Efficiency and cost analysis of growing tea in Turkey

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Abstract

Although Turkey ranks sixth in the world in tea production, it does not have a say in tea export. The reason for this is that the tea production season is short and the inputs used in production are not used efficiently. Therefore, this study aims to determine the efficiency levels of enterprises growing tea and the unit cost of fresh tea production. In the study, 220 tea growers were interviewed face-to-face by using the proportional sampling method. Questionnaires were administered to 100, 70, and 50 tea growers in Rize, Trabzon, and Artvin provinces, respectively. the Bootstrap method was used for estimating the technical efficiency coefficients, and cost analysis was employed for calculating profitability. According to the first stage of the Bootstrap results, 66.8% of the enterprises had technical efficiency, but 33.2% of them did not work efficiently. In the second stage of this method, Rize and Artvin provinces were found to have better efficiency compared to Trabzon province. The socio-demographic characteristics such as age, education, having non-agricultural jobs, income, and experience of the householder; and size and years of tea farm belonging to the enterprise with and the tea price of the previous year were having a positive effect on technical efficiency. In addition, the cost of 1 kg fresh tea in the region was found to be 2.02 TRY. Apart from reducing the inputs used in tea production, minimizing the problems encountered in the production process will provide both economic and environmental gains.

Keywords: Bootstrap Analysis. Cost. Data Envelopment Analysis. Efficiency. Tea,

1. Introduction

Tea (Camellia Sinensis) is the product with the highest consumption habit in the world after water and its consumption is increasing (Rietveld and Wiseman (2003). In addition to being generally preferred as hot, there are also varieties offered for consumption as cold or even iced drinks. It is known to have a rich sociocultural background enriched with economic, medical, and political benefits (Awasom, 2011).

Soil structure and climate are the most important factors in the cultivation of tea. It develops in regions with an annual average temperature of over 14 °C, humid and rainy around 0-40°C throughout the year. During the growing season, it is desired that the precipitation amount is above 1200 mm and the annual relative humidity average is 70% (İlçi, 2015). Tea grows in acidic soils with a pH value of 5.5-6.0, good permeability, and rich plant nutrients (RTB, 2019).

The homeland of tea is the Assam region of China, and China and India produce ⅔ of the world's dry tea production. 6.50 million tons of dry tea were produced in the world in 2019, 42.74% of this production was in China. Other important countries were India, Kenya, Siri Lenka, Vietnam, Turkey, Indonesia, and Myanmar. The percentages of these countries' dry tea production are 21.39, 7.06, 4.62, 4.14, 4.02, 2.12, 2.04, respectively. These 8 countries account for 88.14% of the world's dry tea production (FAOSTAT, 2021).

As of 2020, 68.59% of 1.4 million tons fresh tea of produced in Turkey was produced in Rize. The share of Rize province in production was followed by Trabzon, Artvin, Giresun, and Ordu, their production percentages were 19.15, 9.98. 2.27, and 0.01, respectively. In other words, Rize Trabzon and Artvin provinces constitute approximately 98% of tea production in Turkey (TURKSTAT, 2021). The amount of dried tea processed in 47 public factories in Turkey in 2020 is almost the same as 229 private sector factories, and the production is 142.000 tons. 95.24% of the production in public factories is black tea, 4.72% organic black tea, 0.040% green tea, and 0.026% organic green tea, and around 50 kg of white tea is produced (ÇAYKUR, 2020).

The labor cost in tea garden management is quite high (Hazarika, 2011). Labor charges constitute more than 60% of the total production cost. Electricity, fuel, pesticides and agricultural chemicals, and irrigation, etc. increase in input costs put the production companies in a difficult situation (Shah and Pate, 2016).

Cost reduction methods aim to increase the amount of production or to reduce wasteful variables. Increasing the amount of production in tea can be in several ways, the first is to bring the use of insufficient input and technology to a sufficient level, the second is to extend the harvest period, and finally; the number of harvests can be done 4 times instead of 3 in under good climatic conditions. Thus, producers can extend the harvest time and increase the number of harvests. But, processes related to tea harvest and duration can cause a decrease in tea quality and even in the price of tea. In other words, in order to express that the increase in production is profitable or has a cost-reducing effect, returns to scale need to be taken into account. while cost alone is a measure of business success, the degree of this measure is increased with efficiency analysis. Also, one of the most important aspects of efficiency analysis is to prevent the negative effects on the environment by ensuring optimum use of resources.

