least cost or maximum profit. According to the output, the distance function can be generated by x, the set of y's being S. $d(x, y) = \min\{\delta : (y/\delta) \in S\}$

Is defined in this model d (x, y) are the values obtain by the distance function, 1.0 if y is above the production limit; y vector within the production limit if it defines the point > 1.0 and y is a non-possible if it defines the point < 1.0. The Malmquist total factor productivity index according to the output between the baseline period and the following period t, following the work of the Färe et al. (1989, 1992); which we express in figure (5).

$$m(Y_s, X_s, Y_t, X_t) = \sqrt{\left[\frac{d^s(Y_t, X_t)}{d^s(Y_s, X_s)} \times \frac{d^t(Y_t, X_t)}{d^t(Y_s, X_s)}\right]} \quad (5)$$

In this formula $d^s(X_t, Y_t)$, *t* refers to the distance of the period observation from s to period technology. If the value of *m(.)* Function is greater than 1.0, then the total factor productivity increases from period t to period t; and less than 1.0 indicates that the decrease in total factor productivity is the same period. This equation can be expressed in figure (6).

$$m(Y_s, X_s, Y_t, X_t) = \frac{d^t(Y_t, X_t)}{d^s(Y_s, X_s)} \sqrt{\left[\frac{d^s(Y_t, X_t)}{d^t(Y_t, X_t)} \times \frac{d^s(Y_s, X_s)}{d^t(Y_s, X_s)}\right]} \quad (6)$$

The term other than the square root on the right side of the equation is the measure of Farrell's total technical efficiency change between period’s s and t. The term in parentheses refers to technological change. The separation of the Malmquist MPI exchange index as a change in technological change and technical efficiency helps to determine the contribution of these factors to total factor productivity. For this reason, the change in technical activity can be measured with model (7).

$$\frac{D_o^t(x^t, y^t)}{D_o^s(x^s, y^s)} \quad (7)$$

Technological change is determined by formula (8)

$$\sqrt{\left[\left(\frac{D_o^s(x^t, y^t)}{D_o^t(x^t, y^t)}\right)\left(\frac{D_o^s(x^s, y^s)}{D_o^t(x^s, y^s)}\right)\right]} \quad (8)$$

The change in the technical efficiency gives the in process evaluated of the distance of the decision making units to the efficiency frontier. Technological change provides the change in the efficiency frontier in the process (Kula; Kandemir; Özdemir, 2009; Bilişik, 2015).

4. FINDINGS AND DISCUSSIONS

In this study, 9 iron and steel companies quoted on Stock Exchange Istanbul were evaluated of efficiency. Calculation of comparative activities of these companies and determination of potential improvement targets for ineffective companies were aimed. Data envelopment analysis has been chosen as the method to be used in the research because it has more than 1 input and output in practice and measures the relative efficiency of the companies. Efficiency scores for these companies covering the years 2014 and 2015 were calculated and results were included. Inputs in a production system pass through the production process and turn into output. Outputs are seen as a result of production and can also be defined as earnings. Inputs are defined as the sources of decision making units (DMUs) and are factors that affect their performance depending on their use. In the selection of the data to be used in measuring the effectiveness of DMUs, the literature on efficiency analysis in the iron and steel industry was searched and the input and output factors frequently used in the literature were obtained into consideration. In the literature, despite the small amount of change between inputs and outputs, the total number of inputs and outputs to be used must be less than the number of DMUs, so the elimination is performed in the input and output factors. In the measurement of the effectiveness of the DMUs that are the subject of the study, the optimization solution was realized under the assumptions DEA's constant fixed return to scale (CCR) as well as the variable return to scale (BCC). In both methods, output-based approach efficiency measures were made to ensure the highest possible output from sources (inputs).The minimum number of DMUs (n + m + 1) required for analysis was fulfilled. n: number of inputs: 3, m: number of outputs: 2. Frontier Analysis program was used for the analysis and efficiency measurement.

