FINANCIAL AND PERFORMANCE ANALYSIS OF FOOD COMPANIES: APPLICATION OF TOPSIS AND DEA

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Abstract

This study is conducted to determine relative efficiency levels and financial performance status of businesses in BIST Food, Beverage index. In empirical application, using firms' financial data of the period 2012-2013, firms' efficiency levels are researched via Data Envelopment Analysis (DEA) technique and firms' financial performances are sorted via accordance to their closeness to ideal solution via TOPSIS method as Multiple Criteria Decision Making Method. As a result, it is concluded that efficiency and performance ranks of businesses did not coincide; and firms which were observed efficient according to DEA method, did not have similarities with firms with high performance according to TOPSIS analysis.

Keywords: Financial Performance, Efficiency, TOPSIS, DEA, Food Companies.

Introduction

In today's competitive environment, businesses must stand against their competitors and know their position in this competitive environment. This issue forces firms to learn efficient and effective use of their sources, to evaluate relatively their performances in the sector they compete and to determine firms which they should take as reference. Businesses achieved this goal can make deliberate planning while both using their sources effectively and increasing their efficiency (Bakırcı et al. 2014, Özer et al. 2010).

While Businesses are planning to shape their future, they are commonly being in the position where they have to choose alternatives with different features which generally contradict with each other. In those situations, there should be scientific explanatory decision making techniques to reach more reliable results and to avoid subjective decisions. One of these techniques is TOPSIS as one of Multiple Criteria Decision Making Methods. By this technique, there is availability of selection and arrangement between alternatives which contradict with each other and provide multiple criterions. In addition, TOPSIS technique is rational and understandable, computation process is simple and it allows objective weights to be included in the comparison process (Deng et al. 2000: 965).

This study is conducted to determine firms' effectiveness and financial performance levels and whether effective businesses also have high financial performances is discussed. By this purpose, to determine effectiveness levels of firms DEA method, to arrange the financial performances of these firms TOPSIS method is used.

Literature

There are studies in the literature measuring firms effectiveness and performances via DEA and TOPSIS methods.

Deliktaş (2006) scaled performances of manufacturing firms by analyzing these firms' data in the period 1991-2000 via Data Envelopment Analysis- Malmquist efficiency index methods. In study, there are comparisons of subsectors according to scale size into their own activity area and according to different activity branches. Small businesses in the food sector as one of subsectors are determined with lower production performance according to businesses with different scale.

Perçin and Talha (2007) analyzed effectiveness of food and textile businesses quoted to BIST by the data of 2000-2002 via DEA and Malmquist Total Factor Efficiency Index approaches. As a result of analysis, in 2002, decrease in efficiency of food businesses was lower than textile businesses. Moreover, the most important reason behind the decrease in efficiency of textile and food businesses was negativity emerged from technical change.

Kumar and Basu (2008) investigated efficiency of Indian food sector businesses by Malmquist Efficiency index and observed that firms were not effective due to slow technological development in food industry. In another conducted study to measure efficiency of Indian food firms, Ali (2005) determined that the total factor analysis dropped from 1064 between periods 1080-1990 to 1031 between periods 1990-2001. In both studies, the technological insufficiency of firms has proven to have effects on their efficiency.

Dimara et al. (2008), determined technical and efficiency scores of Greek food businesses via Data Envelopment Analysis method. In study, it is stated that both technical and scale efficiency have important effects on sustainability of food businesses' life.

Assaf and Matawie (2009), investigated technical, distribution and cost efficiencies of firms providing food services to hospitals in Australia via Data Envelopment Analysis. In their study, they stated that technical, distribution and cost efficiency were respectively 65.3%, 81.5% and 52.3% and distribution efficiency was more vital than technical efficiency.

Özer et al. (2010), measured the efficiency of Food and Beverage businesses quoted to BIST via DEA, Cluster Analysis and TOPSIS method. They measured businesses' efficiency by

Data Envelopment Analysis, clustered resembling firms by Cluster Analysis and arranged business efficiency by TOPSIS analysis and compared both three methods. According to Data Envelopment Analysis, 14 firms in 2007, 11 firms in 2008 were found efficient. Furthermore, some businesses observed efficient via Data Envelopment Analysis did not performed well in TOPSIS analysis and findings gained from Cluster analysis did not coincide with other methods' results.

