MEASUREMENT OF FINANCIAL PERFORMANCE IN PRODUCTION SECTOR

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Abstract
Measuring effectiveness and performance of manufacturing sector, one of the basic dynamics of growth, has gained importance for companies in the evolving competence environment. In this study, effectiveness and performance of companies, operating in the manufacturing sector are tried to be measured on the basis of sector balance sheet data provided by the Central Bank. For this purpose, data for the years of 2009-2010 are evaluated financially using the DEA method and whether the firms are effective or not is tried to be determined.
Key Words*: Production Industry, Performance Measurement, Financial Performance, Data Envelopment Analysis*
JEL Classification: G1,G2
Özet
İmalat Sektöründe Finansal Performansın Ölçümü
Büyümenin temel dinamiklerinden biri olan imalat sektörünün performans ve etkinliğini ölçmek gelişen rekabet ortamında firmalar açısından gittikçe önem kazanmıştır. bu çalışma da imalat sektöründe faaliyet gösteren firmaların TCMB de yayınlanan sektör bilanço verileri baz alınarak etkinlik ve performansları ölçülmeye çalışılmıştır. Bu amaçla 2009-2010 yıllarına ait veriler VZA yöntemi kullanılarak finansal açıdan değerlendirilmiş ve firmaların etkin olup olmadığı tesbit edilmeye çalışılmıştır.
Anahtar Kelimeler: *İmalat Sanayi, Performans Ölçümü, Finansal Performans, Veri Zarflama Analizi*

1. INTRODUCTION

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The global financial crisis, which initially erupted in the USA in 2007 and then influenced the entire globe after Lehman Brothers went bankrupt on 15 September 2008, has shown that among the primary issues to which enterprises should attach importance is their financial structures. Making financial analyses in enterprises on a regular basis is essential for healthy decision-making and for the execution of planning and supervision mechanisms effectively. Among the most important responsibilities of managers is, therefore, the measurement and analysis of financial performance (Acar, 2003: 21)

In today's competitive environment, the sine qua non of firms' survival and good performance is the efficient use of resources. Therefore, firms have to investigate their level of efficiency through analyses performed on a regular basis. Productivity, in its most general definition, is the ratio of outputs obtained in a production process to inputs (resources) used to obtain them. Efficiency analysis enables the firm to see its place in the existing competitive setting and shows how better level of output can be produced using the available resources (Yolalan, 1993: 6).

Measurement systems used for efficiency analysis are ratio analyses and parametric and nonparametric methods. Ratio analysis is employed in cases in which there exist multiple inputs and outputs and all these inputs and outputs cannot be converted into a single unit. Therefore, in this type of analysis, the inputs and outputs of the process whose efficiency is analyzed should be considered separately, and thus, such analyses produce results that are mostly impossible to interpret. Basically, ratio analysis can be defined as "the ratio of a single output to a single input". Parametric methods, on the other hand, aim to determine the parameters of the production function with the assumption that this function has an analytical nature (Yolalan, 1993: 5). Regression analysis, which is the most widely known among parametric methods, is aimed at determining the causal nature of the relationship between dependent and independent variables that are known to have a cause and effect relationship (Hays, 1973: 676). In regression analysis, the production function pertaining to the decision units whose efficiencies are analyzed is assumed to have an analytical structure. Nonparametric methods, finally, do not have such an

assumption and are employed to measure relative performance by mostly using mathematical programming (Karsak and Özyiğit, 1999: 398).
Data Envelopment Analysis (DEA), a linear-based technique aimed at measuring relative performances of decision units, is among the common nonparametric methods employed in cases where comparison is difficult as inputs and outputs are more than one and have different units of measurement (Bouofiance vd., 1991: 3). Analyses are based on the evaluation of the production activities of decision units that are of a similar type. The decision units to be analyzed should carry out similar functions aimed at the same objective, operate under the same market conditions and all the elements defining the efficiencies of all of the units in the group (except for the differences in their intensity and size) should be the same (Kayalıdere and Kargın, 2004: 196).
The most used method in firms' financial analysis is ratio analysis. It is aimed at determining firms' power to pay back their short-term debts, the level of efficiency in using their investments, the ways they finance their assets (through foreign assets or capital), and if they operate at a sufficient level of profitability.
In this study, multi-directional efficiency and productivity measurement was performed on the 2009-2010 financial ratios of a total of 160 firms operating in the Turkish manufacturing sector using the nonparametric method of "Data Envelopment Analysis". In the analysis, efficiency of the subsectors of the manufacturing sector is assessed.

