Journal of Tekirdag Agricultural Faculty
Tekirdağ Ziraat Fakültesi Dergisi

Eylül/September 2022, 19(3)
Başvuru/Received: 04/08/21
Kabul/Accepted: 13/05/22
DOI: 10.33462/jotaf.978947

http://dergipark.gov.tr/jotaf
http://jotaf.nku.edu.tr/

ARAŞTIRMA MAKALESİ **RESEARCH ARTICLE**

Analyzing The Effects of Livestock Policies on Farm-level Efficiency in Turkey; Thrace Region Case

Türkiye'de Hayvancılık Politikalarının İşletmelerin Etkinlik Düzeyine Etkilerinin İncelenmesi; Trakya Bölgesi Örneği

Gökçe KOÇ[1*], Ayşe UZMAY[2]

Abstract

The effect of agricultural subsidies on the efficiency of farms is one of the main issues discussed today. Dairy farming benefits from various types of subsidies and take a lion share from the agricultural support budget. In this context, this study has four important aims. Firstly, to analyze the technical efficiency of dairy farms, secondly, to investigate the effects of policy tools on efficiency, thirdly to determine factors affecting efficiencies and finally to bring proposals. This study was carried out in Thrace Region of Turkey and interviewed with 140 dairy farmers. The three-stage method was applied in this study. The technical efficiency and policies effects on efficiency were determined by using Data Envelopment Analysis. Tobit Analysis was used to investigate the relationship between efficiency and farmer or farms-oriented characteristics. The results of Data Envelopment Analysis show that average efficiency scores are 0.700 under constant return to scale, 0.795 under variable return to scale and 0.886 for scale efficiency. The technical efficiency increases by 1.13%-2.43% thanks to subsidies and the scale efficiency is 1.35% higher. It is noteworthy that subsidies affect efficiency positively but provide a small improvement, also the effects vary across the farm-scale groups. According to Tobit Analysis, the education level of farmers, the share of livestock in total income, family size and whether tend to give up farming are significantly affecting efficiency. It is recommended for governments should provide subsidies to increase the scale of small farms that work with increasing return to scale and to improve the technology of larger farms that work with decreasing return to scale.

Keywords: livestock subsidies, Agricultural policy, Technical efficiency, Data envelopment analysis, Tobit model

[1]***Sorumlu Yazar/Corresponding Author:** Gökçe Koç, Ege University, Izmir, Turkey. E-mail: gkc_add@hotmail.com OrcID: 0000-0002-3719-3390
[2] Ayşe Uzmay, Ege University, Izmir, Turkey. E-mail: ayse.uzmay@ege.edu.tr OrcID: 0000-0003-1662-2544
Atıf/Citation: Koç G, Uzmay A. Analyzing the effects of livestock policies on farm-level efficiency in Turkey; Thrace Region case. *Tekirdağ Ziraat Fakültesi Dergisi,* 19 (3), 515-528.

Öz

Tarımsal desteklerin işletmelerin etkinlikleri üzerindeki etkileri son dönemlerde tartışılan önemli konulardan biridir. Süt sığırcılığı, hem birçok farklı destekleme çeşidinden yararlanmakta, hem de tarımsal destekleme bütçesinden önemli bir pay almaktadır. Bu kapsamda, araştırmanın dört temel amacı bulunmaktadır; bunlardan ilki süt sığırcılığı işletmelerinde teknik etkinliğin belirlenmesi, ikincisi; destekleme politika araçlarının etkinlik üzerindeki etkisinin ortaya koyulması, üçüncüsü; etkinliğin belirleyicisi olan üretici ve işletmeye ait ayırt edici faktörlerin analiz edilmesi ve son olarak da tarım politikalarına yönelik öneriler getirilmesidir. Araştırma kapsamında Trakya Bölgesi'nin üç ilinde 140 üretici ile yüz yüze anket çalışması gerçekleştirilmiştir. Araştırmada üç aşamalı metodoloji kullanılmıştır; Veri Zarflama Analizi yardımı ile süt sığırcılığı işletmelerinin teknik etkinliği ve desteklemelerin teknik etkinlik üzerindeki etkisi hesaplanmış, Tobit analizi yardımıyla ise etkinlik ile işletmeye ve üreticiye ait özellikler arasındaki ilişki analiz edilmiştir. Veri Zarflama Analizi sonuçlarına göre, işletmelerin ölçeğe sabit getiri skorları ortalama 0.700, ölçeğe değişken getiri skorları ortalama 0.795, ölçek etkinliği skorları ise ortalama 0.886 olarak hesaplanmıştır. Desteklemeler ile işletmelerin ölçeğe sabit getiri skorları %2.43, değişken getiri skorları %1.13, ölçek etkinlikleri ise %1.35 artmıştır. Tarımsal desteklerin süt sığırcılığı işlemelerinde etkinliği pozitif etkilediği ancak küçük oranda bir iyileşme sağladığı, ayrıca ölçek büyüklüğüne göre desteklerin pozitif etkisinin farklı olduğu dikkati çekmektedir. Tobit analizi sonuçlarına göre ise etkinliğin belirleyicileri; üreticilerin eğitim düzeyi, geliri, aile büyüklüğü, işletmelerin ölçek ve arazi büyüklüğü, üreticilerin üretime devam etme düşüncesi ve işletmenin ortalama süt verimidir. Araştırma sonucunda, hayvancılık desteklerinin ölçeğe artan getiri ile çalışan küçük ölçekli işletmelerde ölçeğin büyütülmesine, ölçeğe azalan getiri ile çalışan büyük ölçekli işletmelerde ise teknolojinin geliştirilmesine yönelik verilmesi önerilmektedir.