In addition to the use of input and capital that affect the cost, socio-demographic and economic characteristics of the household such as age, education, income, non-agricultural work, and experience in tea production, as well as belonging to the enterprise the age and size, slope, altitude of the tea farm, and the previous year's tea price has been reported to be effective on efficiency in previous studies (Basnayake *et al.*, 2002; Dube and Guveya, 2014; Haq and Boz, 2019; Karayar, 2019).

Although Turkey is among the leading countries in tea yield, most of the tea gardens are about to complete their economic life. Both there are wastes in the use of fertilizers and labor in tea cultivation, and producers state that their earnings in tea production are low. For this reason, the primary aim of the study is to determine the unit cost of tea as well as the efficiency level in tea production in Turkey. After the efficient enterprises were determined by the econometric model, as the secondary purpose, the relations of technically efficient of enterprises with the demographic, social, and economic characteristics of the household leader were investigated. As a result of this study, costs will decrease by providing less labor and fertilizer use in Turkey. The use of fewer inputs will contribute to the protection of nature and the environment. Thus, both consumers will eat healthier, and producers will earn more with sustainable production.

2. Literature Review

In many studies in the international arena, production costs and efficiencies related to many agricultural products have been discussed, and very few studies have been reached on the production efficiency and cost of tea. These studies can be listed as follows:

Dağdemir (2004) determined the cost of one kg of tea leaves in enterprises of different sizes by evaluating the data obtained from 152 enterprises in the Çayeli district of Rize province in 1993. According to the results of the study, he was concluded that as the size of the tea garden increases, the unit tea costs decrease, and therefore net incomes increase. As a suggestion, he has revealed that the tea gardens should be rejuvenated by pruning and the producers should be informed about the use of fertilizers.

Basnayake and Gunaratne (2002) used the technical efficiency method to determine the potential for production increase by keeping the inputs constant in 60 small-scale tea enterprises. In the study, they determined the technical efficiency in enterprises as 64.6%. Using stochastic frontier, Cobb-Douglas, and translog models, they estimated the effects of tea garden size, family and foreign labor, fertilizer, chemicals, and dolomite function on wet tea leaf activity. They suggested that small-scale tea producers should produce with more productive tea seedlings to take advantage of more subsidies.

Dube and Guveya (2014) conducted a study on the technical efficiency of 50 small-scale tea farms in the Chipinge district of Manicaland province of Zimbabwe. They found that the average technical efficiency to be 79% with DEA. Also, they have stated increases in tea production area, extension services, and yield increased the level of technical efficiency, but the increase of the age of the producer and tea garden, and use of fertilizer, labor, and the degree of commercialization decreased it. After all, they suggested that technical efficiency would be increased by determining the most appropriate amounts of wasted labor and fertilizer in this region, and by informing the individuals involved in production about production.

Hong and Yabe (2015) analyzed the data obtained from 258 farmers in Vietnam with DEA and determined the technical efficiency ratio. According to the results obtained from the research, they determined that tea production could increase by an average of 10.4% by using existing technologies. They determined the factors that have a positive effect on the level of technical efficiency in tea production are the application of soil and water conservation technologies, access to extension services, membership in cooperatives, and male gender.

Hong and Yabe (2017) determined that the irrigation water of the small-scale tea production enterprises in Vietnam was not efficient used making analyses with the Stochastic Frontier Analysis of the data they received from 243 producers. They emphasized that climate change in recent years has greatly reduced water resources, and it is necessary to determine the appropriate irrigation level in order to obtain a stable tea production. They determined that the rate of those who use irrigation water effectively is 42.19% in line with the decreasing returns to scale. In addition, they analyzed the efficiency of irrigation water use of tea fields with the Tobit model. As a result of this model, men, those who are aware of water scarcity, those who practice soil and water conservation, those who have non-agricultural income, and those who reach extension services, that water has a positive effect on effective use but draw irrigation water from wells have a negative effect have determined. They suggested that the government should inform all farmers, especially women farmers, about water scarcity, encourage soil and water conservation techniques with strengthen extension services, and use appropriate irrigation systems in order to increase water use efficiency.

