EGE AKADEMİK BAKIŞ / *EGE ACADEMIC REVIEW*

Cilt: 13 • Sayı: 2 • Nisan 2013
ss. 237-244

Measuring the Efficiency of Turkish Apparel Retailers

Türk Hazır Giyim Perakendecilerinin Etkinliklerinin Ölçümü

Nazan ERDUMLU[1], Canan SARIÇAM[2]

ABSTRACT

This study analysed the efficiencies of Turkish apparel retailers in 2010 by using actual retail data based on the research conducted by PricewaterhouseCoopers and published in Turkish-Time periodical by using data envelopment analysis method in Excel Solver. The efficiencies of the retailers were evaluated in terms of overall technical efficiency, pure technical efficiency and scale efficiency. In addition, input targets for each company were calculated in order to identify the improvement ratios that each of the inefficient companies can become efficient by achieving these ratios.

Keywords: Apparel, retailing, efficiency, data envelopment analysis.

ÖZET

Bu çalışmada, Türkhazır giyim perakendecilerinin Pricewater house Coopers tarafından gerçekleştirilen ve Turkish Time'da yayınlanan araştırma verilerine dayanarak 2010 yılındaki etkinlikleri veri zarflama analizi yöntemi ile Excel Solver kullanılara kanaliz edilmiştir. Perakendecilerin etkinlikleri teknik etkinlik, saf teknik etkinlik ve ölçek etkinliği bazında değerlendirilmiştir.Ayrıca, etkin olmayan firmalar için etkin hale gelmesi için gerekli olan iyileştirme oranlarını belirlemek amacıyla her bir firma için girdi hedefleri hesaplanmıştır.

Anahtar Kelimeler: Hazır giyim, perakende, etkinlik, veri zarflama analizi.

1. INTRODUCTION

One of the fastest developing sections of the retailing industry is apparel retailing on both global and national scales. On the other hand, the changing trade circumstances in textile and apparel industry in the world has also affected the apparel retailing. In recent years, Turkish retailing industry has left the traditional patterns and gained modern and organized structure in order to adapt to the new trade environment. Moreover, increase in the number of retailers in Turkish apparel market continuously has intensified the competition in apparel retailing. Therefore, measuring the efficiency of retailers existing in Turkish apparel retailing industry has become rather significant.

Measurement of efficiency is essential in order to evaluate the efficiencies of different units in the companies and organizations or the overall regional or sectorial efficiencies of the companies and organizations. Data Envelopment Analysis (DEA) is a nonparametric efficiency measurement method that uses mathematical programming and has the ability to evaluate the efficiencies of a set of entities called Decision Making Units (DMUs), which convert multiple inputs into multiple outputs, and to identify which of the DMUs are inefficient and the magnitude of the efficiency (Sherman and Zhu, 2006; Ray, 2004). DEA was first designed to measure the relative efficiency of DMUs by Charnes, Cooper and Rhodes (CCR) in 1978, and further developed by Banker, Charnes and Cooper (BCC) in 1984. In CCR model, relative efficiency of the DMUs is based on constant return to scale assumption, while in BCC model, it is based on variable return to scale assumption. Both CCR and BCC models can be used as input-oriented and output-oriented.In the input-oriented models, inputs are minimized and the outputs are kept at their current levels. On the other hand, outputs are maximized while using no more than the observedamount of any input in the output-oriented models (Duzakin and Duzakın, 2007; Charnes et al, 1978; Banker et al, 1984).

The literature survey showed that the use of DEA for evaluating the efficiency of the retailers in different segments of the retailing industry is quite limited. Donthu and Yoo(1998) applied DEA to 24 stores of a fast food restaurant chain for an internal benchmarking. They used store size in square yards of serving area, store manager experience with the