2. LITERATURE

Performance measurement refers to determining the extent enterprises achieve their objectives. One of the most commonly used methods for this purpose is DEA, which was developed by Charnes, Cooper and Rhodes based on Farrel's boundary analysis. DEA takes multiple inputs and outputs at the same time and measures relative efficiency. What distinguishes DEA from other methods is that it allows the use of multiple numbers of inputs and outputs in the analysis and that the analyst does not have to determine their weights (Kocakoç, 2003: 1)
Regarding to this subject, the study conducted by Mahadevan (2002) examined the productivity growth performance of Malaysia's 28

manufacturing industries from 1981-1996. The data envelopment analysis technique was used in this study and it was found that the annual total factor productivity growth of the Malaysian manufacturing sector was lower than 0.8%.

In the study of Atılgan and Gülsevin (2006), efficiencies of eight textile firms that operated mostly in the field of home textile were measured through DEA by using together three inputs that they consumed in different quantities and three outputs that they obtained in different amounts.

Elitaş and Eleren (2007) conducted an efficiency analysis study through DEA by using the data that belonged to ten cement producer firms and found that especially those firms with low sizes of assets have better efficiency results.

Yalama and Sayım (2008) compared the performances of Istanbul Stock Exchange manufacturing firms using DEA. Financial ratios were used to this end, and the average efficiency score for December 2005 was calculated to be 83,94%.

Ata and Yakut (2009) measured the efficiencies of manufacturing firms based on financial performance using their data belonging to the 1996-2006 period. After the analysis, it was observed that a couple of sectors achieved ever-increasing and high efficiency levels, although there was not any sector always efficient throughout the period.

A case study was conducted by Liu and Wang (2009) to evaluate the performance of printed circuit (PCB) manufacturing firms in Taiwan. The data envelopment analysis was used in this study to calculate productivity of manufacturing firms and it was found that none of the PCB manufacturing firms performed efficiently. In addition to this, it was indicated that to improve productivity and profitability, the manufacturing firms need to consider the issues of product improvements and technological innovation in the future.

Saranga (2009) examined the performance analysis of 50 firms in Indian auto component industry by using Data Envelopment Analysis (DEA) technique. In this study, the 2003 data was used and it was found that short-run efficiency in working capital management increases the operational productivity in the industry. It was also stated that use of technology does not have any significant impact on productivity.

Kaya, Öztürk and Özer (2010) analyzed ten ratios obtained from balance and income tables of 25 metal and machinery firms demonstrating four quarters of 2008. According to their findings, five firms that were efficient in all four quarters were determined, although firms' efficiency scores differed among the quarters.

Sueyoshi and Goto (2010) examined the impacts of environmental, operational and financial situations of listed manufacturing firms upon their performances using DEA. In the study, it was determined that large firms should improve their managerial capabilities in order to increase their performances.

Jain, Triantis and Liu (2011), finally, presented a DEA-based approach in performance measurement and target setting of manufacturing systems.

In a study conducted in 2012 by Soba et al., efficiency evaluation and performance measurements between 2008 and 2010 were done for 26 industries operating in stone-soil sector and 28 industries operating in fabricated metal products, machinery and equipment sector. Data Envelopment Analysis and TOPSIS method were used and it was found that the energy consumption cost is high in the industries operating in stone-soil and fabricated metal products, machinery and equipment sectors.

In the study conducted by Tosunoğlu and Uysal in 2012, it was tried to investigate the efficiency of the firms in the manufacturing sector that were listed in the İstanbul Stock Exchange and in the İSO500 by using Data Envelopment Analysis (DEA). Examined a total of 29 firms by 2009 and concluded that 8 of these firms were efficient and 21 of them are ineffective.