Anahtar Kelimeler: Hayvancılık destekleri, Tarım politikası, Teknik etkinlik, Veri zarflama analizi, Tobit model

1. Introduction

Turkey is one of the leading countries for dairy production in the World; 9th largest producer of world milk production and ranked 24th for the number of cattle. Nevertheless, there are remaining some structural and economic problems. The annual milk yield per cattle is 3.2 tons and ranked 56th in the World. The annual milk yield for other countries is; 5.7 t for Poland, 5.6 t for Ireland, 8.2 t for Netherlands, 9.5 t for Denmark, 7.0 t for European Union (EU), 4.15 t for New Zealand, 13.2 t for Israel (DairyNz, 2018; EU, 2018a; FAO, 2019; Ministry of Agriculture and Forestry (MAF), 2021).

Beef and dairy farming in Turkey contribute 27.13% of total agricultural production value and 88.39% of animal production value (Turkish Statistical Institute (TurkStat), 2020). There are 18.43 million head cattle and 6.58 million of them are dairy cows. The production quantity of beef and milk is 1.08 and 20.78 million tons, respectively (MAF, 2021). The number of dairy farms is 1.11 million. Generally, most of them are small-scale farms; 71.5% of them have 9 cows and below, 28% have 10-99 cows and only 0.5% have 100 cows and above (National Dairy Council, 2019).

Turkish government's agricultural subsidy budget is a total of 22 billion TL and 6.3 billion is allotted for livestock subsidies. The main policy tools to solve structural and economic problems of dairy farms and increase their efficiencies are subsidies for forage crops, for calves, for insurance, for disease-free farms, for agricultural credits, for investments, and also milk premium. Yet, it is still a controversial topic that which policy tools should be used in Turkey (Karakuş, 2011; Erdal et al., 2016; Uzmay and Çınar, 2016; Uzmay, 2017). One of the main problems is creating new policies without analyzing the effectiveness of used instruments (Uzmay and Ozden, 2016). So, it has the utmost importance to analyze the efficiency of farms and develop policy recommendations based on these results.

Farm subsidies affect the price of inputs and outputs, income, production methods, investment decisions, farm-scale, and therefore technical and economic performance. If the farmers use subsidies in a targeted manner and turn them into investments, it has a positive impact on efficiency, while they may have a negative effect if the farmers thought they are tools to raise income (Kumbhakar and Lien, 2010). Thus, it is important to analyze the relationship between the efficiency of dairy farms and policy instruments. It is noteworthy that, there are limited studies in the literature for investigating technical efficiency of dairy farms and the effects of policies; Chang and Mishra (2011) for America, Zhu et al. (2012) for Germany, Netherland and Sweeden, Silva and Marote (2013) for Portugal, Latruffe and Desjeux (2016) for France, Bajrami et al. (2017) for Kosovo. In Turkey, there are several studies from different regions on the technical efficiency of dairy farming, but none of them associated with policies (Uzmay et al., 2009; Gül et al., 2018).