[1] **Phd., İstanbul Technical University, Faculty of Textile Technologies and Design,Departmant of Textile Engineering, okurn@itu.edu.tr**
[1] **Phd., İstanbul Technical University, Faculty of Textile Technologies and Design, Departmant of Textile Engineering, saricamc@itu.edu.tr**

chain in years, store location (inside a shopping mall versus free-standing) and promotion/give-away expenses in USD were used as the input variables, and sales and customer satisfaction measured on a 5 point scale via survey were used as the output variables. They compared the results obtained using DEA and regression. They also performed tracking of retail productivity over time and the sensitivityanalysis of individual stores by using DEA. Kamakura et al. (1996)evaluated multiple branches of a commercial bank as multiple retail stores in Latin America for their efficiency using DEA and translog costfunction estimation. They used total number of man-hour at the branch and size of the customer service area in square meters as the input variables, and volume of cash deposits, volume of other deposits, volumes of funds in transit in the branch and volume of service fees charged to customers by the branch as the output variables. In another study, Donthu et al (2005) used DEA to measure the efficiency of 26 stores of a fast food restaurant chain in a major metropolitan area, and illustrated both advantages and limitations of the DEA technique using actual retail data. They used advertising and promotion expenses, manager experience and number of employees as the inputs; customer satisfaction and sales as the outputs. The literature review clearly points out that any evaluation in the apparel retailing industry in terms of efficiency by using DEA has not been conducted so far. Therefore, this study was carried out in order to measure overall technical efficiency, pure technical efficiency and scale efficiency of 30 apparel retailers in Turkey via DEA by using actual retail data, and hence it was attempted to obtain a comprehensive understanding of the current situation of the apparel retailing industry in Turkey.

2. METHOD

In this study, the efficiencies of the apparel retailers in 2010 were analysed in terms of overall technical efficiency, pure technical efficiency and scale efficiency. The analysis was established for 36 apparel retailers listed in retailing research conducted by PricewaterhouseCoopers and published in a Turkish business journal entitled "TurkishTime" (2011). 6 companies were eliminated since they have missing data in terms of number of employees. Thus, 30 companies were used for the analysis. In the analysis, number of employees, sales area, number of stores and number of franchise were used as inputs, and domestic revenue was used as the output. The number of inputs and outputs are convenient for the analysis, since if the number of inputs is m, and the number of outputs is s, at least (m+s+1) DMUs is required in order to conduct DEA. The other constraint, which is satisfied for the analysis is that; the number of DMUs must be at least 2*(m+s). In this study, the number of inputs is 4 and the number of output is 1. The minimum number of DMU required to conduct the analysis is (4+1+1) = 6 and 2*(4+1) = 10 (Tektufekci, 2010).

Overall technical efficiency was calculated by input-oriented model under constant returns to scale assumption (CCR), while pure technical efficiency was calculated by input-oriented model under variable returns to scale assumption (BCC). Scale efficiency was calculated as the ratio of CCR efficiency to BCC efficiency (Kasap, 2011). Figure 1 shows the graphical representation of the relationship between overall technical efficiency and pure technical efficiency.

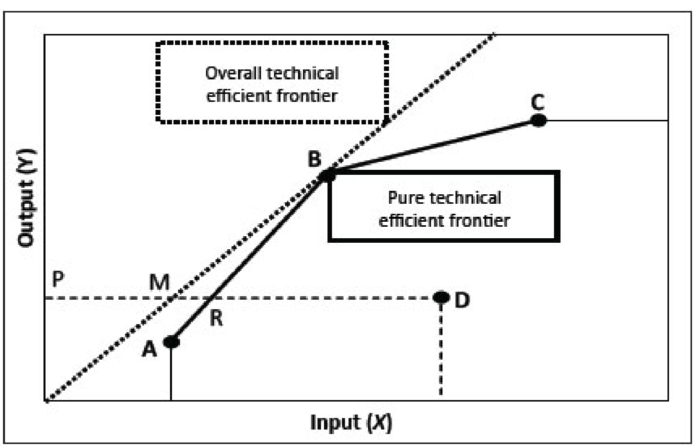

Figure 1: Components of the data envelopment analysis used (Kasap, 2011)
Efficiency scores are calculated with the radial distances of inefficient units within the enveloped surface from the centre.