In a study conducted by Yavuz and İşçi (2013), the relative efficiency belonging to 2009, 2010 and 2011 years of 25 firms which ranked among the top 500 largest companies operating in the food sector in Turkey in the last three years, were measured. DEA was used with 3 inputs and 3 outputs. Inputs were; equity, total assets and number of employees. Outputs were; net sales, profit and export variables. As a result of the study, the percentage of the average activity was found as 77%.

3. DATA AND METHOD

In the study, the sectoral financial performances of 160 firms, which are operating in manufacturing sub-sectors and listed on Istanbul Stock Exchange (ISE), will be measured through nine ratios (seven inputs and two outputs) that could represent financial performance using the data obtained from their 2009 and 2010 balance and income tables. Balance and income tables of the firms were obtained from the website of the Public Disclosure Platform. As the costs of manufacturing goods and profitability were significant concerns of firms, an output-oriented CCR model was adopted and DEAP 2.1 was used to solve this model.

3.1. Data Envelopment Analysis

Data Envelopment Analysis is a method that is based on linear programming and used to measure the relative efficiencies of monitored decision units in cases in which it is difficult to compare these units due to the presence of more than one input and output (Emrouznejad, 2011). The main assumption in DEA is for all enterprises to have similar strategic goals and to obtain the same kind of output by using the same kind of input (Golany and Yu, 1997: 28).

The way DEA measures relative efficiency can be summarized in two stages as follows (Yolalan, 1993: 6–7):

1. It determines the best observations (or the decision units that form the efficiency boundary) in a given observation cluster that produce the highest output composition by using the lowest input composition.

2. By taking this boundary as the reference point, it proportionately measures the distances (or efficiency levels) of inefficient decision units to this boundary.

Main reasons to use this method effectively in efficiency evaluation are;

1. It doesn’t require an analytical functional structure,

2. It can assess multiple inputs and multiple outputs together,

3. It states efficient and inefficient decision making units and finds reference sets among those efficient units,

4. It can be used even inputs and outputs cannot be defined in common units,

DEA, therefore, is employed successfully in measuring efficiencies of numerous different institutions such as schools, healthcare units, banks and branches, armed forces, agriculture, transportation and public administration (Özcan, 2005: 1).

The most important novelty brought about by the method is that it can perform measurement in environments where multiple inputs are used to produce multiple outputs without requiring the presence of any pre-defined analytical production function, as it is the case in parametric methods. In addition, inputs and outputs are independent from measurement units. Therefore, it is possible to evaluate different dimensions of an enterprise (Karsak and İşcan, 2000: 2).

Nonparametric measurement techniques can be divided into two groups: input- and output-oriented efficiency measurement. Input-oriented measurement techniques investigate to what extent inefficient decision units should decrease their inputs for a given level of output. Output-oriented measurement techniques, on the other hand, focus on how outputs can be increased in order to render decision units efficient for a given input composition.

As being a non-parametric test like Mann-Whitney U, Kruskal-wallis, Friedman, Median and Chi-Square, DEA models can also be divided into two sub-groups as "input-oriented" and "output-oriented". Although input- and output-oriented DEA models are essentially very similar to each other, input-oriented DEA models investigates how the most appropriate input composition should be in order to obtain a certain output composition in the most efficient way, whereas output-oriented DEA models explores the maximum amount of output composition that can be produced from a given input composition (Charnes vd., 1981:669).

3.1.1. DEA's Mathematical Expression

The mathematical expression of the output/input ratio, to be maximized for n number of decision units that have m number of inputs and s number of outputs, proposed by Charnes, Cooper and Rhodes (1978) for DEA model is as follows (Cooper and Seifard, 2000: 35).

