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Analysis of the Efficiency Determinants of Turkey's Agriculture Sector by Two-Stage Data Envelopment Analysis (DEA)

Türk Tarımının Etkinlik Bileşenlerinin İki Aşamalı Veri Zarflama Analizi (VZA) ile İncelenmesi

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ABSTRACT

In the country-wide providing the efficiency will only be provided by distributing the resources in the non-efficient provinces and regions well-balanced by correcting the deficiencies and by building separate plans. For this purpose, the efficiency of Turkey's agriculture sector in 2009 on the basis of provinces and regions by using two-stage data envelopment analysis (DEA) method is analyzed, the factors that have an impact on productivity are determined and the differences between provinces and regions are focused on. Firstly, an input-oriented DEA was performed by using 4 inputs and 1 output under variable returns to scale assumption. While the average technical efficiency was found to be 75%, it was understood that the cost of agricultural labour force and energy needed to be reduced. Secondly, the Tobit regression model was used to analyse the relation between the technical efficiency values of the provinces and the variables considered to have an external impact on the agricultural productivity. As a result of the predicted model; precipitation per m2, the households engaged in agriculture, literacy ratio and ratio of asphalt roads were determined as variables which contribute the agricultural efficiency of the provinces. Furthermore, regional efficiency differences were observed and results were evaluated.

Keywords: Agriculture, technical efficiency, tobit regression, Turkey, two-stage data envelopment analysis

ÖZET

Ülke genelinde etkinliğin sağlanabilmesi ancak verimsiz olan iller ve bölgelerdeki kaynakların dengeli dağıtılarak, yetersizliklerin giderilmesi ve her biri için ayrı planlamaların yapılması ile mümkün olabilecektir. Bu amaçla, makalede, iki aşamalı veri zarflama analizi (VZA) yöntemi ile 2009 yılı Türk tarım sektörü etkinliği iller ve bölgeler bazında analiz edilmiş, verimliliğe etki eden faktörler belirlenmiş ve bölgeler arasındaki farklılıklara odaklanılmıştır. İlk olarak, ölçeğe göre değişken getiri varsayımı altında 4 girdi, 1 çıktı kullanılarak girdi odaklı veri zarflama analizi yapılmıştır. İllerin ortalama teknik etkinliği %75 bulunurken, tarımsal işgücü ve tarımsal elektrik kullanımı girdilerinin azaltılması gereği ortaya çıkmıştır. İkinci olarak ise Tobit Regresyon modeli kullanılarak, illerin teknik etkinlik değerleri ile tarımsal verimliliği dışsal olarak etkileyen değişkenler arasındaki ilişki incelenmiştir. Kestirilen model sonucunda; m2'ye düşen yağış miktarı, tarımla uğraşan hane halkı, okur yazar ve asfalt yol oranı illerin tarımsal verimliliğine katkıda bulunan değişkenler olarak belirlenmiştir. Ayrıca, bölgesel etkinlik farklılıkları incelenerek sonuçlar değerlendirilmiştir.

Anahtar Kelimeler: Tarım, teknik etkinlik, tobit regresyon, Türkiye, iki aşamalı veri zarflama analizi

1. INTRODUCTION

The agriculture sector which meets the most important basic needs of people is one of the key sectors of the Turkish economy. However, despite its importance, this sector has been in recession in the last decade. One of the most important indicators of recession is the decreasing employment rate in the agriculture sector. The employment rate fell from 36% in 2000 to 25% in 2009. The main reason for this fall is the rural to urban migration. The decreasing share of agriculture in the national income, increasing input prices in agriculture, fragmentation of lands into small pieces by inheritance and high profit in the non-agricultural sectors increased immigration to cities.

The status of agriculture in the Turkish economy between 2000 and 2009 is presented in Table 1. Both the total Gross Domestic Product (GDP) and the share of agriculture in GDP increased between 2000 and 2009. Despite such increase, the share of agriculture in the total GDP decreased in general. This value fell from 10.09% in 2000 to 8.27% in 2009. The reason for such decline was that the share of the other sectors in the GDP increased at a higher ratio than that of agriculture sector.