As shown in Figure 1, the units remaining under the frontier in terms of forming the appropriate OTE frontier, combining the efficient units (M and B DMUs) with the origin, are regarded as overall technical inefficiency.A PTE frontier consists of points A, R, B and C. Point D, on the other hand, which is outside of both frontiers, indicates both an overall inefficient and a pure technically inefficient unit.Once the technical efficiency score has been determined, it is possible to determine the scale efficiency score. The DMU's ability to produce the maximum possible output by optimal use of the input combination it possesses is defined as pure technical efficiency and the ability to carry out production on the appropriate scale is defined as scale efficiency (SE). Finally, the overall efficiency score is gained by multiplying the scores for these two efficiencies as in Equation 1 below (Kasap, 2011):

$$OTE = PTE \times SE \quad (1)$$

Accordingly, overall technical efficiency (OTE), pure technical efficiency (PTE) and scale efficiency (SE) can be calculated by the Equations 2-4:

$$OTE = PM / PD \quad (2)$$

$$PTE = PR / PD \quad (3)$$

$$SE = PM / PR \quad (4)$$

The mathematical programming problems composed of the equations in Table 1 were solved in order to measure the efficiency for Decision Making Unit (DMU_o) in Excel Solver (Zhu, 2003). As it can be seen from Table 1, the $\sum_{j=1}^{n}(\lambda_j = 1)$ constraint is addedin order to obtain efficiency under variable return to scale assumption.

Table 1: Envelopment Models

Input Oriented CCR Model	Input Oriented BCC Model
$\theta^* = min\theta$ (5) subject to $\sum_{j=1}^{n}(\lambda_j x_{ij} \leq \theta x_{io})$ $i = 1,2, \ldots, m$; (6) $\sum_{j=1}^{n}(\lambda_j y_{rj} \geq y_{ro})$ $r = 1,2, \ldots, s$;(7)	$\theta^* = min\theta$(5) subject to $\sum_{j=1}^{n}(\lambda_j x_{ij} \leq \theta x_{io})$ $i = 1,2, \ldots, m$;(6) $\sum_{j=1}^{n}(\lambda_j y_{rj} \geq y_{ro})$ $r = 1,2, \ldots, s$;(7) $\sum_{j=1}^{n}(\lambda_j = 1)$ λj ≥ 0 $j = 1,2, \ldots, n$.(8)

(**Note:** Where DMU_orepresents one of the n DMUs under evaluation, and $x_{io}$and $y_{ro}$are the *i*th input and *r*th output for DMU_o, respectively. θ^* represents the efficiency score of DMU_o.)

Considering the reference sets, the input targets for the companies were calculated and based on the target values, improvement ratio in percentage for input variables was determined individually for each retailer by using the Equation 9.

Improvement ratio (%) = (Target value – Actual value) / Actual value x 100(9)

3. RESULTS AND DISCUSSION

Table 2 shows the descriptive statistics for the apparel retailers in terms of sales area, domestic revenue and number of employees, stores and franchises, whose mean values are 95111, 113862758, 923, 41, and 28 respectively.

Table 2: Descriptive Statistics of Input and Output Variables

	No. of Employees	SalesArea (M^2)	No. of Stores	No. of Franchise	DomesticRevenue(TL)
RF1	12.153	3.017.241	297	12	2.169.000.000
RF2	1.604	37.185	152	24	257.092.320
RF3	2.136	61.937	115	39	172.000.000
RF4	1.209	29.536	97	90	148.246.000
RF5	537	13.612	50	0	115.454.945
RF6	3.542	43.809	64	83	103.789.262
RF7	280	5.713	39	3	72.737.708
RF8	394	15.623	42	48	70.494.128
RF9	610	18.368	45	23	66.554.048
RF10	505	12.745	43	0	64.292.443