Efficiency = Output /Input

$$Max h_k = \frac{\sum_{r=1}^{s} u_{rk} y_{rj}}{\sum_{i=1}^{m} v_{ik} x_{ij}}$$

(1)

In this expression, the parameter of $X_{ij}>0$ refers to the amount of inputs ($_i$) used by the decision unit "$_j$", and the parameter of $Y_{rj}>0$ denotes the amount of outputs ($_r$) used by the decision unit "$_j$". For this equation that meets the requirement of maximization, reference variables are the weights to be given by the decision unit "$_k$" for input "$_i$" and output "$_r$", which are shown as "v_{ik}" and "u_{rk}". The constraint that prevents the efficiency from going above 100% when the reference weights of the organizational decision unit "$_k$" are used by other decision units is as follows;

$$\frac{\sum_{r=1}^{n} u_{rk} y_{rj}}{\sum_{i=1}^{m} v_{ik} x_{ij}} \leq 1$$

$u_r \geq 0$ j= 1,……n and k = 1,……n (2)

$v_i \geq 0$

The constraint that prevents the input and output weights to be used from being negative is as follows;

$u_{rk} \geq 0$; r =1,.......,s

$v_{ik} \geq 0$; i =1,.......,m

(3)

After the conversion of the above fractional programming model into linear programming model, the CCR data envelopment model was obtained (Charnes vd., 1978: 432). In order to convert this set of inequalities into the form of linear programming and thus to reach a solution with Simplex or similar algorithms, it is enough to set the denominator of the objective function in the maximization form to 1 and thus make it a constraint.

Objective Function;

$$Maxh_k = \sum_{r=1}^{n} u_{rk} y_{rk} \tag{4}$$

Constraint Conditions;

$$\sum_{i=1}^{m} v_{ik} x_{ik} = 1$$

$$\sum_{r=1}^{n} u_{rk} y_{rj} - \sum_{i=1}^{m} v_{ik} x_{ij} \leq 0 \tag{5}$$

$$u_{rk}, v_{ik} \geq 0$$

h_k = efficiency coefficient, h_k is always equal to or lower than 1. If h_k < 1; the decision unit is relatively inefficient. If h_k = 1; the decision unit is relatively efficient.

The mathematical expression of the output-oriented CCR model is as follows;

Objective Function:

$$Minh_k = \sum_{i=1}^{m} v_{ik} x_{ik} \qquad k = 1,2,\ldots.n \tag{6}$$

Constraint Conditions:

$$-\sum_{r=1}^{s} u_{rk} y_{rj} + \sum_{i=1}^{m} v_{ik} x_{ij} \geq 0 \qquad j=1,2\ldots\ldots m$$

$$\sum_{r=1}^{s} u_{rk} y_{rk} = 1$$

$$u_{rk}, v_{ik} \geq 0 \qquad r=1,2\ldots\ldots\ldots s$$

i=1,2………m

In this study, output-oriented CCR model is employed. The aim of this model is to determine the weights of inputs and outputs that will minimize the ratio of the actual input to the actual output for the target decision unit. Constraints limit the ratio of the actual input to the actual output to be at least 1 for each decision unit, and all input and output weights to be non-negative.

3.2. Assessment of Efficiencies of Firms listed on ISE and Operating in Manufacturing Sub-Sectors through DEA

In DEA practices, decision units that implement the same decisions and operate in similar fields should be selected in order to be able to compare their efficiencies. The Appropriate Decision Making Units is defined based on the subject matter and aim of the study.

In the selection of decision making units, aside from them being similar in terms of their manufacturing technologies, they should not be less than the number required by the linear programming model to be used in the study. If the number of selected inputs is m and outputs is p; it is important to have at least m+p+1 number of decision units for the reliability of the research. Another constraint is that the number of decision units included in the scope of the study should be at least twice the number of total variables (Boussofiane vd., 1991: 15).

The decision units in this study are those enterprises that are listed on ISE and operating in manufacturing sub-sectors, shown in Table 1. Since the fact that the sub-sectors of Forest Products and Furniture had two firms and the sub-sector of "other manufacturing" had three firms did not comply with DEA constraints, these two sub-sectors were merged with the sub-sector of "Paper and Paper Products, Printing and Publication"; and 12 firms in the "Main Metal Industry" were brought together with the sub-sector of "Metal Products, Machines and Equipments". The research was carried out using the ratios belonging to 160 firms that were listed on ISE and operating in the sub-sectors of the manufacturing industry.

The inputs and outputs in the research should be selected carefully, as they form the basis of the comparisons made between the decision units. Since different input and output groups will take different values for the same decision unit, it is necessary to determine significant inputs and outputs.