The growth of the agriculture sector has not

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showed a consistent tendency in the last decade as shown in Table 1. Although positive growths were achieved throughout the entire period that was analysed, a shrinkage was experienced in 2001, 2003 and 2007. The growth rate of the agriculture sector that started to grow again as of 2008 reached 3.5% in 2009, which was still below 7.1% in 2000.

Table 1: Agricultural Indicators of Turkey

	GDP			Year-to-Year Growth Rate	
Year	Total GDP (current buyers' prices, Thousand TRY)	GDP of agriculture sector (current buyers' prices, Thousand TRY)	Share of agriculture sector in the total GDP (%)	Overall growth rate (% by the constant prices of 1998)	Growth rate of agriculture sector (% by the constant prices of 1998)
2000	166 658 021	16 817 322	10.09	6.8	7.1
2001	240 224 083	21 236 673	8.84	-5.7	-7.9
2002	350 476 089	36 058 281	10.29	6.2	8.8
2003	454 780 659	45 137 960	9.93	5.3	-2.0
2004	559 033 026	52 997 645	9.48	9.4	2.8
2005	648 931 712	60 713 747	9.36	8.4	7.2
2006	758 390 785	62 662 754	8.26	6.9	1.4
2007	843 178 421	64 331 717	7.63	4.7	-6.7
2008	950 534 251	72 274 585	7.60	0.7	4.3
2009	952 634 796	78 760 567	8.27	-4.7	3.5

(**Source:** State Planning Organization (SPO); 2011)

Although the GDP of the agriculture sector increased, its share in GDP decreased and it didn't have a consistent growth which made it necessary to analyse the performance of the agriculture sector in Turkey. To this end, the agricultural efficiency of Turkey in recent years was analysed by methods such as Data Envelopment Analysis (DEA), Malmquist Productivity Index, Stochastic Frontier Analysis and Cobb-Douglas production function (see Başarır et al., 2006; Ören and Alemdar, 2006; Tipi and Rehber, 2006; Deliktaş and Candemir, 2007; Armağan et al., 2010; Artukoğlu et al., 2010; Kaya and Erdoğan Aktan, 2011). Gül (2006), Ören and Alemdar (2006), Bozoğlu and Ceyhan (2007) and Tipi et al. (2009) used the two-stage analysis method and analysed the factors that affect productivity/unproductivity in addition to measuring the agricultural productivity.

The productivity of Turkish agriculture sector has usually been studied on country and regional level. This study makes a difference as it was conducted on provincial level by using the two-stage DEA method. Each province has a different contribution to the agriculture sector of the country, thus the factors that lead to productivity or unproductivity should be analysed separately for each province. In this way, it is aimed to assess the agricultural productivity of the entire country more effectively. The efficiency country-wide can only be provided with distributing the resources well-balanced in non-efficient provinces and regions and removing the deficiencies and planning each resource separately.

By using a two-stage approach in this study, first the technical efficiency of the provinces were calculated through the DEA method and then the explanatory variables that had an impact on the efficiency of the provinces were analysed through the Tobit regression method. Thus, agricultural efficiency was analysed in terms of controllable and uncontrolled variables. With this study besides identifying the factors that effect the agricultural efficiency, efficiency differences evaluation was ensured in the basis of provinces and regions. The subsequent chapters of this paper consisting of five chapters explain the data, method used in this study and the application results, respectively. The conclusion provides findings and suggestions with respect to the efficiency of Turkey's agriculture sector.

2. MATERIALS

The variables used in the DEA consist of the ones that directly affect the agricultural productivity. However in Tobit regression, the environmental variables were used in order to analyse the reasons of rural-urban migration in addition to the impacts of the factors specific to the provinces.