RF11	285	20.101	25	96	51.269.000
RF12	1.981	11604,63	42	5	42.398.225
RF13	215	11.200	19	50	40.000.000
RF14	130	3.081	20	0	28.434.084
RF15	60	2.770	11	3	26.138.704
RF16	83	3.400	22	5	23.500.000
RF17	410	2.450	35	18	21.198.770
RF18	649	19.500	24	34	19.250.000
RF19	95	2.600	19	1	17.000.000
RF20	63	1.750	5	9	15.000.000
RF21	210	6.905	26	10	14.350.000
RF22	144	2.600	19	0	12.000.000
RF23	139	3.090	11	14	8.781.279
RF24	20	1.062	1	0	8.698.292
RF25	42	2.710	10	0	8.457.950
RF26	28	1.003	4	0	7.052.731
RF27	57	850	11	0	6.258.405
RF28	53	1.800	12	26	5.500.000
RF29	35	628,16	7	2	2.726.111
RF30	16	344	2	0	1.643.327
Mean	923	95.111	41	28	113.862.758
Min.	16	344	1	0	1.643.327
Max.	12.153	3.017.241	297	96	2.169.000.000
Std.Dev.	2268,33	548937,31	59,18	27,91	391434798,72

The standard deviations were found to be very high due to the differences between the minimum and maximum values. Even some maximum values were found to be thousand times of some minimum values as in the cases of number of employees and sales area. Besides, nine companies do not have franchises whereas seven companies had more than 28 franchises leading that around 25 % of the companies contributed 75% of total number of franchises.

Table 3: Correlation Coefficient Results of The Selected Variables

	No. of Employees	Sales Area (M^2)	No. of Stores	No. of Franchise	Domestic Revenue
No. of Employees	1	0,94	0,90	0,13	0,96
Sales Area (M^2)	0,94	1	0,83	-0,04	0,99
No. of Stores	0,90	0,83	1	0,20	0,89
No. of Franchise	0,13	-0,04	0,20	1	0,01
Domestic Revenue	0,96	0,99	0,89	0,01	1

Correlation analysis was established in order to know the extent of variations in the domestic revenues and the degree of relationships between the inputs and the output. The results in Table 3 showed that, the output is significantly correlated with the inputs, "Number of employees", "Number of stores" and "Sales Area". On the other hand, it was found out that the input "Number of franchises" is very low correlated or negatively correlated with the output variable and the other input variables. This is because some companies do not prefer to do marketing via franchises due to their strategic decisions. Therefore, the input "Number of franchises" was eliminated from the calculations.The overall technical efficiency, pure technical efficiency and scale efficiency values of the apparel retailers are shown in Table 4.

The mean values for the overall technical, pure technical and scale efficiencies are 0.54, 0,71 and 0,77 respectively. According to these results, an average company has to increase its output by 46 percent using existing level of inputs in order to be overall technical efficient; improve its managerial efficiency by 29 percent in order to be regarded as pure technical efficient and finally it should correct its size by 23 percent to be scale efficient. The minimum values increased in parallel with the mean efficiency values with the minimum of 0.12 in overall technical efficiency, 0.21 in pure technical efficiency and 0.40 in scale efficiency. On the other hand, the standard deviations decreased from 0.25 to 0.19 in the same order.

Table 4: Overall Technical, Pure Technical and Scale Efficiencies of the Apparel Retailers

	Overall Technical Efficiency	Pure Technical Efficiency	Scale Efficiency
RF1	0,84	1,00	0,84
RF2	0,65	1,00	0,65
RF3	0,31	0,71	0,44
RF4	0,50	0,74	0,67
RF5	0,82	1,00	0,82
RF6	0,28	0,64	0,43
RF7	1,00	1,00	1,00
RF8	0,48	0,74	0,65
RF9	0,39	0,60	0,65
RF10	0,50	0,62	0,81
RF11	0,41	0,76	0,55
RF12	0,36	0,41	0,87
RF13	0,43	0,77	0,55
RF14	0,77	0,80	0,97
RF15	1,00	1,00	1,00
RF16	0,71	0,72	0,99
RF17	0,68	0,74	0,91
RF18	0,12	0,22	0,53
RF19	0,58	0,62	0,93
RF20	0,89	0,91	0,98
RF21	0,21	0,21	0,97
RF22	0,36	0,43	0,84
RF23	0,28	0,31	0,88
RF24	1,00	1,00	1,00
RF25	0,46	0,47	0,98
RF26	0,70	0,85	0,83
RF27	0,58	0,81	0,71
RF28	0,29	0,40	0,74
RF29	0,34	0,68	0,50
RF30	0,40	1,00	0,40
Mean	0,54	0,71	0,77
Min	0,12	0,21	0,40
Max	1,00	1,00	1,00
St Dev	0,25	0,24	0,19