In this context, this study is the first for Turkey and has four important aims. Firstly, to analyze the technical efficiency of dairy farms in the region, secondly, to investigate the effects of policy tools on efficiency, thirdly to determine factors affecting efficiencies, and finally to bring proposals.

2. Material and Method

2.1 The study area

Thrace Region is in the northwest of Turkey, on the Continent of Europe, and has three provinces: Kırklareli, Edirne and Tekirdağ. In the Thrace Region, the share of animal and plant production in the total agricultural production value is 83.1% and 16.9%, respectively (TurkStat, 2020). The leading crops are sunflower, wheat and paddy and crop yields are higher than the country's average (TDA, 2013).

Annual milk production is 675 tons from 178 thousand head dairy cows. The milk yield is higher than the average of the country (3.16 t); 3.83 t for Tekirdağ (2nd), 3.75 t for Kırklareli (5th), and 3.7 t for Edirne (8th) (TurkStat, 2019). Thrace is the most critical region for Turkey due to the high share of culture and crossbred cattle and is the only vaccinated free zone from foot-and-mouth (EU, 2018b). This study was conducted in the Thrace Region of Turkey where leads to milk production and industry and affects others in terms of milk prices.

2.2. Material

The material of this research is based on data collected from dairy farmers in the region. The sample size was determined as 140 by using the proportional sampling method (0.9 confidence interval and 0.07 margin of error) (Newbold, 1995). The sample size is n, population size is N (35214), and the rate of prediction is p in the equation 1;

$$n = \frac{Np(1-p)}{(N-1)\,\sigma_p^2 + p(1-p)} \quad \text{(Eq. 1)}$$

For determining the distribution of interviews, the share of milk production in provinces was used; 37.85% from Edirne (53), 32.14% from Kırklareli (45), and 30.01% from Tekirdağ (42). Data were only collected from farms that have at least 5 dairy cows and registered in the herd book. The farms were split into 5 scale groups; 5-14, 15-29, 30-49, 50-99, 100 and above. The two-part questionnaire was conducted in August 2017 with a total of 96 questions. The first part includes 13 questions for collecting sociodemographic characteristics of farmers. The second part, 83 open-ended questions, was about some data related to farms such as land and herd size, used feeds, variable costs, and livestock products.

2.3. Method

The three-stage method was applied in this study. Firstly, to calculate the technical efficiency of farms, secondly to investigate the effects of policies on efficiency, and finally to analyze the determinants of efficiency related to characteristics of farms and farmers.

The objective of the study is to analyze the relative efficiency of homogeneous decision-making units under the same climatic conditions. Since policy impact analysis is usually based on reference prices and quantities that do not belong to the region, efficiency analysis was preferred to policy impact analysis in this study. According to the results of the efficiency analysis, it is thought that faster action can be taken by evaluating the current situation of both policymakers and enforcement agencies and farmers.

2.3.1 Technical efficiency

The importance of efficiency and productivity measurements in production units was brought up by Farrell (1957). Efficiency can be measured by parametric or non-parametric methods. Non-parametric methods are based on mathematical programming, while parametric methods are ground on econometrics (Coelli et al., 2005). The most widely used methods are non-parametric Data Envelopment Analysis (DEA) (Uzmay et al., 2009; Özden, 2016; Silva et al., 2018; Gül et al., 2018) and parametric Stochastic Production Frontier approach (Cabrera et al., 2010; Curtis et al., 2016; Hazneci and Ceyhan, 2015). In this study, DEA was used to measure the efficiency of dairy farms. The efficiency of decision-making units (DMUs) with multiple inputs and outputs can be calculated by DEA. Charnes et al. (1978) (CCC model) was developed a constant return to scale (CRS) and Banker et al. (1984) (BCC model) was improved variable return to scale (VRS).

There are input or output-oriented approaches. Input-oriented reflects how much inputs could be reduced without a decrease in output, while output-oriented reveals how much can output be increased without changing the inputs. Thus, DEA steers decision-makers by determines how inefficient DMUs should reduce their inputs or increase their outputs.