Tektaş and Tosun (2010), analyzed supply chain performances of food-beverage firms in Turkey via DEA and compared with the competitors from USA. They observed that firms' performances in USA were much better. In the study, high supply chain costs were observed an important criterion on decrease in performance level and it is suggested that supply chain efficiency must be provided for competitiveness of Turkish food industry.

Gubta and Mittal (2010), investigated the efficiency of 43 food firms in Delhi via DEA method. In the study with 6 inputs and 2 outputs, 16 of firms were observed efficient and inputs were used most suitably for output process.

Zeytinoğlu et al. (2011), analyzed efficiency of food businesses via Data Envelopment Analysis and used assets ratios as input values and rantability ratios as output. As a result, both efficient and not efficient businesses were determined.

Soba and Akcanlı (2012) measured efficiency of Food, Beverage and Tobacco businesses in BIST between the years 2006-2011 via DEA method, and number of efficient firms in 2011 was determined as 3.

Yavuz and İşçi (2013), observed average efficiency of food businesses as 77% via DEA in their study. For 2011, 10 firms were according to CCR model, 12 firms were obtained efficient according to BCC model.

Dizkırıcı (2014) analyzed efficiency of firms quoted to BIST Food and Beverage Index via Data Envelopment Analysis and determined efficient and inefficient firms and calculated potential amendment ratios for inefficient businesses. Moreover, efficiency values for each business for related period were compared according to Malmquist Index. As a result of study, ÜLKER was observed only business both efficient in each year and having continuously increasing efficiency values.

As seen in the studies, there is lack of literature where DEA and TOPSIS were used together.

Data Envelopment Analysis

DEA is a non-parametric technique which does not require any assumptions about the functional form of a production function and a priori information about inputs and outputs.

DMU is measured with the estimated ratio of weighted outputs and inputs and it is compared with other DMUs. In order to maximize efficiency of DMU, DEA allows each DMU to select the weights of inputs and outputs. (Lee et al. 2009).

In DEA process, empirical efficiency surface is created by using input and output data of decision units and each decision units are evaluated according to their radial closeness to this surface. The units on the surface are labelled as efficient while rest of them are inefficient (Kocakoç, 2003).

Basic DEA models can be divided into CCR and BCC varieties. While CCR model is measuring total efficiency under the constant return to scale (CRS) assumption, BCC model is comparing units with similar scales under the variable return to scale (VRS) assumption to measure pure technical efficiency. In the constant return to scale assumption, changes in the inputs return to same amount of output. In the variable return to scale assumption however, changes in the input return as higher or lower amount of output (increasing-decreasing return) (Bakırcı 2006, p.206).

CCR and BCC models can be either input or output oriented. The *input-based* DEA models view the possible input decrease while maintaining the current levels of outputs. With keeping the current levels of outputs, the *output-based* DEA models consider the possible output increase. To evaluate possible input decreases and output increases, in this study the productivity measurement approach is used and it adopts the additive DEA model of Charnes et al. which focuses on the estimation of Pareto–Koopman's efficient empirical production functions (Seifert and Zhu,1998, p.281).

For DEA model, the mathematical explanation of output/input ratio to be maximized for n decision unit with m input and s output alleged by Charnes, Cooper and Rhodes (1978) is as follows (Kaya et al.,2010, p.134):

Efficiency=Output/Input, Max hk= $\frac{\sum_{r=1}^{s} urk\ yrj}{\sum_{i=1}^{m} vik\ xij}$

In this expression, $x_{ij}>0$ parameter represents i inputs used by j decision units, yrj>0 parameter represents r outputs used by j decision units. The reference variables for this equality providing maximization condition are shown as v_{ik} and u_{rk}, also these are weights of k decision units to give for i inputs and r outputs. The constraint providing efficiency not to exceed 100% when reference weights of k organizational decision units were used by other decision units is shown as below:

$$\frac{\sum_{r=1}^{n} urk\ yrj}{\sum_{i=1}^{m} vik\ xij} \leq 1, \quad u_r \geq 0, v_i \geq 0, \text{j and k} = 1,\ldots\ldots,n$$

Topsis Method

TOPSIS (technique for order performance by similarity to ideal solution) is one of the useful techniques in dealing with multiattribute or multi-criteria decision making (MADM/MCDM) problems and it helps decision maker(s) organize the problems to be solved, and execute analysis, comparisons and rankings of the alternative solutions (Shih et al., 2007, p.801).