Table 1. Manufacturing Industry Sub-Sectors

SUB-SECTORS	NUMBER OF

	FIRMS
Food, Beverage and Tobacco	23
Weaving, Clothing and Leather	27
Paper and Paper Products, Printing and Publication Forest Products and Furniture Other Manufacturing	19
Chemical, Petroleum, Rubber and Plastic Products	26
Stone and Soil Based Manufacturing	26
Metal Products, Machines and Equipments Production Main Metal Industry	39

Since negative values of net period profit, which is among output factors, for some firms in some periods will violate the assumption of DEA that the variables should be positive, these values were converted into positive values through the following normalization formula (Yıldız, 2005: 291).

$$\frac{Xrj - XjMin}{XjMax - XjMin}$$

Xrj = Output value "r" for the decision unit "j"

$XjMin$ = Minimum "r" value

$XjMax$ = Maximum "r" value

The input and output variables determined by considering the financial structure of the manufacturing industry are given in Table 2.

Table 2. Input and Output Variables used in the Study

Inputs	**Outputs**
Current Ratio	Net Profit / Total Assets
Financial Leverage	Net Profit / Equity Capital
Shareholder's Equity / Total Assets	
Shareholder's Equity / Total Debts	
Short-term Liabilities / Total Liabilities	
Shareholder's Equity Turnover Rate	
Asset Turnover Rate	

DEA quantitatively measures the efficiencies of decision units operating in the same market, and those units with a 100% efficiency score are considered efficient whereas others with efficiency scores less than 100% are seen as inefficient (Küçük, 2007: 21).

The efficiency scores pertaining to 2009 and 2010 periods, calculated using output-oriented DEA, are given in Table 3, Table 4, Table 5, Table 6, Table 7 and Table 8.

Table 3. Efficiency Scores of Firms Operating in Food, Beverage and Tobacco Industries

FIRM	**2009**	**2010**	**FIRM**	**2009**	**2010**	**FIRM**	**2009**	**2010**
KENT	0.586	0.442	PINARET	0.493	0.494	ULKRBIS	0.776	0.977
KERVITŞ	1.000	1.000	PINARSU	0.432	0.404	AEFES	0.883	0.564
KONFRT	0.668	0.725	PINARST	0.632	0.522	BANVIT	0.712	0.718
KRISTK	1.000	1.000	SELÇKG	0.587	0.546	CCOLA	0.595	0.653
MANGO	0.680	0.676	SEKERP	0.725	0.528	DARDNL	1.000	1.000
MERKO	0.956	0.322	TUBORG	0.519	0.444	ERSU	1.000	1.000
MERTG	1.000	0.719	TATKNSR	0.771	0.856	FRIGO	0.760	1.000
PENGUEN	0.669	0.482	TUKASG	0.856	1.000			

Table 3 shows that 5 of 23 firms operating in the Food, Beverage and Tobacco industries were found efficient in 2009, whereas 6 of them were found efficient in 2010. Firms that were found to be efficient in 2009 are KERVİTŞ, KRİSTK, MERTG, DARDNL and ERSU, and in 2010 are KERVİTŞ, KRİSTK, TUKAŞG, DARDNL, ERSU and FRIGO. MERTG is efficient in 2009; however, it becomes inefficient in 2010. On the other hand, TUKAŞG and FRIGO are inefficient in 2009 but they are efficient in 2010.

Table 4. Efficiency Scores of Firms Operating in Weaving, Clothing and Leather Industries

FIRM	**2009**	**2010**	**FIRM**	**2009**	**2010**	**FIRM**	**2009**	**2010**
HATEKS	0.587	0.643	SONME	1.000	1.000	BERDAN	1.000	1.000
IDAS	0.532	0.491	SNPAM	0.815	1.000	BRKO	0.832	0.706
KARSU	1.000	0.829	YUNSA	0.699	0.643	BRMEN	0.459	0.391