In this study, both CRS and VRS approaches of input-oriented DEA was used. Furthermore, output-oriented efficiency scores were also calculated. The notation for input-oriented CRS assumption is given below (Eq.2) (Coelli et al., 2005);

$$\begin{aligned} & \min_{\Phi,\lambda} \theta, \\ \text{st} \quad & -y_i + Y\lambda \geq 0 \\ & \theta x_i - X\lambda \geq 0 \\ & \lambda \geq 0 \end{aligned} \quad \text{(Eq. 2)}$$

where θ is a scalar, and λ is a N x 1 vector of constants. When the convex constraint, N1' λ=1 is added to this linear programming problem, an input-oriented DEA model which is according to VRS is obtained. In this model, the problem is solved as follows Eq.3;

$$\begin{aligned} & \min \Phi_{,\lambda}\theta, \\ \text{st} \quad & -y_i + Y\lambda \geq 0 \\ & \theta x_i - X\lambda \geq 0 \\ & N1'\lambda = 1 \\ & \lambda \geq 0 \end{aligned} \qquad \text{(Eq. 3)}$$

Where N1 is a N x 1 vector of ones. The value of θ obtained will be the efficiency score of i_{th} DMU. Furthermore, scale efficiency (SE) was calculated with the following formula to investigate whether the farms work at optimal scale (Coelli et al., 2005); $TE_{CRS} = TE_{VRS} \times SE$.

Studies on measuring technical efficiency of dairy farms usually used the production quantity of milk and dairy products or monetary value derived by sales of these products, as an output (Uzmay et al., 2009; Chang and Mishra, 2011; Gelan and Muriithi, 2012; Mareth et al., 2017). In this study, two models were set to investigate the effects of livestock subsidies on technical efficiency. On the first model (Model 1), income from the sale of milk, live animals, and carcass meat were taken as output. On the second model (Model 2), livestock subsidies were added to output and efficiency scores were remeasured. A total of six types of subsidies are added to Model 2: 1) for forage crops, 2) for calves and feeder cattle, 3) for livestock insurance, 4) for disease-free or 5) EU-certified farms, and 6) milk premium. All farmers benefit from at least three types of subsidies. The milk premium (32.8%) and support for calves and feeder cattle (28.5%) have the largest share in total subsidies, and almost all farmers benefit from these two important subsidies. In this study, the total amount of support was considered in determining the effect of the subsidies on farm-level efficiency. This method that adding subsidy payments to output was also used by Ferjani (2008) for Sweden, Gaspar et al. (2009) for Spain, Galanopoulos et al. (2011) for Greece and Silva and Marote (2013) for Portugal. The selected eight input variables were also used commonly in other studies *(Table 1)* (Gonçalves et al., 2008; Pfeiffer et al., 2009; Cabrera et al., 2010; Gelan and Muriithi, 2012; Madau et al., 2017; Galluzzo, 2018a);

1. The livestock unit (LSU): 0.20 for calves, 0.70 for heifers, 0.60 for steers, 1.00 for dairy cows (Aras, 1988).
2. Land area
3. Annual homegrown feed cost: costs for producing feed crops (seed, fertilizer, oil, harvest, water, etc.)
4. Annual purchased feed cost
5. Annual veterinary, medicine, and artificial insemination cost
6. Annual water and electricity cost
7. Annual additional costs: cleaning, vehicle renting, pasture renting, insurance, transportation
8. Annual labor costs: family labor, payments for permanent and temporary workers

Table 1. Summary statistics of the inputs used in the efficiency analysis (TL)

Outputs	**Min.**	**Max.**	**Mean**	**Std. Dev.**
Model 1. (without subsidies)	37800.0	13834400.0	1552402.5	2792332.1
Model 2. (with subsidies)	39145.0	15499400.0	1689755.6	3054894.1
Inputs				
LSUs	5.8	1307.7	170.9	278.6
Land (ha)	0.0	600.00	44.3	68.1
Homegrown feed cost	0.0	3845000.0	90464.9	347209.4
Purchased feed cost	20300.0	8145000.0	941642.0	1785286.5
Veterinary, medicine and artificial insemination cost	2000.0	670000.0	61130.7	111533.8
Water and electricity cost	360.0	496000.0	35326.2	72390.4
Additional costs	150.0	965000.0	58726.1	156581.1
Labor cost	5657.5	2280960.0	188146.6	378714.6

2.3.2 Tobit Regression

At the third stage of the study, due to efficiency scores change between 0 and 1, a Censored Regression Analysis known as Tobit Regression was used. This method was chosen to analyze the relationship between technical efficiency and characteristics of farmers or farms. The relationship (Eq.4) is described as (McDonald, 2009);

$$y_i^* = x_i \beta + \varepsilon_1 \quad \text{(Eq. 4)}$$

where the x_i/ε_1 are normally, identically and independently distributed with mean, zero, and variance, σ^2, x_i is a 1 x k vector of observations on the constant and k - 1 efficiency factor explanatory variables and β a k x 1 vector of unknown coefficients, , y_i^* is latent variable (Eq.5);

If $y_i^* \leq 0$, $the\ efficiency\ score\ for\ the\ i_{th}\ production\ unit, y_i = 0,$
If $y_i^* \geq 1, y_i = 1,$ (Eq. 5)
If $0 < y_i^* < 1, y_i = y_i^*$
y_i, are the censored values of y_i^* , with censoring below zero and above one.