Hwang and Yoon (1981) proposed a particular technique for order preference by similarity to an ideal solution. This ideal solution which refers to positive ideal solution, maximizes the benefit criteria/attributes and minimizes the cost criteria/attributes. The negative ideal solution which is namely anti-ideal solution, maximizes the cost criteria/attributes and minimizes the benefit criteria/attributes (Monjezi et al., 2012).

The ideal solution in this method, when considered all criterions, selected alternative must satisfy these criterions at ideal levels. However, ideal solution may not always be possible to achieve. In these situations, the closest point to ideal is accepted as the ideal solution (Özden, 2011).

Via TOPSIS, the distance of all alternatives to positive and negative-ideal solution is calculated by Euclidean distance and each criterion assumed that they have monotonous increasing or decreasing benefit trend. Since method accepted the closest alternative to positive-ideal solution as the best alternative, ordering all alternatives can be available by comparing relative distances (Özden, 2011).

The steps of TOPSIS application process are as follows Bakırcı et al. (2014):

Step 1: By creating decision matrix, normalized values (N) are calculated.

Step 2: The normalized values gained from previous step are multiplied with weight degrees (W) related to evaluation factors to create Weighted Normalized Decision Matrix (V).

$$\mathbf{V = N \times W_{n\times n}} \quad (1)$$

Step 3: The determinants according to positive-ideal and negative-ideal solutions are explained as following:

(V_j^+) Positive-Ideal Solution = the best value for j^{th} criterion among all possible alternatives.

(V_j^- *) Negative-Ideal Solution* = the worst value for j^{th} criterion among all possible alternatives.

Step 4: At this stage, the distances from each alternative to both positive-ideal (d_i^+) and negative-ideal solution (d_i^-) are calculated. For this purpose, the following formula is used:

$$d_i^+ = \sqrt{\sum_{j=1}^{n}(v_{ij} - v_j^*)^2} \qquad , i=1,2,.....,m$$

(2)

$$d_i^- = \sqrt{\sum_{j=1}^{n}(v_{ij} - v_j^-)^2} \qquad , i=1,2,.....,m$$

Step 5: Ideal and negative ideal distinction measurements are utilized in relative distance (C_i) calculation from each one of decision points to ideal solution. The measurement in here is the share of negative ideal distinction measurement among total distinction measurement. The formula used to calculate the relative distance closeness value to ideal solution is as following:

$$C_i = \frac{d_i^-}{d_i^- + d_i^+} \qquad (3)$$

C_i is always in between $0 \leq C_i \leq 1$.

Step 6: At last stage, the relative order and value of each alternative are found. The C_i with the maximum value is selected, after ordering all alternatives according to their descending C_i values.

Applicatıon

In this part of the study, the efficiency values of businesses at BIST Food and Beverage index are calculated. By this purpose, the ratios decided as input and output variables are figured via financial tables of businesses in the period 2012-2013. These ratios are stated in the table.

Input variables	Accounts Payable Turnover
	Current Ratio
	Equity / Total Assets
Output variables	Net Income / Equity
	Net Profit / Total Assets

Using determined financial ratios, DEA model with constant return (CCR) according to input-oriented scale is applied and then the financial performance degrees of firms are ordered via TOPSIS method.

Below, the TOPSIS application of decision units for 2012 is shown.

Step 1: The related matrix is created by using firms’ normalized data for 2012.