FAO (Food and Agriculture Organization of the United Nations) classified the agricultural productivity under the headings of soil, agricultural chemicals (fertilizers and pesticides), population, labour force, agricultural automation, macroeconomic accumulations (GDP and agricultural investments) and agricultural development in its report on the agricultural variables which was published in 2003 (FAO, 2003). Many of the studies conducted on the agricultural productivity referred to these variables defined by FAO. The outputs most frequently used in the studies were the agricultural production index and agricultural gross income calculated by FAO. While the agricultural inputs varied by the studies; in general, the agricultural labour force, cultivated area, irrigated area, number of tractors, amount of feed, seeds and fertilizers used, GDP allocated to agriculture and the energy used in agriculture were preferred.

In the first stage of the study which was based on a two-stage approach, the agricultural technical efficiency of the provinces was measured in accordance with the variables defined by FAO. For this purpose, 4 inputs and 1 output were used in the DEA model. "The total revenue generated from agriculture per cultivated area" was used as the agricultural productivity output. This variable was obtained through dividing the total amount of money received by farmers from fruits, vegetables field crops by the cultivated areas. On the other hand, the inputs used are as follows:

• Number of tractors per cultivated area: number of tractors /cultivated areas

• Cultivation ratio of the agricultural area: cultivated area /total agricultural areas

• Agricultural labour force per cultivated area

• Agricultural energy use per cultivated area: agricultural energy use /cultivated areas

Since the way the provinces produce for the same purpose is similar, the homogeneity which is the main assumption of DEA, was obtained by dividing inputs and output by cultivated area.

In the second stage, the technical efficiency values obtained from DEA were used as the dependent variable in the Tobit model used. The explanatory variables that affect the technical efficiency of the provinces are presented as follows:

• The share of agriculture in the public investments (Public): refers to the amount of investment allocated for agriculture among the total public investments made in the provinces.

• Literacy ratio (Literacy): ratio of the literate individuals older than 15 in the villages to the total population.

• The precipitation per m^2 (Precipitation): ratio of the precipitation in provinces to the surface area.

• Ratio of the households engaged in agricultural activities (Household): Ratio of the total number of households that are engaged in agriculture in the provinces to the total number of households.

• Available agricultural cooperatives (Cooperative): the dummy variable that indicated whether agricultural cooperatives are available in the provinces. This variable has the value of 1 if a cooperative is available in the province and the value of 0 if not.

• The share of agriculture in the total GDP (GDP): The ratio of the agricultural share of the province in the GDP to the total GDP.

• Agricultural credit ratio (Credit): the ratio of the credit used in the province for agricultural purpose to the amount of total credits.

• Ratio of asphalt village roads (Road): the ratio of asphalt village roads of the province to the total village roads.

To determine the explanatory variables, the studies carried out by Hayami and Ruttan (1970); Zaim et al. (2001); Coelli et al. (2002); Binam et al. (2003); Helfand (2003); Hsu et al. (2003); Haji and Andersson (2006); Çakmak et al.(2008); Oni et al. (2009) were referred to.

In this paper, the data of 81 provinces in Turkey for the year 2009 was obtained from the databases of the Turkish Statistical Institute (TSI), The Central Union of Turkish Agricultural Credit Cooperatives, Ministry of Interior General Directorate of Local Authorities, Turkish Electricity Distribution Corporation, State Planning Organization (SPO), Turkish State Meteorological Service, The Banks Association of Turkey.

3. METHODS

In the first stage, the DEA method which is a mathematical programming method and aims to measure the relative impacts of the decision making units which are assumed to be homogen by using multiple inputs-outputs was applied. Initially developed by Farrell (1957), DEA was extended by Charnes et al. in 1978 and by Banker et al. in 1984.

Two assumptions consisting of constant returns to scale (CRS) and variable returns to scale (VRS) are made in calculating the efficiency scores by DEA. The DEA CRS model developed by Charnes et al. (1978) is used when all decision making units (DMUs) are at optimal scale (Javed et al., 2010). When there are factors such as imperfect competition, financing constraints, etc., firms cannot operate at the optimal scale. Therefore, the VRS model developed by Banker et al. (1984) is preferred to the CRS model (Krasachat, 2003; Javed et al., 2010).