After the Tobit model (Eq.6), the changes in the unconditional expected value of the observed dependent variable, which means marginal effects, were calculated by using McDonald and Moffitt (1980) decomposition;

$$\partial E(y_i^*) / \partial x_i \quad \text{(Eq. 6)}$$

According to McDonald (2009), if the probability that y_i takes a limit value is small, marginal effects will be similar to coefficients (β values). In this study, because zero is the lower censored limit and one is the upper censored limit, the coefficients and marginal effects are closer. Descriptive statistics of a dependent and nine independent variables are shown in *Table 2*. In this study, DEAP was used for DEA, and STATA was used for the Tobit model.

Table 2. Descriptive statistics

Dependent Variable	**Min.**	**Max.**	**Mean**	**Std. Dev.**
Technical efficiency scores	0.287	1	0.804	0.198
Independent Variable	**Min.**	**Max.**	**Mean**	**Std. Dev.**
Age (AGE)	24.0	78.0	44.71	10.68
Experience (EXP)	01.0	53.0	19.33	12.56
Family size (FSIZE)	01.0	06.0	02.30	1.24
Share of livestock in agricultural income (SHARE)	20.0	100.0	76.02	22.60

	Type of Variable	**Description**	**Frequency**	**Percent (%)**
Cooperative membership (COOP)	Dichotomous	0: No 1: Yes	48 92	34.3 65.7
Whether have a non-agricultural income (NAINC)	Dichotomous	0: No 1: Yes	68 72	48.6 51.4
Education (EDU)	Ordinal Categorical	1: primary school 2: high school 3: university	58 49 33	41.4 35.0 23.6
Whether tend to give up farming (GIVE)	Dichotomous	0: No 1: Yes	73 67	52.1 47.9
Whether have a credit debt (CRE)	Ordinal Categorical	0: No 1: Yes	68 72	48.6 51.4

3. Results and Discussion

3.1. Characteristics of farmers and farms

Average age and farming experience are 45±11 and 19±13 years, respectively. Income from livestock products constitutes a large share (76%) of total farm income. The ratio of primary school, high school, and university graduates are 41.4%, 35%, and 23.6%, respectively. Most of them are member of cooperatives (65.7%) *(Table 2).*

The number of dairy cows is a minimum of 5 and a maximum of 1050. The LSUs are at least 5.8 and at most 1307.7. The quantity of milk production varies between 30 t and 9840 t. The average daily milk yield is 23.4±5.8 kg. Most of the farms (82.9%) produce both plant and livestock products. The agricultural land is totally 6.2

thousand ha and averagely 44.3 ha. The area used for feed crops is 4.2 thousand ha. Farmers mostly cultivate wheat (44.2%), silage corn (21.3%), barley (15.6%) and vetch (11.0%).

The feed used in the farms split into two groups; home-grown and purchased. Purchased feed constitutes almost all (94%) the feed costs. The most important feeds in terms of costs are factory produced feed (62%), corn silage (14%), alfalfa (8%), and wheat straw (5%).

3.2. Results of DEA

The distribution of technical efficiency (TE) values by DEA are shown in *Table 3*. In Model 1, the average input-oriented efficiency scores are 0.700 under CRS, 0.795 under VRS, and 0.886 for SE. It is noteworthy that farms could produce the same output level with a reduction of 30.0% on inputs and they could be fully efficient. Moreover, 11.4% of the efficiency could be increased by adjusting the farms to their optimal scale. Output-oriented scores were 0.700 under CRS, 0.774 under VRS, and 0.912 for SE.