Katungwe *et al.* (2017) stated that one of the most important factors in increasing the country's income is ensuring the efficiency of tea production since tea has a significant share in the export revenues of Malawi. They interviewed 230 producers in Southeast Malawi and applied Cobb-Douglas, Stochastic Frontier, and the Tobit models to the data they obtained. They determined the average technical efficiency of tea producers as 67%. According to the results they obtained from the Cobb-Douglas Stochastic Frontier Model in the first stage of their study, they observed that, as labor cost, the amount of fertilizer and pesticide used, and the age of the tea garden increase, the tea producer's efficiency decreased significantly. In the second stage of their work, they have analyzed the relationship between socio-economic and demographic factors and inefficiency in the Tobit model. They found that as the education of the individual, the distance of the garden from the factory, the use of foreign labor, and the experience of the family in tea increased, the technical inefficiency of the enterprises decreased significantly, but the inefficiency has increased in enterprises contracted with the state cooperatives. They emphasized that for effective production, various policies should be applied to inform producers about education and extension.

Gatimbu *et al.* (2020) used Data Envelopment and Tobit analyzes to determine the technical efficiency level of small-scale tea businesses in Kenya. They determined the average efficiency as 49% and concluded that the negative effects on the environment could be reduced by 51% with the effective use of inputs. They found that the investments made to protect the environment reduce the profits of small-scale tea enterprises. For this reason, they have stated that the government should make tax deductions for companies investing in environmental protection, support technologies that guarantee environmental efficiency, and offer the purchase and maintenance of these technologies at more affordable prices.

Haq and Boz (2019) used the data obtained from 138 tea producers in their study on tea in Rize, Turkey, in the DEA analysis and the Tobit model. They have found that shareholder-run farms were 76% more efficient than owner-operated farms by the data envelopment analysis. They determined that the average technical efficiency of the enterprises was 57% and their input usage could be reduced by 43%. They have determined that factors such as aged tea plots, high land slope, and altitude affect the efficiency of the farms negatively. Also, they have identified Mixing the fertilizer into the root zone or soil, terracing of agricultural lands and soil testing contributed positively and significantly to productivity. They have stated that Farmer would work more effectively by renewing their tea gardens, applying fertilizer in the root zone, and teaching the producers about terracing in order to control production costs.

Jeewanthi and Shantha (2021) tried to determine the efficiencies by applying stochastic frontier analysis to the data obtained from 120 small tea producers. They have determined as 78.44% technical efficiency rate of the enterprises in the first stage of the analysis and explained that the production could increase by 21.56% with the same input level. In addition, they stated that the labor force is the most important variable for tea production, the cost input is high, and it is very difficult to increase profits without increasing costs. In the second stage of the analysis, they have convinced that gender and access to quality extension services are the variables that have the greatest impact on technical efficiency.

3. Materials and Methods

3.1. Materials

The primary data of the research material were obtained from the tea producing enterprises in district Merkez, Çayeli, Ardeşen, Pazar, Kalkandere of Rize province, Sürmene, Of and Hayrat districts of Trabzon province, and Hopa, Arhavi, Kemalpaşa, and Borcka districts of Artvin province. The data were obtained through face-to-face interviews with the producers using a questionnaire. The survey data was created based on the 2018 production period data. The secondary data of the research was obtained from the relevant institutions and organizations in the region, as well as the Turkish Statistical Institute (TURKSTAT) and the Food and Agriculture Organization (FAOSTAT). In addition, many domestic and foreign resources on this subject had been used as a reference of study.

3.2. Methods

The Proportional Sampling Method was used to determine the number of samples, DEA and Bootstrap were used for efficiency in the analysis phase, and cost analysis was used for cost determination. In addition, the R statistics program was used in the efficiency analysis.

3.2.1. The method used in determining the number of sampling

The number of questionnaires was determined by considering the records of Agriculture and Forestry Provincial Directorates for the year 2017. The sampling method was based on a 95% confidence interval and a 5% margin of error.