The overall technical efficiency gives the values evaluated in Charnes, Cooper and Rhodes model (CCR), in which the ratio of the weighted outputs to weighted inputs for each company being evaluated is maximized based on constant returns to scale. According to Table 4, only 3 companies were found to be efficient in terms of overall technical efficiency taking the score of 1. These companies determine the best-practice frontier. Besides, 10 companies showed a better efficiency than the 17 companies by getting scores higher than the average efficiency value, which is 0.54. Hence, the inefficiencies of the companies can be based upon the inefficient utilization of the resources or inappropriate scale size. Therefore, the pure technical efficiency values were calculated using Banker CharnesChoper (BCC) model based on assumption of variable return to scale (VRS). The pure technical efficiency indicates how efficiently the inputs are converted into outputs. The size of the firms is not considered in that case. From Table 4, it is observed that 7 companies were found to be pure technical efficient getting the value of 1. Moreover, 11 companies were found to be more efficient than the average leaving 12 companies behind. Considering the size of the firms, the scale efficiencies were calculated by dividing the overall technical efficiencies into pure technical efficiencies. According to the results, 3 companies that were efficient in terms of overall technical efficiency were also found to be scale efficient. Furthermore, with regard to the scale efficiency values, apart from the mentioned 3 companies, 14 companies were found to have higher efficiency than the average value. Based on this, although the number of scale efficient companies is lower than the pure technical efficient companies, they show rather uniform distribution among the whole population.

Nonetheless, further analysis in terms of pure technical and scale efficiencies were established on company base in order to find out if the inefficiencies come from either lack of efficient usage of resources or inappropriate scale size. It was carried out that 5 of the companies showed the poorest efficiency being neither pure technical nor scale efficient. 7 companies were found to be scale efficient and pure technical inefficient, whereas 8 companies were carried out to be pure technical efficient but scale inefficient. Among the latter 8 companies mentioned, 2 of the companies got the pure technical efficiency score of 1, while they could not even reach the average scale efficiency score. This meant that, these companies are highly scale inefficient and therefore they should correct their scale sizes.Table5 lists the companies that can be taken as references by the other companies.

Considering these reference sets, the companies can establish target values in terms of their inputs and in this way, they can improve their efficiencies. Table 5 lists the companies that can be taken as references by the other companies. Considering these reference sets, the companies can establish target values in terms of their inputs and in this way, they can improve their efficiencies. For instance, the apparel retailer entitled with RF3 should consider RF7 and RF24 for being overall technical efficient and the companies RF1, RF2 and RF5 for being pure technical efficient.

Table 5: Reference Sets for Technical and Pure Technical Efficiencies

Retail Firm	Overall Technical Efficiency-CRS			Pure Technical Efficiency-VRS			
RF1	RF24			RF1	RF2		
RF2	RF7	RF24		RF1	RF2	RF5	
RF3	RF7	RF24		RF1	RF2	RF5	
RF4	RF7	RF24		RF1	RF2	RF5	
RF5	RF7	RF24		RF1	RF2	RF5	
RF6	RF7	RF24		RF1	RF5	RF24	
RF7	RF7	RF15	RF24	RF7			
RF8	RF7	RF15	RF24	RF1	RF5	RF7	RF15
RF9	RF7	RF24		RF1	RF5	RF24	
RF10	RF7	RF24		RF1	RF5	RF24	
RF11	RF15	RF24		RF1	RF5	RF15	RF24
RF12	RF7	RF24		RF5	RF7	RF24	
RF13	RF15	RF24		RF1	RF5	RF15	RF24
RF14	RF7	RF15		RF7	RF24	RF30	
RF15	RF15			RF15			
RF16	RF7	RF15		RF7	RF15	RF24	
RF17	RF7			RF7	RF30		
RF18	RF7	RF24		RF1	RF5	RF24	
RF19	RF7	RF15		RF7	RF24	RF30	
RF20	RF7	RF24		RF5	RF7	RF24	
RF21	RF7	RF15	RF24	RF7	RF24	RF30	
RF22	RF7			RF7	RF30		
RF23	RF7	RF24		RF7	RF24	RF30	
RF24	RF24			RF24			
RF25	RF15			RF24	RF30		
RF26	RF7	RF15	RF24	RF7	RF24	RF30	
RF27	RF7			RF7	RF30		
RF28	RF7	RF15		RF7	RF24	RF30	
RF29	RF7			RF7	RF30		
RF30	RF7	RF24		RF30			