Table 3. The distribution of the technical efficiency scores

	Model 1			**Model 2**		
Scores	**CRS**	**VRS**	**SE**	**CRS**	**VRS**	**SE**
1	26	50	30	28	51	32
0.99-0.91	11	13	57	12	11	62
0.90-0.81	13	11	25	11	13	21
0.80-0.71	10	16	9	13	18	9
0.70-0.61	28	25	7	32	24	6
0.60-0.51	26	10	6	22	9	6
0.50-0.41	14	10	2	12	10	-
<0.41	12	5	4	10	4	4
Min.	0.242	0.261	0.303	0.230	0.287	0.303
Max.	1	1	1	1	1	1
Mean.	0.700	0.795	0.886	0.717	0.804	0.898

A case study on Thrace Region's cattle farms conducted by Kumbar (2015) show that TE and SE scores are 0.49 and 0.80. These scores are 0.661 and 0.759 in Kırklareli (Terin et al., 2017). Both the efficiency scores in our research are higher than in earlier studies. The average TE in studies conducted on dairy farms in different regions of Turkey, respectively with CRS and VRS; 0.69 and 0.78 in East Mediterranean Region (Gül et al., 2018), 0.64 and 0.69 in Hatay province (Parlakay et al., 2015), 0.90 and 0.92 in İzmir, Ege Region (Uzmay et al., 2009). In this context, it is noteworthy that the efficiency in the Thrace Region is similar to other regions of Turkey, excluding the Aegean Region.

The average TE scores of dairy farms in other countries, respectively with CRS and VRS; 0.904 and 0.991 in Ireland (Galluzzo, 2018b), 0.966 and 0.988 across Europe (Madau et al., 2017), 0.931 and 0.962 in Bulgaria (Galluzzo, 2018a), 0.499 in South of Brazil (Mareth et al., 2019), 0.70 and 0.86 in Spain (Gaspar et al., 2009), 0.549 and 0.576 in Greece (Siafakas et al., 2019), 0.577 and 0.583 in the USA (Chang and Mishra, 2011).

In this study, all farmers benefit from at least one type of supports. The ratio of them who gets milk premium, calf and feed subsidies is 96.4%, 98.6% and 62.9%, respectively. Besides, about 20% of them gets insurance and disease-free farm subsidies. These subsidies are provided farm income rise by 8.13%. According to Semerci and Celik (2017) in Hatay province, absolute milk profit increases 0.09 $ with subsidies. In this study, it is noteworthy that TE scores increase by 2.43% under CRS and 1.13% under VRS by means of subsidies. The scale efficiency is also 1.35% higher. The milk premium and calf subsidies are important policy tools that affect farm-level efficiency. Almost all producers receive these subsidies, and they take an important place in total subsidies.

In Extremadura, Spain, Gaspar et al. (2009) calculated that subsidies raised technical and scale efficiencies by 13.09% and 12.75%, respectively. In the USA, farmers' efficiency, who are getting Milk Income Loss Contract payments, are 2.53% higher under CRS and 2.36% higher under VRS (Chang and Mishra, 2011). In Portugal, subsidies were increased the Azorean dairy farmers' efficiency by 0.73% under VRS and 1.53% under CRS (Silva and Marote, 2013). Some studies conducted with livestock farms in England, Wales, Germany, and Spain show that direct payments have a positive effect and tend to increase efficiency (Hadley, 2006; Kleinhanß et al., 2007; Chidmi et al., 2010; Guesmi and Serra, 2015). Bajrami et al. (2017) stated that there is no difference in the efficiency of farms with and without quality premium and feed support, in Kosovo. On the contrary, Zhu et al. (2012) showed that an increase of one per cent in the share of total subsidies in total dairy farm income leads to a 1.12%, 0.87% and 0.89% decrease in efficiency in Germany, the Netherlands and Sweden, respectively. Direct payments for France beef farms and Swiss farms, decoupled payments for German dairy farms, operational and investment subsidies for Czech dairy farms were negatively affected and declined efficiency scores (Ferjani, 2008; Latruffe et al., 2008; Latruffe et al., 2009; Skevas et al., 2018). Özüdoğru (2010) found that livestock supports negatively affect the probability of being full efficient, in the Black Sea Region, Amasya.