The equation used to determine this sample size is given below (Newbold, 1995).

$$n = \frac{N * p * (1 - p)}{(N - 1) * (Q_p)^2 + p * (1 - p)} \quad (1)$$

Where n=sample size, N=total number of tea producers (115 001), Q_p^2= variance, r= deviation from the mean (%5), $Z_{\alpha/2}$= z-score (1.96), and p= proportion of individuals under 40 years of experience (83%).

$$Q_p^{\,2} = \left(\frac{r}{Z\alpha/2}\right)^2 = \left(\frac{0{,}05}{1{,}96}\right)^2 = (0{,}0255)^2 = 0{,}000651 \quad (2)$$

$$n = \frac{115001 * 0{,}95 * 0{,}05}{(115000 * (0{,}0255)^2 + (0{,}95 * 0{,}05)} = 216.6$$

100, 70, and 50 survey made from Rize, Trabzon and Artvin province, respectively.

3.2.2. The data envelopment analysis method (DEA)

Parametric and non-parametric techniques are used to measure effectiveness. Econometric estimation methods are used in parametric functions and mathematical programming is used in non-parametric functions (Tutulmaz, 2012). While stochastic frontier analysis uses parametric techniques, data envelopment analysis uses non-parametric techniques (Uzundumlu *et al.*, 2021). DEA is a technique that measures efficiency by looking at the relative approach of decision-making units, business or economic units that transform input into output, based on the linear program principle (Dursun, 2013). The most distinctive features of DEA are that it adheres to the linear programming principle, can consider more than one input and output together, that the inputs and outputs it considers can have different units, and that it compares each decision unit only with the most appropriate decision unit (Kıran, 2008).

Analyzes are made by considering one of the two situations in data envelopment analysis. The first, input-based efficiency, while tries to reduce wasteful inputs for a fixed production amount, the second, output-based efficiency, takes into account the increase in production with a fixed input amount (Huguenin, 2012). Due to its piecewise linear structure, DEA allows determining the return to scale of each unit (Saraç, 2020).

The mathematical expression of Traditional DEA is as follows (Aydemir, 2015);

$$\text{Output} = \sum_{r=1}^{s} u_r y_r \quad r=1\ 2,\ldots\ldots\ldots,s \tag{3}$$

$$\text{Input} = \sum_{i=1}^{m} v_i x_i \quad i=1\ 2,\ldots\ldots\ldots,m \tag{4}$$

$$u_i v_i \geq 0$$

$$\text{Efficiency} = e_k = \frac{\sum_{r=1}^{s} u_r y_{rk}}{\sum_{i=1}^{m} v_i x_{ik}} \tag{5}$$

x: inputs,

y: outputs,

v: weight of inputs,

u: the weight of the printouts,

m: number of input,

s: number of output and

k: the ratio of these two values to show the decision-making unit.

3.2.3. The bootstrap DEA analysis method

Each business is assigned a performance score between zero and one, and showing higher-performing businesses have a higher score. Traditional DEA is sensitive to outliers and does not take into account measurement error, as well as assigning an equal efficiency score to those with outliers. Bootstrap DEA allows examination bias, adjusted scores, and confidence intervals as the statistical properties which result from the distribution of efficiency scores generated by the Traditional DEA (Soumai and Yassine, 2021). The two-stage approach Bootstrap method is used in hypothesis testing, regression analysis, and determining confidence intervals as in probability (Kınacı, 2017).

In the first step of the two-stage Bootstrap method, technical efficiency scores were determined using DEA. The DEA approach assumes the access of all businesses in the sample to the same technology for converting them into M outputs determined as y for the transformation of the N input vector denoted by x (Owusu and Hailu, 2014). This technology is given in Formula 6.

$$T \subseteq \epsilon R_+^N * R_+^M \text{ that is}, \varphi = \{(x,y)\epsilon R_+^N * R_+^M : x\epsilon R_+^N \text{ can be generated } y\epsilon R_+^N\} \quad (6)$$

Where $x\epsilon R_+^N, y\epsilon R_+^N$ is a vector of N inputs that are used to obtain the output vector M. The upper limit of technology is appealing for efficiency measurement. Inefficient businesses range from points within T to the distance representing the ineffectiveness limit at each point in T. Therefore, observations at the limit are considered effective (Nedelea and Fannin, 2013).