Table 1. Normalized Decision Matrix for 2012

	Current Ratio	Equity / Total Assets	Accounts Payable Turnover	Net income / equity	Net Profit / Total Assets
AEFES	0.332305289	0.398214629	0.089186702	0.204022034	0.264897482
COLA	0.519044535	0.285690759	0.51280726	0.441422004	0.411181614
KARSUSAN	0.192243077	0.368226061	0.014416279	0.035925419	0.043134506
KONFRUT	0.414431208	0.31795209	0.275968185	0.32590692	0.337860802
PETUN	0.356367388	0.46782791	0.580718992	0.226349196	0.34526351
PINARSÜT	0.314320126	0.431632241	0.524083483	0.288364955	0.405823588
TUBORG	0.204125953	0.27267738	0.141736951	0.603503668	0.536552442
ÜLKER	0.379464198	0.208805263	0.143947107	0.396750155	0.270111639

Step 2: The weight values of measurement factors (w) are multiplied with normalized values (w) in order to weighted normalized decision matrix.

Weight values: Current Ratio 0.210529101, Equity / Total Assets 0.213534904, Accounts Payable Turnover 0.177196178; Net income / equity 0.195776827; Net Profit / Total Assets 0.20296299

Table 2. Weighted Normalized Decision Matrix for 2012

	Current Ratio	Equity / Total Assets	Accounts Payable Turnover	Net income / equity	Net Profit / Total Assets
AEFES	0.069959934	0.085032723	0.015803543	0.039942786	0.053764385
COLA	0.109273979	0.061004949	0.090867486	0.086420199	0.08345465
KARSUSAN	0.040472762	0.078629117	0.00255451	0.007033365	0.008754708
KONFRUT	0.08724983	0.067893869	0.048900508	0.063805023	0.068573239
PETUN	0.075025706	0.099897588	0.102901186	0.044313927	0.070075714
PINARSÜT	0.066173533	0.092168549	0.09286559	0.056455176	0.082367169
TUBORG	0.042974453	0.058226138	0.025115246	0.118152033	0.108900288
ÜLKER	0.079888256	0.044587212	0.025506877	0.077674486	0.054822666

Step 3: In this stage, Positive Ideal (V_j^+) and Negative Ideal (V_j^-) solution clusters are created for each criterion. These clusters are established by choosing the highest value of each column of Weighted Normalized Decision Matrix for Ideal (V_j^+) set and lowest value of each column for Ideal (V_j^-) set

Positive Distance Values:

V_j^+=*[0.390700082,0.465550496,0.485861293,0.653318594,0.624716494]*

Negative Distance Values:

V_j^-=*[0.23443203,0.247414447,0.265451255,0.175765231,0.179240711]*

Step 5 and 6: The distance from each alternative to positive-ideal and negative-ideal solution is calculated by formula 2 and closeness is calculated by formula 3.

Table 3. The Values of Distances to Positive Ideal Solution Set, Negative Ideal Solution and Relative Closeness to Ideal Solution

	d^+	d^-	C_i
AEFES	0.136048564	0.076090542	0.358682297
COLA	0.057548563	0.157113597	0.731911004
KARSUSAN	0.193989449	0.034041905	0.149286071
KONFRUT	0.094895958	0.108076471	0.532468727
PETUN	0.090179585	0.139544635	0.607444155
PINARSÜT	0.080799804	0.137629627	0.630087378
TUBORG	0.110375673	0.151913664	0.579183529
ÜLKER	0.120313999	0.09587918	0.44348846

Findings

1) DEA Results

The decision units' efficiency values of 2012-2013 according to CCR method are given in the following table.

Table 4. The Efficiency Values of Businesses Operating in BIST Food and Beverage Index

	2012 DEA Results %	2013 DEA Results %
AEFES	78.5	54.6
COLA	73.1	60.9
KARSUSAN	79	52.5
KONFRUT	54	26.9
PETUN	37.5	38.3
PINARSÜT	49.1	48
TUBORG	100	100
ÜLKER	85.9	63.8

According to 2012 DEA results, PETUN efficiency value is selected as the lowest, TUBORG is selected as the highest decision unit. In 2012, the average efficiency value of businesses in BIST Food Beverage index is 69.6375 %.

According to results of 2013, while KONFRUT has the lowest efficiency value, TUBORG has become the business with the highest efficiency value. For this year, businesses' average efficiency value is identified lower (55.635%) than the other year. Moreover, among the other decision units TUBORG is determined as the only efficient business for both 2012 and 2013.

2) TOPSIS Results

At this stage, the decision units are sorted according to the closeness to ideal solution via TOPSIS method.