KORDSA	0.696	0.827	YATAS	0.755	0.673	BISAS	1.000	1.000
LUKSK	0.778	0.728	BYINDR	1.000	1.000	BOSSA	0.873	0.773
MENDRS	0.488	0.594	AKALT	1.000	1.000	DERIM	0.908	0.927
MENSA	1.000	1.000	ATEKS	0.546	0.530	DESA	0.959	0.913
METEM	1.000	0.314	ALTIN	0.701	0.971	GEDIZ	0.462	0.170
SOKTAS	0.797	0.787	ARSAN	0.492	0.395	ESEMS	1.000	0.087

The number of firms operating in this sub-sector is 27. Among them, the number of efficient firms in 2009 is 9, and in 2010 is 7. Efficient firms in 2009 are KARSU, MENSA, METEM, SÖNME, BYINDR, AKALT, BERDAN, BİSAS and ESEMS, and in 2010 are MENSA, SÖNME, SNPAM, BYINDR, AKALT, BERDAN and BİSAS. Whereas KARSU, METEM and ESEMS turned to be inefficient in 2010; SNPAM, on the other hand, turned to be efficient in 2010.

Table 5. Efficiency Scores of Firms Operating in Paper and Paper Products, Printing and Publication Industries

FIRM	**2009**	**2010**	**FIRM**	**2009**	**2010**	**FIRM**	**2009**	**2010**
HURRYT	1.000	1.000	IPEKMAT	0.657	0.789	SERVE	1.000	1.000
IHLSGAZ	1.000	1.000	ALKA	0.839	0.707	ADEL	1.000	1.000
KARTNAN	1.000	0.855	BAKAB	0.780	0.709	GOLDS	1.000	1.000
KOZA	0.646	0.789	DENTA	1.000	1.000	KLBEKM	1.000	0.988
MONDI	0.922	0.567	DOBUR	1.000	1.000	GENTS	0.873	1.000
OLMKSA	0.724	0.768	DGZTE	1.000	1.000			
VIKING	1.000	1.000	DURDO	1.000	1.000			

Of 19 firms operating in this sub-sector, 12 were efficient in 2009 and 11 were efficient in 2010. Those firms that were efficient in 2009 are HURRYT, İHLSGAZ, KARTNAN, VİKİNG, DENTA, DOBUR, DGZTE, DURDO, SERVE, ADEL, GOLDS and KLBEKM; and in 2010 are HURRYT, İHLSGAZ, VİKİNG, DENTA, DOBUR, DGZTE, DURDO, SERVE, ADEL, GOLDS and GENTS. KARTNAN and KLBEKM are the firms that were efficient in 2009 but inefficient in

2010. GENTS, on the other hand, is the firm that was inefficient in 2009, but became efficient in 2010.

Table 6. Efficiency Scores of Firms Operating in Chemical, Petroleum, Rubber and Plastic Industries

FIRM	2009	2010	FIRM	2009	2010	FIRM	2009	2010
HEKTAS	1.000	1.000	AKSA	0.846	0.809	EGGUB	0.498	0.358
MARSHLL	0.873	0.959	ALKIM	1.000	0.818	EGPRO	0.991	0.970
PETROFS	0.767	0.881	AYGAZ	0.537	0.614	EPLAS	1.000	1.000
PETKIM	0.508	0.595	BAGFS	0.849	0.777	ECILC	1.000	1.000
PIMAS	0.947	0.974	BRISA	0.757	0.798	EKIZ	0.734	0.749
ADVNSA	1.000	0.687	CBSBO	1.000	1.000	ERBOS	1.000	0.943
SODA	0.696	0.828	PRTAS	1.000	1.000	GOODY	0.779	0.877
TURCAS	1.000	1.000	DEVA	0.720	0.743	GUBRF	0.603	0.687
TUPRAS	0.673	0.776	DYOBY	1.000	0.885			

A total of 26 firms operate in the Chemical, petroleum, Rubber and Plastic Products sub-sector. 10 of them were efficient in 2009 and 6 of them were efficient in 2010. The efficient ones in 2009 are HEKTAŞ, ADVNSA, TURCAS, ALKIM, CBSBO, PRTAS, DYOBY, EPLAS, ECILC and ERBOS; and in 2010 are HEKTAŞ TURCAS, CBSBO, PRTAS, EPLAS and ECILC. Those that turned to be inefficient in 2010 are ADVNSA, ALKIM, DYOBY and ERBOS; while there was no firm that turned to be efficient in 2010.