The technical efficiency (TE) obtained through the DEA has the value range of 0-1 and when TE=1, the DMU produces at the production frontier and it is technically efficient (Chavas and Aliber, 1993). The scale efficiency (SE) which is one of the components of technical efficiency is the ratio of CRS efficiency to VRS efficiency; and when it is equal to 1, it indicates that the DMU is scale efficient (Yu and Ramanathan, 2008; Tipi et al., 2009).

The managers prefer the input or output-oriented model according to their possibility to control the variables. As the controllability of inputs is higher than that of the outputs in this study, the input-oriented DEA was used. For N number of decision makers obtaining the M outputs by using K number of inputs, an input-oriented VRS DEA model is presented in the equation 1, below (Tipi et al., 2009; Javed et al., 2010).

$$\min_{i,\lambda}\theta \quad \text{Subject to} \quad \begin{aligned} & y_i + Y\lambda \geq 0 \\ & \theta x_i - X\lambda \geq 0 \\ & N1'\lambda = 1 \\ & \lambda \geq 0 \end{aligned} \qquad (1)$$

In this equation, Y indicates the output matrix for the N number of DMUs; Θ indicates the input-oriented technical efficiency score valued from 0 to 1; X indicates the input matrix for N number of DMUs; λ indicates the Nx1 vector of the weights defining the linear combination of the peers of i. DMU; y_i indicates the output of the i. DMU and x_i indicates the input of the i. DMU (Javed et al., 2010).

At the second stage of the study, the Tobit model was used to analyse the relations between the technical efficiencies of the provinces calculated under the DEA VRS assumption and the environmental variables. The reason why the VRS scores were preferred is that the provinces don't produce at an optimal scale.

As the technical efficiency scores used as the dependent variable in the regression obtained through the Ordinary Least Squares (OLS) prediction are limited in the range of 0-1, they don't have a normal distribution, leading to the results of the prediction being biased. For this reason, it is convenient to use the Tobit regression in this study.

The Tobit model which is also known as truncated or censored regression was applied by Tobin (1958) for the first time. This model is expressed in the equation 2 shown below (Oni et al., 2009):

$$y_i^* = \beta_0 + \sum_{j=1}^{K} \beta j x_{ij} + \mu_i \qquad (2)$$

$$\mu_i - IN(0, \sigma^2)$$

y_i^* is a latent variable that indicates the efficiency score of i. DMU while x_{ij} indicates the j. explanatory variable of the i. DMU. μ_i is the disturbance term. However, y_i which is defined as the observed dependent variable is expressed in the equation 3 shown below:

$$y_i = 0 \text{ if } y_i^* \leq 0 \qquad (3)$$

$$y_i = y_i^*, \text{ if } 0 < y_i^* < 1 \text{ and}$$

$$y_i = 1, \text{ if } y_i^* \geq 1$$

The existence of a correlation between the technical efficiency scores obtained at the first stage and the independent variables used at the second stage may lead to inconsistency and bias in the predictions. This issue was also reviewed in the literature and the bootstrap procedure was proposed to be applied to eliminate such correlation (Barros, 2006; Simar and Wilson, 2007; Yu and Ramanathan, 2008). However, as also stated by Barros (2006), when the sources where the variables used in the DEA model are obtained are independent from the sources of the variables applied in the Tobit regression model and different data sources are used, there won't be any correlation between the sets of data; therefore, it won't be necessary to apply a bootstrap procedure any more. For this reason, the bootstrap procedure was not applied in this study.

In the study, WIN4DEAP (Coelli, 1996) program was used for DEA and Eviews5 program was chosen for Tobit regression analysis.

4. EMPIRICAL RESULTS

4.1. Results of Technical Efficiency

The input-oriented DEA analysis of 81 provinces in Turkey was conducted under VRS assumption. The distribution of the TE and SE scores of provinces as well as the descriptive statistics is presented in Table 2. According to the VRS assumption, 13 provinces were technically efficient and 6 of these provinces were also scale efficient. The technical efficiency of the provinces ranged between 0.49 and 1.00, while the average technical efficiency was calculated as 0.75. It is necessary to reduce the inputs by 25% in order to make all the other inefficient provinces efficient. 16% of the provinces were efficient, and 44 provinces remained below the Turkey's average.