Table 1: Efficiency Scores and Malmquist Index with Technical Efficiency Results

DMUs	CCR score (TE) (2014/ 15)		BCC score (PE) (2014/ 15)		Scale efficiencies		Returns to scale (2014/ 15)		Technical efficiency change	Techno-logical change	Malmquist Index (MPİ)
Asil Çelik	1	0,90	1	1	1	0,90	c.	i.	0,90	0,77	0,69
Burçelik	0,69	0,76	1	1	0,69	0,76	d.	d.	1,10	1,03	1,13
Çemtaş	1	1	1	1	1	1	c.	c.	1	0,83	0,83
Erdemir	0,84	0,55	0,86	0,59	0,98	0,92	d.	d.	0,65	1,29	0,84
İsdemir	1	1	1	1	1	1	c.	c.	1	3,22	3,22
İzmir D.Ç.	1	1	1	1	1	1	c.	c.	1	0,89	0,89
Kardemir	1	0,64	1	1	1	0,64	c.	i.	0,64	0,74	0,48
Tuğçelik	0,09	0,11	1	1	0,09	0,11	d.	d.	1,26	0,84	1,06
Özbal	1	1	1	1	1	1	c.	c.	1	1,31	1,31

*(TE) Technical efficiency; (PE) Pure efficiency; (i) increasing returns to scale; (c) constant returns to scale; (d) decreasing returns to scale

Scale efficiency is an efficiency form based on the size of the output / input ratio. If the increase in the input rate is greater than the increase in the output rate, it is expressed as a decreasing return to scale; If the increase in the input rate is equal to the increase in the output rate, it is expressed as constant return to scale; If the increase in the input rate is less than the increase in the output rate, it is expressed as increasing the return to scale. The DMU Asil Steel, Çemtaş, Isdemir, İzmir Demir Çelik, Kardemir and Özbal, according to the activity scores belonging to 9 iron and steel companies in 2014, all shows efficient production scale and efficient resources in terms of scale efficiency. Burçelik and Tuğçelik DMUs are not efficient in scale. This is because they are purely efficient but not technical. Erdemir is not efficient in terms of pure technical efficiency and technical efficiency. It is seen that Burçelik and Tuğçelik, which have pure technical efficiency score 1 but not technical efficiency, have lower scale efficiency than the pure and technical inefficient Erdemir. It is seen that Erdemir has greater scale efficiency because the DMUs technical efficiency and pure technical efficiency values are close to each other. Burçelik, Erdemir and Tuğçelik companies have a decreasing return to scale. Other companies have shown constant return to scale due to their full effectiveness in all efficient observations. When the efficiency scores of 9 iron and steel companies obtained for the year 2015, data and the imports according to the scale are examined, Çemtaş, Isdemir, İzmir Demir-Çelik and Özbal own the largest scale efficiency. These companies used both their resources properly and operated at the most effective production scale. Erdemir is not located on any efficiency frontier. Nonetheless, DMUs with pure technical efficiency is more effective in terms of scale efficiency than technical inefficient DMUs. This is because the difference between the efficiency scores is very low. DMU Asil Çelik and Kardemir shows increasing return to scale. Çemtaş, Isdemir, İzmir Demir-Çelik and Özbal shows a steady return to scale and operates at the highest scale. DMU Burçelik, Erdemir and Tuğçelik show a decreasing return to scale and it is necessary to use their resources efficiently. When the Malmquist total factor productivity results of 2014 to 2015 are examined, it is seen that Burçelik, Isdemir, Tuğçelik and Özbal DMUs increase in total factor productivity. It is seen that the increase in total factor productivity of Burçelik is mainly due to the increase in technical efficiency. The DMU Isdemir has the highest Malmquist total factor productivity index (MPI). It is seen that the main reason for the growth in total factor productivity of the DMU, which is technically efficient in both periods, is due to the increase in technological change. The DMU Tuğçelik shows an increase in Malmquist total factor productivity. The reason for this is that the company increases its technical efficiency according to the previous turn. Özbal emerged as another company with an increase in the Malmquist total factor productivity index (MPI). DMUs technical efficiency values for 2014 and 2015 shows that the DMU is full efficient. The reason for the increase in MPI is due to the increase in technological change. According to the Malmquist total factor change index DMU Asil Çelik, Çemtaş, Erdemir; İzmir D.Ç. and Kardemir experienced a decrease. A decrease in total factor productivity, compared to the previous turn was seen because of the decrease in both, technical and technological change of Asil Çelik. Due to a decrease in technical efficiency from the DMU Erdemir, the total factor productivity reduced as well. Erdemir misused his resources according to the previous turn. This DMU also has not used the advantage of technological development. Kardemir has the lowest Malmquist total factor productivity index. During the period from 2014 until 2015, the company reduced its efficiency and remained behind in technological change.