$$\hat{\theta}(x,y) = \min \{\theta > 0 | y \leq \sum_{i=1}^{n} \lambda_i y_i ; \theta x \geq \sum_{i=1}^{n} \lambda_i x_i ; \sum_{i=1}^{n} \lambda_i = 1, \lambda_i \geq 0, i = 1 \ldots n \} \quad (7)$$

In formula 7, θ is the input technical efficiency measure with a value of $0 \leq \theta \leq 1$. If $\theta = 1$, the farmer is at the frontier. y_i is an output vector and x_i is an input vector. Vector λ is an Nx1 weight vector that describes the linear combination of the peers of the i^{th} business. $\lambda_i x_i$ and $\lambda_i y_i$ are efficient projections at the frontier. The linear programming problem was solved N times to provide a value for each business in the sample (Owusu and Hailu, 2014).

However, this procedure can cause problems with serial correlation and bias in efficacy estimates, as well as a correlation between the error term and the explanatory variables in the second-stage model. Therefore, Simar and Wilson (2007).

The most common procedure used in the second phase of the analysis is the determination of DEA efficiency estimations against peripheral variables using the Least Squares method (LSM) or Tobit regression (Stanton, 2002). However, this procedure can cause serial correlation and bias problems in efficiency estimates. For this reason, Simar and

Wilson (2007) proposed a pair of bootstrapping processes where biased corrected scores are used in a parametric bootstrapping on the nonlinear maximum likelihood estimation here, confidence intervals are created for regression parameters as well as efficiency scores. The second stage regression model is defined as follows:

$$0 < \hat{\theta}_i = z_i\beta + \mathrm{i} \leq 1 \quad \mathrm{i} = 1{,}2, \dots, \mathrm{n} \tag{8}$$

Where $\hat{\theta}_i$ is the technical efficiency of *the first* business; ε_i is the statistical noise assumed to be distributed to the left at $-z_i\beta$ and the right at $1 - z_i\beta$; and z_i is the vector of factors affecting the efficiency of the businesses (Uzundumlu *et al.*, 2021).

In this study, an input-oriented, variable return to scale (VRS) approach was used, based on the assumption that businesses do not operate at optimum scale. This study investigated to what extent the enterprises that waste resources can reduce their inputs to reach a stable output with input-oriented two-stage Bootsrap DEA.

4. Findings and Discussion

In the efficiency analysis, the variables constituting the inputs used for the same production level were taken into account in the first stage. In the second stage, the changes in efficiency were investigated by taking into account the variables related to the business, the owner, and the family.

4.1. Variables used in the bootstrapping and the DEA and their explanations

Descriptive statistics and explanations of variables are given in Table 1. In there, the dependent variable is total tea production, and the independent variables are total tea land (da), total labor expenditures (TRY), value of total fixed assets (TRY), the total amount of nitrogen, phosphorus, and potassium used (kg). The age of the household leader was 23 at the youngest and 80 at the oldest with an average of 49.72 in the enterprises. 57% of the household leaders have low education level (illiterate, did not go to school but can read and write, primary school graduate), 29% have secondary education level (high school graduate) and 14% have higher education level (university graduate).