Table 2: Distribution Of Efficiency Scores of the Provinces

	Number of provinces		
Degree of efficiency(%)	CRS	VRS	SE
1.00	6	13	6
0.90-0.99	-	8	-
0.80-0.89	-	11	-
0.70-0.79	-	13	1
0.60-0.69	2	18	3
0.50-0.59	1	15	2
0.40-0.49	-	3	1
<0.40	72	-	68
Mean Value	0.190	0.748	0.231
Minimum	0.012	0.487	0.012
Maximum	1	1	1
SD	0.263	0.172	0.267

Table 3 demonstrates the inputs having the slacks, the amount of slacks and the number of provinces where the input slacks were recorded. In order to provide efficiency to all inefficient provinces, the agricultural labour force and energy used in agriculture should be reduced. The energy used in agriculture should be reduced in 67% of the provinces of Turkey. The agricultural labour force should be decreased in 13 provinces. The energy used in agriculture should be reduced by 7090 units on average and the labour force should be decreased by 4995 units on average throughout the country.

4.2. Technical Efficiency: Regional Results

6 of 13 efficient provinces are located in the Black Sea Region, 5 are located in the Eastern Anatolia Region; while the Central Anatolia Region and Marmara Region each have one efficient province. The Black Sea Region, Central Anatolia Region and the Eastern Anatolia Region have outperformed the efficiency average of Turkey. Having the highest efficiency, the Eastern Anatolia Region only has 9% production loss on average due to inefficiency.

Table 3: The Distribution of Input Slacks of The Provinces

Inputs	Number of Provinces	Mean Slack
Number of tractors	-	0.000
Cultivated agricultural areas	2	0.002
Agricultural labour force	13	4994.598
Energy used in agriculture	54	7090.436

The efficiency differences between the regions were checked by performing the ANOVA and Post-Hoc tests. The homogeneity of the variations was tested by Levene's Test, the Levene statistic was found to be 2.952 and the null hypothesis was rejected at a significance level of 5%. For this reason, it was deemed appropriate to run the Dunnett T3 test which is one of the Post-Hoc tests applied for the groups having inhomogeneous variations.

Table 4 shows the regions with a significant efficiency difference at the confidence level of 5% according to the Dunnett T3 test results. The Eastern Anatolia Region is more efficient than the Aegean Region, Mediterranean Region, Marmara Region and South-eastern Anatolia Region. The Central Anatolia Region is more efficient than the Aegean, Mediterranean and Marmara Regions; whereas the South-eastern Anatolia Region and Black Sea Region are more efficient than the Aegean and Mediterranean Regions.

Table 4: Efficiency Differences Between The Regions

Region 1	Region 2	Test Statistics	SE	95% Confidence Interval	
				Lower Bound	Upper Bound
Mediterranean	Eastern Anatolia	-0.336	0.039	-0.471	-0.201
Mediterranean	South-eastern Anatolia	-0.163	0.042	-0.313	-0.012
Mediterranean	Central Anatolia	-0.252	0.037	-0.381	-0.124
Mediterranean	Black Sea	-0.234	0.046	-0.387	-0.081
Eastern Anatolia	Aegean	0.364	0.038	0.233	0.495
Eastern Anatolia	South-eastern Anatolia	0.173	0.047	0.013	0.334
Eastern Anatolia	Marmara	0.285	0.052	0.107	0.463
Aegean	South-eastern Anatolia	-0.190	0.041	-0.338	-0.042
Aegean	Central Anatolia	-0.280	0.036	-0.404	-0.155
Aegean	Black Sea	-0.261	0.045	-0.411	-0.112
Central Anatolia	Marmara	0.201	0.050	0.027	0.375

4.3. Results of Tobit Regression

The relation between the technical efficiency values of the provinces and the variables which were considered to have an external impact on agricultural efficiency was analysed through Tobit regression. Within this context, GDP, household, cooperative, credit, public, literacy, precipitation and road variables were taken as independent variables; while the agricultural efficiency scores of the provinces were used as the dependent variable; and the results of the model are presented in Table 5. When the model was predicted without a constant, it yielded better values; therefore it was decided to use it without a constant.