Table 7. Efficiency Scores of Firms Operating in Stone and Soil Based Manufacturing Industries

FIRM	2009	2010	FIRM	2009	2010	FIRM	2009	2010
HAZNDR	1.000	1.000	ADANA	0.839	0.651	CMBTN	1.000	1.000
IZOCAM	0.863	0.710	AFYON	0.991	0.690	CMENT	0.726	0.984
KONYCIM	1.000	1.000	AKCNS	0.752	0.820	CIMSA	0.712	0.699
KUTHYPR	0.900	0.899	ANACM	1.000	0.987	DENCM	1.000	1.000
MARDNCI	0.758	0.483	ASLAN	1.000	1.000	DOGUB	1.000	1.000
NUHCIM	0.593	0.652	BTCIM	0.805	0.679	ECYAP	1.000	1.000
TRKYCM	1.000	1.000	BSOKE	1.000	0.750	EGSER	0.812	0.812
USAKSER	1.000	1.000	BOLUC	0.861	0.535	GOLTS	0.631	1.000

UNYECIM	0.908	0.639	BUCIM	0.819	0.787			

In this sub-sector, 26 firms operate. Of them, 11 were efficient in 2009 and 10 were efficient in 2010. The efficient firms in 2009 are HAZNDR, KONYÇİM, TRKYCM, UŞAKESER, ANACM, ASLAN, BSÖKE, CMBTON, DENCM, DOGUB and ECYAP; and in 2010 are HAZNDR, KONYÇİM, TRKYCM, UŞAKESER, ASLAN, CMBTON, DENCM, DOGUB, ECYAP and GOLTS. Those firms that ceased to be efficient in 2010 are ANACM and BSOKE; whereas GOLTS became efficient in 2010.

Table 8. Efficiency Scores of Firms Operating in Metal Products, Machines and Equipments Industries

FIRM	**2009**	**2010**	**FIRM**	**2009**	**2010**	**FIRM**	**2009**	**2010**
IHLSHOL	0.782	0.989	VESTELKT	0.649	0.442	GEREL	0.803	0.746
KARSAN	1.000	0.268	VESTLB	0.724	0.532	IZMIRDR	0.436	0.384
KATMRC	0.603	0.629	ALCAR	1.000	1.000	SARKYSN	0.529	0.309
KLIMSN	0.651	1.000	ASUZU	0.683	0.574	BRSAN	0.330	0.372
MAKNTK	1.000	1.000	ARCLK	0.591	0.825	BURCE	1.000	0.515
MUTLU	0.595	0.491	BFREN	1.000	0.223	BURVA	1.000	0.764
OTOKAR	0.714	0.673	BSHEV	0.264	0.569	COMDO	0.186	0.981
PARSAN	0.982	0.659	DITAS	0.676	0.564	CELHA	0.608	0.412
SILVRLIN	0.591	0.460	EGEEN	0.922	0.667	CEMAS	0.363	0.647
T.DEMIRD	0.941	0.799	EMKEL	0.423	0.339	CEMTS	1.000	0.545
TOFAS	0.608	0.532	EMNIS	0.540	0.493	DMSAS	0.494	0.488
TPRYSMN	0.725	0.458	FMIZIP	1.000	1.000	EREGLI	0.395	0.922
TTRAK	0.892	0.624	FROTO	0.727	0.440	FENIS	1.000	0.880

Under this sub-sector, 39 firms were included in the analysis. Of these firms, 9 (KARSAN, MAKNTK, ALCAR, BFREN, FMIZIP, BURCE, BURVA, CEMTS and FENIS) were found to be efficient in 2009 and 4 (KLİMSN, MAKNTK, ALCAR and FMIZIP) were found to be efficient in 2010. While KARSAN, BFREN, BURCE, BURVA, CEMTS and FENIS ceased to be efficient in 2010, KLMSN became efficient in 2010.