Table 6 shows the changes in inputs in percentages that the companies should have to accomplish so that they can be counted as efficient in terms of overall technical and pure technical efficiencies. The value with minus sign implies that the company should reduce the usage of that resource in given percentage. For instance, the first company RF1 was found to be pure technical efficient whereas it was inefficient in terms of overall technical and scale efficiencies. This means that the problem with this company is related with the size. In addition, it should improve its scale efficiency by 16% as shown in Table 6. To this aim, from the data in Table 6, if the company RF1 decreases its number of employees 58.96%, number of stores 16.04%, and uses 8.78% of its sales area then it can reach the efficiency of the company of RF24.

The mean values in Table 6 indicate that most problematic input is "The number of employee" for being overall technical efficient for the companies in concern. On the other hand, the two important inputs for pure technical efficiency are the "Number of employees" and "Number of stores". This refers that the problem with the scale efficiency comes much from the input of "The number of employees". The companies should put particular effort on the managing the efficiency of the personnel and better plan their stores.

4.CONCLUSION

In this study, the efficiency of apparel retail companies were analysed by input-oriented DEA model under variable return to scale and constant return to scale assumptions. The analysis provided evaluating the companies in terms of overalltechnical, pure technical and scale efficiencies. Besides, the reference set for the inefficient companies was developed for making suggestions by determining role models in the input values. The analysis revealed that, almost half of the companies showed higherefficiency than the rest of the companies, but only 3 companies in overall technical and scale efficiencies and 7 companies in pure technical efficiency got the efficiency score of 1. Besides, it was found out that the efficiency values show smoother distributions in terms of scale efficiencies. The concentrations in the improvement ratios evaluated for each company revealed that the two inputs for the pure technical efficiencies have special concern, which were "The number of employees" and "The number of stores". The problematic field was related with "The number of employees" within the case of overall technical efficiencies. Therefore, it can be recommended that more companies should correct their sizes by making small changes whereas less number of companies should make major changes in order to be pure technical efficient.