Table 5. TOPSIS Results of Decision Units

	C (2013)	Ordering (2013)	C (2012)	Ordering (2013)
AEFES	0.062700498	4	0.358682297	7
COLA	0.045818861	6	0.731911004	1
KARSUSAN	0.021048469	8	0.149286071	8
KONFRUT	0.114034127	2	0.532468727	5
PETUN	0.047172914	5	0.607444155	3
PINARSÜT	0.043592678	7	0.630087378	2
TUBORG	0.092588405	3	0.579183529	4
ÜLKER	0.216836507	1	0.44348846	6

In Table 5, according to 2012 and 2013 data of decision units financial performance ordering was performed in descending form. For 2012, COLA, PINARSÜT, PETUN are observed as the businesses with the best performance while KARSUSAN and AEFES are the worst.

Conclusion

In this study, DEA and TOPSIS methods are used in order to evaluate the efficiency and performances of businesses in Food and Beverage Index for 2012 and 2013. According to DEA results, the only efficient business for 2012 and 2013 is determined as TUBORG. According to TOPSIS results, the businesses with the best performances are obtained as COLA, PINAR SÜT and PETUN for 2012; ÜLKER, KONFRUT and TUBORG for 2013.

Considering DEA and TOPSIS results together, efficiency and performance ordering did not coincide and businesses observed efficient by DEA method did not resemble with the businesses with high performance in TOPSIS analysis. TUBORG as the only business efficient in 2012 and 2013 according to DEA results has the performance with rank 4 for 2012 and rank 3 for 2013. Similarly, PINAR SÜT and PETUN for 2012 and KONFRUT for 2013 have lower efficiency level, although they have higher rank in performance ordering. The reason behind this as similarly stated by Özer et al. (2010) is considered as that in TOPSIS analysis weight coefficients of input and output variables are determined subjectively.

In this study, TOPSIS method was used to evaluate company performances. In addition, the current study also utilized from DEA to measure company efficiencies. Future studies should also benefit from other techniques to evaluate efficiency and performance of companies. To gain additional insights, other indexes results should be compared with BIST food and drink indexed companies. Future research should also determine the role of crises in companies' efficiency and performance levels with techniques such as ELECTRE, PROMETHEE, Fuzzy TOPSIS.

References

Ali, J. (2005), "Analysis of Total Factor Productivity Change in Indian Food Processing Industry: A Nonparametric Approach", Proceedings Of The 11th International Conference On Productivity and Quality Research, Indian Institute of Technology, Delhi (India) in Association with International Society For Productivity and Quality Research (USA).

Assaf, A. and Matawie, K. M., (2009), " A Two-Stage Approach To Efficiency Modeling: An Application to the Australian Hospital Food Production Industry", *Journal of Hospitality and Tourism Research,* Vol. 33 No.3, pp. 284-304.

Bakırcı, F. (2006), "Sector Based Efficiency Measurement with DEA, Atatürk Üniversitesity Journal of Economics and Administrative Sciences, Vol. 20, No. 2, pp. 199-217.

Bakırcı, F., Shiraz, S. E., Sattary, A. (2014), " *Financial Performance Analysis of Iron, Steel Metal Industry Sector Companies in The Borsa İstanbul: DEA Super Efficiency and TOPSIS Methods ",* Ege A*cademıc* R*evıew , Vol: 14 No: 1,pp. 9-19*

,Deliktaş, E. (2006), "İzmir Small and Medium Enterprise Manufacturing Industry Productivity Efficiency and Total Factor Productivity Growth", *Ege University Working Papers in Economics* , İzmir.

Deng, H., Yeh, C.H., Willis, R.J.(2000), "Inter-Company Comparison Using Modified TOPSIS With Objective Weights", *Computers and Operations Research* , Vol.27 No.10, pp.963-973.

Dimara, E., Skuras D., Tsekouras K., Tzelepis D. (2008), "Productive Efficiency and Firm Exit in the Food Sector, *Food Policy*,Vol. 33, No.2, pp. 185–196.

Dizkırıcı, A. S. (2014), " Measuring the Financial Performances of the Companies Listed on Istanbul Stock Exchange Food, Beverage Index via Data Envelopment Analysis and Their Comparision According to Malmquist Index ", The *Journal of Accounting and Finance*, Vol. 63, pp.151,169.