The farms with the highest TE scores are in the 1st, 2nd, and 5th scale groups. In terms of SE, the efficiency of medium-sized farms (2nd and 3rd group) is higher (Table 4). There was also a statistically significant difference between the farm scale groups (Kruskal Wallis, $p<0.05$). Earlier studies have shown that large-scale farms have higher scores (Uzmay et al., 2009; Zhu et al. 2012; Kumbar, 2015; Gül et al., 2018). According to the potential improvement rates of the input-oriented model, small and medium farms must reduce their feed costs to produce the same output, while the largest farms must reduce their labor and additional costs. Moreover, output-oriented model results show that to achieve full efficiency without any increase in inputs, subsidies should be increased 20.1%-28.8% on the first four scale groups, while 18.9% for the largest one (over 100 dairy cow).

Farms with the highest increase in efficiency scores with supports are medium-sized (3rd and 4th groups) *(Table 4)*. It is noteworthy that these groups have the lowest TE scores. In Wisconsin, the USA, Chidmi et al. (2010) and Curtis et al. (2016) found that farms that have lower efficiency were benefited more from government payments. According to Curtis et al. (2016), the effect of the payments is about eightfold higher for lower TE farms. Besides, the other farms that the subsidies increase the efficiency have largest scale (5th group). An important reason for this is that large-scale farms benefit from EU-approved and disease-free farm subsidies, while small-scale ones cannot. Also, large scale farms use these payments for on-farm investments and implement some cost reduction strategies. Chang and Mishra (2011) reported that supports had significant effects only on large-scale farms. Milk yield is also an important determinant of production value and efficiency. The daily yield is 24.7 kg for full efficient farms, while 22.8 for others. The results of studies such as Gonçalves et al. (2008) in Minas Gerais Brazil, Allendorf and Wettemann (2015) in North Rhine-Westphalia, Germany also reported the same results. In a study conducted by Špička and Smutka (2014) among EU Regions, it was found that the milk yield was higher where dairy farming was more efficient.

Table 4. Technical efficiency scores by farm scale

		Group-1 5-14	Group-2 15-29	Group-3 30-49	Group-4 50-99	Group-5 100 +	p
Model 1	**CRS**	0.651	0.791	0.608	0.590	0.824	.000*
	VRS	0.862	0.855	0.643	0.681	0.895	.000*
	SE	0.756	0.923	0.944	0.889	0.920	.002*
Model 2	**CRS**	0.659	0.801	0.629	0.616	0.849	.000*
	VRS	0.862	0.859	0.659	0.700	0.905	.000*
	SE	0.768	0.929	0.956	0.899	0.937	.001*
Difference between models (%)	**CRS**	1.24	1.20	3.47	4.42	2.99	
	VRS	0.00	0.47	2.49	2.79	1.12	
	SE	1.59	0.65	1.27	1.12	1.85	

* Kruskal Wallis, significant at $p<0.05$.

The ratio of fully efficient farms is %18.6 (26 farms) under CRS and %35.7 (50 farms) under VRS. The ratio is %52 with CRS and %62 with VRS in İzmir, %14 with CRS and %23 with VRS in the Eastern Mediterranean Region (Uzmay et al., 2009; Gül et al., 2018). It was found that 11.5% of farms in Greece and 7.4% in Portugal are fully efficient (Silva et al., 2013; Siafakas et al., 2019). Out of 29 in 50 (58%) fully efficient farms are on the first two scale groups, while 14 of them (28%) are on the largest group.

According to results of DEA, 48.6% of farms exhibit increasing return to scale (irs), 28.6% decreasing return to scale and 22.8% constant return to scale (crs). An earlier study in Thrace found that 82.3% of farms have irs and 8.6% drs (Kumbar, 2015). The ratio of farms exhibit irs is 75.7% in the Eastern Mediterranean Region and 61.6% in Hatay (Parlakay et al., 2015; Gül et al., 2018). It is noteworthy that the farms in the two largest groups mostly work with drs, while small and medium-sized farms operate with irs. The Chi-square test results were also significant *(Table 5).* Accordingly, a 1% change in inputs leads to smaller changes in output in most large-scale farms. Ceyhan and Hazneci (2010) stated that small and medium-sized farms have irs and Špička and Smutka (2014) reported that large farms have drs. In Brazil, the ratio of small and medium-sized farms works with irs are 74.11% and 60.70%, while this ratio is 48.2% for larger farms (Gonçalves et al., 2008).