Table 1: Descriptive Statistics and Variable Explanations

DEA Variables	Explanations of Variables	$\bar{X}$	Sd
	Output and Input Variables		
Y	The total tea production (tons)	14.41	16.42
X_1	The total tea land (da)	9.51	9.74
X_2	The total labor expenditures (TRY)	8 433.12	8 488.56
X_3	Value of total fixed assets (TRY)	697.75	323.47
N	The total amount of nitrogen used (kg)	232.10	225.86
P	The total amount of phosphorus used (kg)	47.45	46.27
K	The total amount of potassium used (kg)	93.61	91.05
	Socio-economic, Demographic and Other Factors		
	Provinces (Dummy)		
Rize	(Rize province:1, others:0)	0.45	0.50
Artvin	(Artvin province:1, others:0)	0.23	0.42
Trabzon	(Trabzon province:1, others:0)	0.32	0.47
	Farmer-Specific Factors		
Age	Age of the household leader (year)	49.72	10.83
Leducation	Low education (<9 years:1, others:0)	0.57	0.50
Seducation	Secondary education (9-12 years: 1, others:0)	0.29	0.45
Heducation	Higher education (12 years >:1, others:0)	0.14	0.35
Nonagri	Non-agricultural work (yes:1, no:0)	0.89	0.31
Lrevenue	Low revenue (<20,000:1, others:0)	0.20	0.40
Mrevenue	Middle revenue (20,001-50,000:1, others:0)	0.50	0.50
Hrevenue	Higher revenue (50,000>:1, others:0)	0.30	0.46
Lexperience	Low experience <23 years:1, others :0)	0.25	0.44
Mexperience	Medium experience (23-40 years:1, others:0)	0.55	0.50
Hexperience	High experience (41≥ years:1, others:0)	0.20	0.40
	Land Condition		
Sland	Small land (<3.99 da:1, others:0)	0.25	0.43
Mland	Middle land (4.0-10.0 da:1, others:0)	0.49	0.50
Lland	Large land (> 10.0 da:1, others:0)	0.26	0.44
Credit	Use of credit (yes:1, no:0)	0.03	0.18
Statesport	Benefiting from state support (yes:1, no:0)	2 184.30	2 226.69
Gardenage	Age of the tea garden (years)	49.36	11.29
	Price Of The Product		
Pprice	Price of the previous year (TRY/kg)	2.07	0.15

The provinces surveyed were evaluated as a dummy variable in the analysis. 89% of tea producers have non-agricultural professions as retired, worker, civil servant, driver, self-employed, etc. 20% of the producers have low income (10,000-20,000 TRY), 50% have medium income (20,001-50,000 TRY) and 30% have high income (50,001-300,000 TRY). 25% of producers' tea experience has low (5-20 years), 55% has medium (23-40 years) and 20% has high experience (43-68 years). Considering the economic conditions, 25% of the enterprises are small land (0.5-3.99 da), 49% are medium land (4.00-10.00 da) and 26% are large land (10.01-60.00 da). 3% of producers benefit from agricultural loans. The average support they received from tea in 2018 was 2,184.30 TRY, and the average price of the previous year was 2.07 TRY. Age of tea garden, the smallest 23, the largest 74 years, an average of 49.36 years.

4.2. The results of the bootstrapping and the DEA

Table 2 shows DEA and bootstrapping efficiency values according to fixed and variable returns.

Table 2: DEA and Bootstrap Efficiency Values According to Fixed and Variable Returns

	$\bar{X}$	Sd	Min	Max	Fully Effective Employee
DEA Fixed Return	0.643	0.217	0.270	1.000	4
Difference Fixed Return	0.023	0.022	0.000	0.150	
Bootstrap Fixed Return	0.620	0.209	0.260	0.980	
DEA Variable Return	0.715	0.200	0.290	1.000	20
Difference Variable Return	0.047	0.036	0.010	0.230	
Bootstrap Variable Return	0.668	0.183	0.270	0.970	

In this study, while efficiency was 64.3% in the DEA according to the fixed return scale and it was 62.0% in the bootstrap, there was a deviation of 2.3%. Also, variable returns to scale are 71.5% and 66.8%, respectively in DEA and bootstrap. The difference between the two methods is 4.7%. The reason for this is that DEA chooses the best business on the main population and determines the effectiveness of other situations accordingly. Bootstrap efficiency results for the entire sample business determines according to the most efficient use of all inputs. Therefore, while there are fully efficient businesses in DEA, but there is not fully efficient business in Bootstrap.

Table 3 presents the technical efficiency estimations in the DEA.

Table 3: Technical Efficiency Estimations in the DEA

Some Statistical Calculates	TE (Variable Return)	Adjusted Bootstrap	Minimum	Maximum
Average	0.716	0.668	0.630	0.708
Standard deviation	0.200	0.183	0.173	0.198
Minimum	0.290	0.270	0.250	0.290
Maximum	1.000	0.970	0.940	0.990
Some Statistical Calculates	**TE (Fixed Return)**	**Adjusted Bootstrap**	**Minimum**	**Maximum**
Average	0.644	0.620	0.596	0.640

Standard deviation	0.217	0.209	0.202	0.216
Minimum	0.270	0.260	0.240	0.270
Maximum	1.000	0.980	0.960	0.990

In DEA, while enterprises with variable returns to scale have technical efficiency of 71.6%, they are 66.8% efficient according to the adjusted Bootstrap analysis. In DEA, the efficiency value of enterprises in variable return is 29-100%, while it is 27-97% in the adjusted Bootstrap. At constant return to scale in DEA and adjusted Bootstrap businesses have a technical efficiency of 64.4% and 62.0%, respectively. In DEA, the efficiency value of the enterprises in fixed returns to scale is 27-100%, while it is 26-98% in the adjusted Bootstrap.