5. CONCLUSION

Investments in the steel sector and the trade agreement after the 1990s, Turkey made a substantial advance. Considering the iron and steel consumption rates, which are also indicated as the level of development of the countries, Turkey is seen among the developing countries. That Industry also provides raw materials for many sectors such as transportation, machinery, construction, automotive, white goods and transportation. In recent years, import and export balances have moved in the negative direction to become a net importer. More than half of the raw material needed by the industry is also covered by imports. In addition, nearly 70% of the iron and steel production in our country is provided by electric arc furnace plants. These plants use scrap as raw material in production. Considering large producers, around 70% of the world production is realized in integrated plants. Integrated plants use iron ore as raw material in basic oxygen furnaces. In recent years with the decline in iron ore prices and the increase in scrap prices, the price difference between these two raw materials has been fully opened. Therefore, Turkey's use of scrap in most of its production has reduced its competitive power compared to other countries. In addition, the resources used as raw materials are reflected in dollars as an extra financial difficulty for companies every day because of the exchange rate difference. In this context, it is imperative that companies convert their scarce resources to the highest possible output. In this study, which includes the efficiency study of iron and steel companies, data envelopment analysis was used for efficiency measurement. A non-parametric method, DEA measures the distances to the efficiency frontier by making relative comparisons of the companies called the decision making units (DMUs). It uses the various constraints to provide values to the DMUs (0,1), which allows the DMUs with multiple inputs and outputs to measure the activities, avoids the need to make input and output transformations to measure, and offers suggestions for identifying and eliminating inefficiencies it provides important information to the managers. 3 inputs (number of employees, fixed assets, current assets) and 2 outputs (revenue, gross profit) obtained from the financial statements for 2014 and 2015 of 9 iron and steel companies listed in Stock Exchange Istanbul were analysed via output-based CCR and BCC methods. In addition, the change in total factor productivity of firms over the 2-year period has been examined by the Malmquist index. An effective and efficient use of available resources is not an appropriate input-based approach to reduce the number of employees in today's conditions, where the increase in unemployment rates is more concerned with the reduction of resources than the reduction of resources. We consider as an important indicator, the CCR efficiency in 2014 and 2015 from the DMU Erdemir, which is well above Tuğçelik. Considering the BCC efficiency scores DMU Erdemir lagged behind of Tuğçelik. Erdemir was not efficient, while Tuğçelik was efficient. In scale efficiencies for the year 2014, DMU Asil Çelik, Çemtaş, İzmir Demir Çelik, Kardemir and Özbal has operated in the most efficient scale of production. Burçelik, Erdemir and Tuğçelik shows decreasing returns to the scale. These DMUs can increase their efficiency by reducing their resources and they can suitable operate at maximum scale. Considering the scale efficiencies for the year 2015, the DMU Çemtaş, Isdemir and İzmir Demir-Çelik Özbal were found to operate in the most efficient production scale.