Table 5: Results of Tobit Regression

Variable	Coefficient	z-statistic
GDP	0.765	0.198
Household	0.455	3.127*
Public	0.001	0.203
Cooperative	-0.009	-0.164
Credit	0.001	0.088
Literacy	0.783	4.309*
Precipitation	0.507	2.995*
Road	-0.628	-4.661*

* Significant at the 5% level

In the model that was developed the literacy, household, precipitation and road variables were found to be significant at the confidence level of 5%; while it was concluded that the public, cooperative, GDP and credit variables did not affect the agricultural technical efficiency. Among the other studies using similar variables, Haji and Andersson (2006) who analysed the efficiency of the vegetable fields in Ethiopia and Hefland (2003) who studied the agriculture in Brazil did not either find the credit variable significant.

It was observed that the agricultural productivity increased as the ratio of the households engaged in agriculture in the province rose. Haji and Andersson (2006) who also addressed the household variable in their studies found this variable significant but they also found that as the number of the household members engaged in agriculture increased, it had a negative impact on efficiency.

Another finding is that the efficiency was higher in the provinces that had more precipitation or higher literacy ratio. Haji and Andersson (2006) also found the education variable positive and significant. However, Coelli et al. (2002) did not find the education variable significant in the studies that they analysed the efficiency of rice production at farms in Bangladesh.

Contrary to the expectations, as the asphalt road ratio rose, the efficiency decreased. Similarly, Zaim et al. (2001) who studied the agricultural productivity of Turkey for the period 1990-1996 similarly found the asphalt ratio negative and explained this as the negative impact of urbanization on the efficiency of the agriculture sector.

Given that the geographical regions differ in terms of factors affecting the agricultural efficiency, a province in a more advantageous region is expected to have higher efficiency. To this end, the second Tobit regression model was used to analyse the relation between the geographical regional conditions and the agricultural technical efficiency. Whereas the technical efficiency values were taken as the dependent variable; the regional dummies were also used as the independent variable in addition to the environmental variables which were found to be statistically significant. 6 dummy variables were used for 7 regions in the analysis. The Eastern Anatolia Region with the highest technical efficiency was selected as the constant term and the assessments were made according to this region.

Table 6 demonstrates the results. It was found in the second model that only the precipitation and road variables were significant and the other two variables lost their significance. The impacts of these two variables were contained in the regional dummy variables. Like in the first regression model, the precipitation and road variables were also found to be positive and negative respectively in this model.

Table 6: Tobit Regression Model Including The Regional Dummy Variables

Variable	Coefficient	z-statistic
Constant	0.988	4.152
South-Eastern Anatolia	-0.155	-2.914*
Mediterranean	-0.203	-2.871*
Aegean	-0.179	-2.329*
Marmara	-0.153	-1.882*
Black Sea	-0.130	-2.257*
Central Anatolia	0.064	1.019
Precipitation	0.523	4.632*
Literacy	-0.093	-0.268
Household	0.047	0.406
Road	-0.426	-3.672*

*Significant at the 5% level.

As also indicated in Table 6, the dummy variables of all regions except the Central Anatolia Region are statistically significant at the confidence level of 5%. The coefficients of all significant regions are negative. This indicates that the provinces in the Eastern Anatolia Region are more efficient than those in the other regions.

5. CONCLUSION

The study aimed to analyse the efficiency of the agriculture sector in Turkey for 2009 at provincial and regional level and to determine the factors that affect efficiency by using a two-stage DEA method.

As a result of the analysis, it was found that 16% of 81 provinces were at the efficient frontier; while 54% of them had values greater than the national average. The inefficient provinces are also expected to rise above this frontier by reducing the agricultural inputs by 25% throughout the entire country. This expectation can be met through a reduction in the agricultural labour force and agricultural energy use inputs.