Table 9. Number of Efficient Firms in Manufacturing Industry Sub-Sectors

SUB-SECTORS	NUMBER OF FIRMS	2009	%	2010	%
Food, Beverage and Tobacco	23	5	21,7	6	26,1
Weaving, Clothing and Leather	27	9	33,3	7	25,9
Paper and Paper Products, Printing and Publication Forest Products and Furniture Other Manufacturing	19	12	63,2	11	57,9
Chemical, Petroleum, Rubber and Plastic Products	26	10	38,5	6	23,1
Stone and Soil Based Manufacturing	26	11	42,3	10	38,5
Metal Products, Machines and Equipments Production, Main Metal Industry	39	9	23,1	4	10,3

The numbers of efficient firms in 2009 and 2010 are presented in Table 10. The sub-sectors that were most efficient in 2009 are: Paper and Paper Products, Printing and Publication (%63,2), Stone and Soil Based Manufacturing (%42,3), Chemical, Petroleum, Rubber and Plastic Products (%38,5), Weaving, Clothing and Leather (%33,3), Metal Products, Machines and Equipments Production (%23,1) and Food, Beverage and Tobacco (%21,7) industries, respectively. In 2010, on the other hand, the most efficient firms were the following: Paper and Paper Products, Printing and Publication (%57,9), Stone and Soil Based Manufacturing (%38,5), Food, Beverage and Tobacco (%26,1), Weaving, Clothing and Leather (%25,9), Chemical, Petroleum, Rubber and Plastic Products (%23,1), Metal Products, Machines and Equipments Production (%10,3), respectively.

Efficiencies decreased in 2010 compared to the previous year. The only sub-sector that increased its efficiency in 2010 is Food, Beverage and Tobacco industry.

4. CONCLUSION

As a result of globalization, which emerged along with political and technological developments and is defined as the removal of borders between countries, firms faced the obligation to compete with foreign competitors along with domestic ones. Today, as several international firms in developed and developing countries moved their productions to countries that offer cheaper labour and raw materials, domestic firms' competition capacities have declined. Performance, which is defined as a firm's level of success attained in a given time period, becomes more important for firms during crisis times. The global financial crisis, which erupted in the USA in 2007 and spread over the entire world in 2008, has shown that among the primary issues to which firms must attach importance is their financial structures.

In the study, the 2009 and 2010 financial performances of firms, which were operating in manufacturing industry sub-sectors and listed on ISE, were measured using DEA. After the analysis, it was determined that 5 of 23 firms operating in the Food, Beverage and Tobacco industry were efficient in 2009 and 6 in 2010. As for other sub-sectors; the findings are as follows (number of firms in the sector, number of efficient firms in 2009, and number of efficient firms in 2010; respectively given in parentheses): Weaving, Clothing and Leather (27, 9, 7); Paper and Paper Products, Printing and Publication (19, 12, 11); Chemical, Petroleum, Rubber and Plastic Products (26, 10, 6); Stone and Soil Based Manufacturing (26, 11, 10); and Metal Products, Machines and Equipments Production (39, 9, 4).

In the analysis, it was observed that financial performances of all sub-sectors except for the Food, Beverage and Tobacco sub-sector declined in 2010, compared to 2009. In both years, the two sectors that exhibited highest financial performances were found to be the Paper and Paper Products, Printing and Publication, and Stone and Soil Based Manufacturing sub-sectors. On the other hand, the sub-sectors with the lowest financial performances were found to be the Food, Beverage and Tobacco and Metal Products, Machines and Equipments Production sub-sectors in 2009; and the Metal Products, Machines and Equipments Production and Chemical, Petroleum, Rubber and Plastic Products sub-sectors in 2010.

It was determined that the financial performances of the manufacturing industry sub-sectors listed on ISE declined in the years of 2009 and 2010, which followed the 2008 financial crisis. This finding indicates that enterprises encountered financial difficulties. In case firms take all necessary measures for inefficient variables defined according to the input and output values obtained from DEA results in order to improve their financial structures with the aim of increase their efficiency and competitiveness power, then this will ensure the development of firms and the real sector. Besides, lawmakers should also take decisions aimed at strengthening and supporting the financial structures of the real sector and especially of the manufacturing industry in order to maintain the level of macroeconomic growth achieved by Turkey in the recent years, to solve the problem of foreign trade deficit and to bolster export.

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