Considering returns to scale, DMU Asil Çelik and Kardemir have shown increasing return to scale. By increasing their input, these DMUs can achieve a greater output and increase their efficiency. In 2015 Burçelik, Erdemir and Tuğçelik also showed decreasing return to scale comparable as in 2014. The Malmquist total factor productivity index is the result of the reviews. In general terms, the average of MPI has been increased. While the technical efficiency value decreased, the average technological change has been increased. While the hugest MPI exchange is seen in Isdemir, the reason for this change is that it is the company that benefits the most from technological change. DMUs also seen growths with İsdemir are Burçelik, Tuğçelik and Özbal. DMU Tuğçelik increases MPI due to technical efficiency change, unlike other increasing DMUs. In this process, DMUs that shown a decrease in total factor productivity are Asil Çelik, Çemtaş, Erdemir, İzmir Demir-Çelik and Kardemir. Total Factor Productivity and two-year activities have been observed in more than half of the total factor productivity. The total factor productivity considered in two-year activities observed that more than half of the DMU's have decreased in MPI. It is seen that inefficient companies also have shown an increase in total factor productivity. Since activities are directly proportional to the use of resources, organizations need to reduce input or take measures to increase their output. The components that weaken Turkey's competitive power need to be rescued from these burdens in order to enable the sector to gain momentum. One of the greatest factors is that the support to the iron and steel sector is hindered from the government. The agreement with ECSC (European coal and steel community) should be re-audited and state benefits and subsidies should be provided. The energy cuts that increase the input costs, which affect competition in exports, will relieve the sector from the withdrawal of funds. Increasing the production of high value added products or increasing the production can increase the incomes. Especially in view of stainless steel, special steel and seamless pipe products, which are insufficient in Turkey, should have an increase in export and imports. With plans and strategies to be implemented in this way, both the cost of inputs can be reduced and the output can be increased.

REFERENCES

Banker, R., Charnes, A., & Cooper, W. 1984. "Some models for estimating technical and scale inefficiencies in data envelopment analysis". *The Institute of Management Sciences*, vol. 9, pp. 1078-1092.

Berger, A.N. & Humphrey, D.B. 1997. "Efficiency of financial intuitions: International survey and directions for future research". *European Journal of Operational Research*, vol. 98, no. 2, pp. 175-212.

Bilişik, M.T. 2015. "Productivity research in turkish banking sector by data envelopment analysis". *Academic View Magazine*, vol. 49.

Bilişik., M.T. 2015. "Analysis of developing and fast growing countries of the agriculture sector with Malmquist total factor productivity". *Trakya University Journal of Social Sciences*, vol. 17, no. 2, pp.77-97.

Çakır, S., & Perçin 2011. "Activity measurement in public sugar factories: DEA - Malmquist MPI application". *Anadolu University Journal of Social Sciences*, vol. 12, no. 4, pp. 49-64.

Çetin, A. 2006. "Determination of the efficiency levels of turkish textile sector and turkish textile firms". Süleyman Demirel University, İ.İ.B.F., Business Administration. Afyon Kocatepe University, *İ.İ.B.F. Magazine*, pp. 255-278.

Charnes, A., Cooper, W., Lewin, Y., & Seiford, L. 1994. "Data Envelopment Analysis: Theory, Methodology, and Application". *Boston: Springer Science + Business Media, LLC.*

Charnes, A., Cooper, W., & Rhodes, E. 1978. "Measuring the efficiency of decision making units". *European Journal of Operational Research*, pp. 429-444.

Çınarer, S., Aksoy, Y. Z., & Dulkan, F. 1989. Industrial Congress Reports (420). *TMMOB, Chamber of Mechanical Engineers*.

Cingi, S., & Tarım, A. 2000. "Performance measurement for the turkish bank system, a DEA-Malmquist total factor productivity index application". *Turkish Banks Association Research Series*, vol. 01, pp. 1-34.

Cooper, W., & Seiford, L. T. 2007. "Data Envelopment Analysis, A Comprehensive Text with Models Applications, References and DEA-Solver Software". *Springer Science+Business Media, LLC.*

Cooper, W., Seiford, L., & Tone, K. 2000. "Data Envelopment Analysis A Comprehensive Text with Models, Applications, References and DEA-Solver". *Kluwer Academic Publisher*.