The precipitation per m^2, the ratios of households engaged in agriculture, literacy and asphalt roads were found to be the environmental variables that explained the agricultural efficiency. Increasing the first three variables will also increase the agricultural productivity. However, as the ratio of asphalt roads rises, the technical efficiency falls and this can be considered as the negative consequence of urbanization on the efficiency of the agriculture sector.

Convenience of the geographical region where the province is located for agricultural production is an important factor for the analysis of agricultural efficiency of that province. From the perspective of agricultural variables, the Eastern Anatolia Region is significantly more efficient than the Aegean, Mediterranean, Marmara and South-eastern Anatolia Regions. The Central Anatolia Region is more efficient than the Aegean, Mediterranean and Marmara Regions; while the South-eastern and Black Sea Regions are more efficient than the Aegean and Mediterranean Regions. When the agricultural technical efficiency and the road and precipitation variables are analysed collectively, it is concluded that the Eastern Anatolia Region is more efficient than the other regions except the Central Anatolia Region.

The focus should be on the differences between the provinces and regions in order to perform an efficient agricultural activity in the entire country. These differences should be eliminated based on the findings of this study which assessed each province and region individually and separate plans should be implemented for each of them. The elimination of the shortcomings by the policy and strategy developers through a balanced allocation of resources to the inefficient provinces and regions will improve the agricultural performance of Turkey. It is thought that this study will contribute not only to the decision makers but also to the academicians who carry out studies in this field.

REFERENCES

Armağan, G., Özden, A. ve Bekçioğlu, S. (2010) "Efficiency and Total Factor Productivity of Crop Production at NUTS1 Level in Turkey: Malmquist Index Approach" *Quality&Quantity,* 44:573- 581.

Artukoğlu, M.M., Olgun, A. ve Adanacıoğlu, H. (2010) "The Efficiency Analysis of Organic and Conventional Olive Farms: Case of Turkey" *Agricultural Economics-Czech,* 56(2):89-96.

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

Barros, C.P. (2006) "Efficiency Measurement among Hypermarkets and Supermarkets and The Identification of The Efficiency Drivers" *International Journal of Retail&Distribution Management,* 34(2):135-154.

Başarır, A., Karlı, B. ve Bilgiç, A. (2006) "An Evaluation of Turkish Agricultural Production Performance" *International Journal of Agriculture&Biology,* 8(4):511-515.

Binam, J.N., Sylla, K., Diarra, I. ve Nyambi, G. (2003) "Factors Affecting Technical Efficiency among Coffee Farmers in Cote d'Ivoıre: Evidence from The Centre West Region" *R&D Management,* 15(1):66-76.

Bozoğlu, M. ve Ceyhan, V. (2007) "Measuring The Technical Efficiency and Exploring The İnefficiency Determinants of Vegetable Farms in Samsun Province, Turkey" *Agricultural Systems,* 94:649-656.

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

Chavas, J-P. ve Aliber, M. (1993) "An Analysis of Economic Efficiency in Agriculture: A Nonparametric Approach" *Journal of Agricultural and Resource Economics,* 18(1):1-16.

Coelli, T.J. (1996) *"A guide to DEAP version 2.0: A Data Envelopment Analysis (Computer) Program"* Center for Efficiency and Productive Analysis (CEPA) Department of Econometrics, University of New England, Armidale, Australia.

Coelli, T., Rahman, S. ve Thirtle, C. (2002) "Technical, Allocative, Cost and Scale Efficiencies in Bnagladesh Rice Cultivation: A Non-Parametric Approach" *Journal of Economic Journal of Agricultural Economics,* 53:607-626.

Çakmak, E., Dudu, H. ve Öcal, N. (2008) "Türk Tarım Sektöründe Etkinlik:Yöntem ve Hanehalkı Düzeyinde Nicel Analiz" *Report prepared for Economic Policy Research Foundation of Turkey,* Ankara.

Deliktaş, E. ve Candemir, M. (2007) "Production Efficiency and Total Factor Productivity Growth in Turkish State Agricultural Enterprises" *Ege University, Working Papers in Economics,* No:03.