Table 4 presents the significance of the data in the second phase of the bootstrap analysis.

Table 4: The Significance of the Data in the Second Stage of the Bootstrap Analysis

Değişkenler	Estimates	$\bar{X}$	Sd
Constant	-0.494***	-	-
Rize	0.110***	0.45	0.50
Artvin	0.140***	0.23	0.42
Age	0.001***	49.72	10.83
Seducation	0.017***	0.29	0.45
Heducation	0.012***	0.14	0.35
Nonagri	0.024***	0.89	0.31
Mrevenue	0.017***	0.50	0.50
Hrevenue	0.011*	0.30	0.46
Mexperience	0.343***	0.55	0.50
Hexperience	0.330***	0.20	0.40
Mland	0.046***	0.49	0.50
Lland	0.027***	0.26	0.44
Credit	0.002	0.03	0.18
Statesport	0.0003	2,184.30	2,226.69
Pprice	0.450***	2.07	0.15
Gardenage	0.00005***	49.36	11.29
Sigma	0.012***	-	-

* $\alpha=0{,}10$ ** $\alpha=0{,}05$ *** $\alpha=0{,}01$

In 14 of the 16 factors given in Table 4 statistically significant results were found. The constant term, Rize and Artvin provinces, age of the household leader, secondary and higher education, non-agricultural work, middle income, medium and high experience, medium and large land, price of the previous year, age of the tea garden, and high revenue is significant statistically.

Rize and Artvin provinces use their resources more effectively than Trabzon province. In addition, 71.8% of the enterprises in Rize are very efficient, 100% of the enterprises in Artvin are efficient and 97.4% of the enterprises in Trabzon are inefficient. Albayrak (2018) determined that the dried black teas grown in Rize and Trabzon provinces have higher content in terms of many quality parameters compared to Artvin province.

As the age of the head of the family increases, the efficiency increases. Basnayake and Gunaratne (2002) and Ghaderi *et al.* (2019) stated in their study that older farmers are more efficient than younger farmers, and they contribute to the increase in efficiency with their developing method skills and experience. But Dube and Guveya (2014) said that the tea production efficiency decreased with the increase in the age of the producer.

Producers with secondary and higher education manage their resources more effectively than producers with low education. Basnayake and Gunaratne (2002), Hong and Yabe (2015), and Ghaderi *et al.* (2019) found a positive relationship between the education level of the tea farmer and technical efficiency, as in this study. Also, Deka and Goswami (2021) recommend increased government support to empower tea growers through appropriate education and training for more efficient use of tea-growing land.

Tea producers with additional professions work more effectively. Hong and Yabe (2017), in the same direction with this study, determined that non-agricultural income had a positive effect on tea efficiency. Zhang and Hu (2020) stated that when there is a non-agricultural activity in the enterprises operating in agricultural areas, labor is used more economically, but the use of fertilizers can be more.

Medium and high-income businesses are more efficient than low-income. Hong and Yabe (2015) stated that farmers with higher agricultural incomes would be able to produce more efficiently because they had a better chance of improving their knowledge of modern cultivation techniques or purchasing good machinery.

Medium and high-experienced producers use their resources more effectively than low-experienced producers. According to Basnayake and Gunaratne (2002), and Hong and Yabe (2015) farmers with a lot of experience can produce more output with given inputs compared to those with less experience. Also, Deka and Goswami (2021) said that experienced producers can provide production with less input (especially fertilizers) with time.

Those with medium and large lands are more efficient than those with small lands. Basnayake and Gunaratne (2002), stated that the efficiency of small-scale tea producers is low, so their efficiency can be increased by subsiding more productive tea seedlings and afforestation. Haq *et al.* (2021) found that a significant decrease in efficiency was observed as farm size decreased, and larger owner-operated farms had higher efficiency.