Cummins, J. D., & Weiss, M. A. 1998. "Analyzing Firm Performance in the Insurance Industry Using Frontier Efficiency Methods". *Wharton* (92-22), pp. 4.

Doğaka, T.C. Eastern Mediterranean Development Agency. 2014. Iron and Steel Sector Report. http://www.dogaka.gov.tr. *Sectoral research reports*, pp. 6; 12.

Farrell, M. 1957. "The Measurement of Productive Efficiency". *Journal of the Statistical Society*, vol. 120, no. 3, pp. 253-290.

Fried, H., Knox Lovell, C., & Schmidt, S. 2008. "The Measurement of Productive Efficiency and Productivity Growth". *Oxford University Press.*

İnan, A.2000. "Measuring Bank Efficiency and Efficiency in Banking in Low Inflation Process". *Bankers Magazine*, vol. 34, pp. 83.

Kadıoğlu, E. 2006. "Factors determining the profitability of intermediate institutions in Turkey. " Master Thesis. *Hacettepe University Social Sciences Institute.*

Karabulut, T., Okka, Ö., & Başel, H. 2006. "Individual performance-based salary and productivity relation: Example application in banking sector". *Selçuk University Karaman İ.İ.B.F. Magazine*, vol. 11, pp. 104-118.

Karaemir, Ç. 2013. "Activity Analysis in Training Centers, Performance Analysis Using DEA". Master Thesis. *Ankara University. Social Sciences Institute*.

Kaya, A., & Gülhan, Ü. 2010. "The effects of the global financial crisis on the efficiency and performance levels of companies: 2008 Financial Crisis Case". Istanbul University. Economics Faculty. *Econometrics and Statistics Journal*, vol. 11, pp. 61-89.

Kaya, A., Öztürk, M., & Özer, A. 2010. "Metal goods, Machinery and Equipment Construction Measurement of Efficiency by Data Envelopment Analysis of Sectors". Atatürk University. *Journal of Economics and Administrative Sciences*, vol. 24, no. 1, pp. 129-147.

Kecek, G. 2010. "Data Envelopment Analysis / Theory and Application Example". Ankara*: Political Bookstore*.

Koçak, H., & Çilingirtürk, A.M. 2011. "Comparative analysis of the efficiency in the use of resources in EU countries and candidate countries". Istanbul University. *Journal of Business Administration*, vol. 40, no. 2, pp. 166-175.

Kula, V., Kandemir, T., & Özdemir, L. 2009. "DEA Malmquist total factor productivity measure: A survey on cement companies in Stock Exchange Istanbul". *İİBF Journal of Social and Economic Research*, p. 188-202.

Lorcu, F. 2008. "Data envelopment analysis (DEA) to evaluate the health activities of Turkey and European Union countries". PhD Thesis. Istanbul University. Social Sciences Institute, pp. 340.

T.C. Ekonomi Bakanlığı. 2016. "Iron-Steel, Iron-Steel Goods Sector". Mine, Metal and Forest Products Department.

Thanassoulis, E. 2001. "Introduction to the theory and application of data envelopment analysis: a foundation text with integrated software". *KluwerAcademic Publishers*, 281s.

Turgutlu, E., Kök, R., & Adnan, K. 2007. "Efficiency in turkish insurance companies: Deterministic and chance constrained data envelopment analysis". *Economics Business and Finance*, vol. 22, pp. 251; 8.

Ulucan, A. 2002. "Data envelopment analysis approach measuring the efficiences of ISO 500 companies: Evaluating with different input output components and returns to scale". *Ankara University SBF Magazine*, 57-2, pp. 186-202.

Wang, Q., & Cui, J.-C. 2010. "A Resource Allocation Mode Based on DEA Models and Elasticity Analysis". *The Ninth International Symposium on Operations Research and Its Applications* , pp. 167-174.

Yolalan, O. R. 1993. "Within companies, relative effectiveness measurement". National Productivity Center, Publication No: 483, Ankara, 96p. *(MPM) Publications*.