Table 6: CRS- VRS Improvement Ratio

%	IMPROVEMENT RATIO-CRS (ForOverall Technical Efficiencies)			IMPROVEMENT RATIO-VRS (ForPure Technical Efficiencies)		
Retail Firm	Number of Employee	SalesArea m^2	Number of Stores	Number of Employee	Sales Area m^2	Number of Stores
RF1	-58,96	-91,22	-16,04	0,00	0,00	0,00
RF2	-47,22	-34,89	-34,89	0,00	0,00	0,00
RF3	-78,71	-68,79	-68,79	-56,32	-29,44	-29,44
RF4	-62,17	-49,80	-49,80	-35,50	-25,51	-25,51
RF5	-25,06	-2,53	-2,53	0,00	0,00	0,00
RF6	-92,67	-72,42	-72,42	-86,17	-36,39	-36,39
RF7	0,00	0,00	0,00	0,00	0,00	0,00
RF8	-51,57	-51,57	-51,57	-26,00	-26,00	-26,00
RF9	-69,01	-61,27	-61,27	-50,49	-40,48	-40,48
RF10	-57,19	-41,65	-41,65	-42,73	-40,39	-38,33
RF11	-58,66	-70,02	-58,66	-24,30	-24,30	-24,30
RF12	-93,21	-64,38	-64,38	-90,98	-58,94	-58,94
RF13	-57,24	-58,05	-57,24	-22,61	-22,61	-22,61
RF14	0,00	0,00	0,00	0,00	0,00	0,00
RF15	0,00	0,00	0,00	0,00	0,00	0,00
RF16	-29,24	-29,24	-53,43	-28,43	-28,43	-56,60
RF17	-80,10	-32,04	-67,53	-78,39	-25,68	-65,21
RF18	-92,84	-88,27	-88,27	-88,86	-77,78	-77,78
RF19	-40,10	-40,10	-62,48	-37,72	-37,72	-62,76
RF20	-29,44	-11,35	-11,35	-25,76	-9,28	-9,28
RF21	-79,47	-79,47	-79,47	-78,85	-78,85	-82,07
RF22	-61,90	-49,99	-55,58	-73,33	-46,16	-78,01
RF23	-80,04	-72,17	-72,17	-77,12	-68,53	-68,53
RF24	0,00	0,00	0,00	0,00	0,00	0,00
RF25	-53,70	-61,89	-90,28	-52,71	-61,71	-89,66
RF26	-18,18	-18,18	-36,41	-31,90	-10,81	-69,17
RF27	-49,80	-20,22	-59,98	-67,34	-4,27	-87,77
RF28	-70,55	-70,55	-78,87	-60,39	-60,39	-82,96
RF29	-70,02	-65,91	-79,12	-42,80	-32,22	-63,38
RF30	-55,61	-47,52	-47,52	0,00	0,00	0,00
Mean	-52,09	-45,12	-48,72	-39,29	-28,20	-39,84
Min	0,00	0,00	0,00	0,00	0,00	0,00
Max	-93,21	-91,22	-90,28	-90,98	-78,85	-89,66
St Dev	27,85	27,74	27,92	30,69	24,64	31,65

REFERENCES

Banker, R.D., Charnes, A. ve Cooper, W.W.(1984) "Some Modelsfor Estimating Technical and Scale Inefficiencies in DataEnvelopment Analysis" *Management Science,* 30(9):1078-1092.

Charnes, A., Cooper, W.W. ve Rhodes, E. (1978) "Measuring TheEfficiency of Decision Making Units" *European Journal of Operational Research,* 2: 429-444.

Donthu, N. veYoo, B. (1998) "Retail Productivity AssessmentUsing Data Envelopment Analysis" *Journal of Retailing,* 74(1):89-105.

Donthu, N., Hershberger, E.K. veOsmonbekov T. (2005) "Benchmarking Marketing Productivity Using Data Envelopment Analysis" *Journal of Business Research,* 58:1474- 1482.

Duzakin, E. veDuzakin, H. (2007) "Measuring the Performance of Manufacturing Firms with Super Slacks Based Model of Data Envelopment Analysis: An Application of 500 Major Industrial Enterprises in Turkey" *European Journal of Operational Research,* 182:1412-1432.

Kamakura, W.A., Lenartowicz, T. veRatchfrord, B.T. (1996) "Productivity Assessment of Multiple Retail Outlets" *Journal of Retailing,* 72(4):333-356.

Kasap, Y. (2011) "The Effect of Work Accidents on the Efficiency of Production in the Coal Sector" *South African Journal of Science,*107(5/6):1-9.

Ray, S.C.(2004) *Data Envelopment Analysis: Theory and Techniques for Economics and Operations Research,* New York, Cambridge University Press.

Sherman, H.D. ve Zhu, J.(2006) "Service Productivity Management: Improving Service Performance Using Data Envelopment Analysis (DEA)" *Springer Science,* Boston.

Tektufekci, E. (2010) "Evaluation of Financial Efficiency by Data Envelopment Analysis in Istanbul Stock Exchange Listed Publicly Traded Technology Companies" *Organizasyon ve Yönetim Bilimleri Dergisi,* 2(2):69-77.

TurkishTime, (2011) "TurkishTime ve AMPDBMD Perakende 100 Araştırması" 116:101-104.

Zhu, J. (2003)*Quantitative Models for Performance Evaluation and Benchmarking,* New York, Springer.