As the tea price of the previous year increases efficiency increases. Liu and Shao (2016) stated that knowing last year's price in Indian tea has great importance in directing tea production activities. Also, they emphasized that it is necessary to analyze the prices of agricultural products impartially in order to guide the behavior of producers and consumers. It is observed that the efficiency increases as the age of tea age gardens increases.

As the age of the tea gardens increases, the efficiency increases. Dube and Guveya (2014), while they stated a result parallel to the result of this study, Katungwe *et al.* (2017), the opposite result was expressed in the study.

4.3. The comparison of the before and after the status of the Data Envelopment Analysis and Bootstrap Analysis

Table 5 shows the comparison of before and after the status of the DEA and the bootstrap analysis.

Table 5: Comparison of Before and after the Status of the DEA and the Bootstrap Analysis.

Variables	Efficiency		
	Pre-analysis (220)	Post-analysis (35)	
		DEA	Bootstrap
X_1 (da)	9.51	6.99	6.68
N (kg/da)	26.88	24.73	25.47
P (kg/da)	5.46	5.00	5.11
K (kg/da)	10.81	9.93	10.20
AFC (TRY/da)	1,705.11	1,692.26	1,951.93
AVC (TRY/da)	1,353.83	1,250.80	1,106.30
Y (tons/enterprise)	14.41	15.17	15.55
Yield (kg/da)	1,515.25	2,170.2	2,286.76
Price (TRY/kg)	2.34	2.05	1.95
GPV (TRY/da)	**3,545.7**	**4,448.91**	**4,527.78**
TC (TRY/da)	**3,058.94**	**2,943.06**	**3,058.23**
Net Profit (TL/da)	**486.72**	**1,505.85**	**1,469.55**
Efficiency DEA (%)	**71.6**	**100.00**	
Efficiency Bootstrap (%)	**66.8**		**92.5**

According to the efficiency results, the average efficiency of 35 enterprises in DEA and Bootstrap analysis was determined as 100.00% and 92.5%, respectively. The amount of nitrogen, phosphorus, and potassium used by the producers is a little higher, and when it is reduced a little more according to both data envelopment and bootstrap analysis, the enterprises realize a more effective production. Owusu and Hailu (2014), stated that efficiency can be achieved by reducing the use of excess fertilizer in tea, where the producers use the fertilizers excessively. Harman (2013) stated that the soil structure takes on an acid character due to the unconscious use of fertilizers in tea gardens by the producers.

As the fixed costs of enterprises increase and the variable costs decrease, the efficiency of the enterprises increases. When pruning tools and similar equipment, which are among the fixed costs, are used, the efficiency of the enterprises increases with the use of less labor. Hong and Yabe (2015) found that the average tea production could be increased by 10.4% using existing technologies. Also, Katungwe *et al.* (2017) stated that producers need to facilitate their access to new technologies so that they can work with fewer labor costs.

Although the price in this period was low in the enterprises operating effectively, the net profit was higher because the average production and efficiency were higher and the expense was less. Qiao et al. (2015) revealed that the farmers were able to make a net profit by compensating for the premium price of organic tea, high labor costs, and low productivity.

5. Conclusions and Recommendations

Dry tea production is 6.50 million tons in the world, Turkey is in the 6th place, meeting 2.73% of the world's tea production. It also ranks first in yield among the leading countries in the tea production. It has been determined that the enterprises in tea production have efficiency-related problems. Since the unit production cost in the enterprises is 2.02 TRY/kg and product sales price is 2.34 TRY/kg without considering the supports, and 2.62 TRY/kg when the supports are taken into account, thus the enterprises make a profitable production. However, according to the Bootstrap analysis, 33.2% of businesses are inefficient. It has been determined that if these problems are resolved and they work more effectively, businesses can work 3 times as profitable. If the excess labor and N, P, K ratios used in the enterprises are reduced and production is carried out using pruning tools within their capital, the production inefficiencies of the enterprises will decrease and it will contribute to their more profitable and environmentally friendly production. In addition, Rize and Artvin provinces work more effectively than in Trabzon province. As the age, experience, education, rate having an additional profession of the household leader increase efficiency of enterprises increases. For these reasons, the training of producers on resource efficiency will increase efficiency.

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