FAO, Food and Agriculture. Organization (2003) "Compendium of Agricultural-Environmental Indicators 1989-91 to 2000" *FAO Statistics Analysis Services, Statistics Devision,* Rome.

Farrell, M.J. (1957) "The Measurement of Productive Efficiency" *Journal of The Royal Statistical Society,* 120(3):253-290.

Gül, M. (2006) "Technical Efficiency of Apple Farming in Turkey: A Case Study Covering Isparta, Karaman and Niğde Provinces" *Pakistan Journal of Biological Sciences,* 9(4):601-605.

Haji, J. ve Andersson, H.C. (2006) "Determinants of Efficiency of Vegetable Production in Smallholder Farms: The Case of Ethiopia" *Food Economics-Acta Agriculturae Scandinavica,* 3:125-137.

Hayami, Y. ve Ruttan, V.W. (1970) "Agricultural Productivity Differences among Countries" *The American Economic Review,* 60(5):895-911.

Helfand, S.M. (2003) "Farm Size and The Determinants of Productive Efficiency in The Brazilian Center-West" *25th International Conference of the International Association of Agricultural Economist,* August 16-22, Durban, South Africa.

Hsu, S-H.,Yu, M-M. ve Chang, C-C. (2003) "An Analysis of Total Factor Productivity Growth in China's Agricultural Sector" *American Agricultural Economics Association Annual Meeting,* July 27-30, Montreal, Canada.

Javed, M.I., Adil, S.A., Ali, A. ve Raza M.A. (2010) "Measurement of Technical Efficiency of Rice-Wheat System in Punjab, Pakistan Using DEA Technique" *Journal of Agricultural Research,* 48(2):227-238.

Kaya, P. ve Erdoğan Aktan, H. (2011) "Türk Tarım Sektörü Verimliliğinin Parametrik Olmayan Bir Yöntemle Analizi" *Journal of Alanya Faculty of Business,* 3(1):261-282.

Krasachat, W. (2003) "Technical Efficiencies of Rice Farms in Thailand: A Nonparametric Approach" *in Proceedings of the Hawaii International Conference on Business,* June 18-21, Honolulu.

Oni, O.A., Akinseinde, A.A. ve Adepoju, A. A. (2009) "Non-Farm Activity and Production Efficiency of Farm Households in Egbeda Local Government Area Oyo State, *Journal of New Seeds,* 10(1):1-13.

Ören, M.N. ve Alemdar, T. (2006) "Technical Efficiency Analysis of Tobacco Farming in Southeastern Anatolia" *Turkish Journal of Agriculture and Forestry,* 30:165-172.

Simar, L. ve Wilson, P.W. (2007) "Estimation and Inference in Two-Stage, Semi-Parametric Models of Production Processes" *Journal of Econometrics,* 136:31-64.

SPO, State Planning Organization. (2011) Available at http://www.dpt.gov.tr/ (15.09.2011).

Tipi, T. ve Rehber, E. (2006) "Measuring Technical Efficiency and Total Factor Productivity in Agriculture: The Case of The South Marmara Region of Turkey" *New Zealand Journal of Agricultural Research,* 49:137-145.

Tipi, T., Yildiz, N., Nargeleçekenler, M. ve Çetin, B. (2009) "Measuring The Technical Efficiency and Determinants of Efficiency of Rice (Oryza Sativa) Farms in Marmara Region, Turkey" *New Zealand Journal of Crop and Horticulturual Science,* 37:121-129.

Tobin, J. (1958) "Estimation of Relationships for Limited Dependent Variables" *Econometrica,* 26:24-36.

Yu, W. and Ramanathan, R. (2008) "An Assessment of Operational Efficiencies in The UK Retail Sector" *International Journal of Retail& Distribution Management,* 36(11):861-882.

Zaim, O., Bayaner, A. ve Kandemir, M.U. (2001) "Tarımda İller ve Bölgeler Düzeyinde Üretkenlik ve Etkinlik: Farklar ve Nedenler" *Agricultural Economics Research Institute Project Report,* Ankara.