Gupta, A., Mittal, S., (2010), "Measuring Retail Productivity of Food & Grocery Retail Outlets Using The DEA Technique", *Journal of Strategic Marketing*, Vol.18 No.4, pp. 277–289.

Kaya, A. Öztürk, M. ve Özer, A. (2010), "Performance Efficiency of Businesses Listed in The Sector of Fabricated Metal Products, Machinery and Equipment on Istanbul Stock Exchange (ISE) by using Data Envelopment Analysis. ", *Atatürk Üniversitesity Journal of Economics and Administrative Sciences*, Vol. 24, No.1, pp. 129-147.

Kocakoç, İ.D. (2003), "Determine The Constraints for Weight Restrictions with Analytic Hierarchy Process", *Dokuz Eylül Üniversity, Faculty of Economics and Administrative Sciences*, Vol.18 No. 2, pp.1-12.

Kumar, M., and Basu, P.(2008), "Perspectives of Productivity Growth in Indian Food Industry: A Data Envelopment Analysis", *International Journal of Productivity and Performance Management*, Vol.57 No. 7, pp.503-522.

Lee, H., Park Y. and C. Hoogon (2009), "Comparative Evaluation of Performance of National R&D Programs with Heterogeneous Objectives: A DEA Approach", *European Journal of Operational Research*, Vol.196 No3, pp.847-855.

Monjezi M., Dehghani, H. , Singh T. N., Sayadi A. R. and Gholinejad A. (2012), "Application of TOPSIS Method for Selecting The Most Appropriate Blast Design", *Arabian Journal of Geosciences* , Vol.5 No 1, pp. 95–101

Özden, Ü. H. (2011)," TOPSIS Method with The European Union Member States of The Candidate and Mappıng of Economic Indicators", *Trakya Üniversitesity Journal of Social Science, Vol.*13, No.2, pp.215-236

Özer, A., Öztürk, M., ve Kaya A. (2010), "Usıng DEA, Cluster and TOPSIS in Measuring Businesses Efficiency and Performance: An Applicatıon on ISE Businesses" *Atatürk Üniversitesity Graduate Journal of Social Sciences*, Vol.14, Nol.1, pp. 233-260

Perçin, S. ve Talha U., (2007), "Efficiency Measurement in Textile and Food Sector: DEA-Malquist Ixdex Application, *Journal of Economıcs, Busıness & Finance*, Vol. 22: pp. 154-171.

Seifert, L.M. and Zhu, J. (1998), "Identifying Excesses and Deficits in Chinese Industrial Productivity (1953-1990): A Weighted Data Envelopment Analysis Approach", *Omega,* Vol.26 No. 2, pp. 279-296

Shih, H.S., Shyur, H.J., Lee E.S. (2007), "An Extension of TOPSIS for Group Decision Making", *Mathematical and Computer Modelling*, Vol.45 No.7-8, pp.801–813.

Soba, M. ve Akcanlı, F. (2012), "Evaluation of effectıveness of the companies operating in the sector of food, beverage and tobacco in Istanbul stock exchange using data envelopement analysis ", *Afyon Kocatepe Üniversitesity Journal of Economics and Administrative Sciences*, Vol.14, No.2, pp. 259-274.

Tektaş, A. ve Tosun, E. (2010), " International performance benchmarking in the food and beverage industry", *Suleyman Demirel University The Journal of Faculty of Economics and Administrative Sciences*, Vol.15, No.1, pp. 29-44.

Yavuz, S. ve İşçi, Ö.(2013), "Measurement with data envelopment analysis of efficiency of the companies making industrıal food productıon", *Dumlupınar Üniversitesity Journal of Sosyal Sciences,* Vol.36 , pp.157-173

Zeytinoğlu, F., Dumanoğlu, S., Uydacı, M. (2011), "Comparison of Efficiencies of Enterprises Engaged in Food Sector in Turkey by Data Envelopment Analysis Taking Account of Their Efficiencies and Rantability Rates", *Journal of Modern Accounting and Auditing*, Vol. 7 No. 2,pp. 182-192.