Table 5. Returns to scale

		Group-1 5-14	Group-2 15-29	Group-3 30-49	Group-4 50-99	Group-5 100 +	Total	Pearson Chi-Square
Model 1	**crs**	5	12	4	2	9	32	χ^2 = 74.131 p= 0.000*
	drs	0	2	5	12	21	40	
	irs	25	16	21	6	0	68	
Model 2	**crs**	6	10	4	3	11	34	χ^2 = 60.381 p= 0.000*
	drs	0	4	7	12	19	42	
	irs	24	16	19	5	0	64	

* Significant at p<0.001

3.3. Results of Tobit analysis

The results of Tobit analysis are shown in *Table 6*. The education level of farmers, the share of livestock in total income, family size and whether tend to give up farming are significantly affecting TE. Factors that did not have significant effects are age, experience, cooperative membership, non-agricultural income, and credit debt.

Table 6. Results of Tobit analysis

	Coef.	Std. Error	t	p	Marginal Effects
AGE	-0.0001532	0.002821	-0.05	0.957	-0.0001612
EXP	-0.0016683	0.002610	-0.64	0.524	-0.0017556
EDU	0.0668275	0.035538	1.88	0.062**	0.0703272
SHARE	0.0036793	0.001236	2.98	0.003*	0.0038719
FSIZE	0.0437597	0.020783	2.11	0.037*	0.0460513
COOP	0.0069908	0.055564	0.13	0.900	0.0069884
NAINC	0.0401845	0.049230	0.82	0.416	0.0401709
GIVE	-0.1195647	0.047672	-2.51	0.013*	-0.1195186
CRE	-0.0099415	0.050897	-0.2	0.845	-0.0099382
CONSTANT	0.4426313	0.173314	2.55	0.012	-

**Significant at p<0.1, * Significant at p<0.05.

The relationship between age and experience and TE is negative, but not statistically significant. Earlier studies conducted both Turkey and other countries were also reported that age and experience had no effects on efficiency (Chang and Mishra, 2011; Gelan and Muriithi, 2012; Guesmi and Serra, 2015; Gül et al., 2018).

Education level has a positive and significant effect. Categorical increase in education raises the efficiency score by 7.0%. The average TE scores of primary and high school graduates are 0.767 and 0.797, while 0.877 for farmers having a university degree. The educational background has utmost importance to efficient use of resources and to adopt new technologies, innovations, and modern methods (Ferjani, 2008; Gül et al., 2018; Mareth et al., 2019).

A 1% rise in the share of livestock in total income increases efficiency by 0.39%. Jiang and Sharp (2015) in South Island, New Zealand, Dagistan et al. (2009) in East Mediterrean, Hazneci and Ceyhan (2015) in Black Sea Region also stated that efficiency could be adversely affected due to reduction of specialization and intensity, increasing crop production and land size and farmers can neglect dairy farming. According to Álvarez et al. (2008) in Spain, extra practices such as fertilization, harvest, pasture silage etc. for plant products lead to reduce the efficiency of extensive dairy farms.

Results of Tobit show that family size has a positive effect on efficiency and a person difference increases the efficiency by 4.6%. This result is consistent with other studies conducted in both different countries like Wisconsin, USA (Cabrera et al, 2010), Catalonia, Spain (Guesmi and Serra, 2015) and Turkey (Uzmay et al., 2009; Ceyhan and Hazneci, 2010).

The relationship between non-agricultural income and the efficiency is positive, but not significant. TE score of farmers that have non-agricultural income is 0.806, while 0.783 for others. In Mexico, Pfeiffer et al. (2009) stated that farmers with higher off-farm income use more additional inputs. Moreover, whether the farmer have a credit debt has negative sign and statistically insignificant. The average TE scores of farmers without credit debt (0.822) are 4.6% higher than those have debt (0.786). Farmers with better financial conditions can easily purchase necessary additional inputs and invest new technologies for increasing milk production, and they can be more attentive to animal health and welfare, veterinary services and feeding practices (Chang and Mishra, 2010; Mareth et al., 2017). The tendency of given up dairy farming leads to a decrease in efficiency by 11.95%. It is noteworthy that the mean TE scores are 0.832 for farmers intend to sustain farming, while 0.773 for those intend to give up.

4. Conclusion

In Turkey, the effects of agricultural policies and subsidies on efficiency are one of the most important issues being discussed today, however, research on the issue is limited and previous studies on dairy farming have not considered the impacts of policies.

Results of DEA show that policy tools have a positive effect on farms efficiency for all the farm scales, except the smallest scale. CRS, VRS and SE scores of farms raised by 2.43%, 1.13% and 1.35%, respectively. It is worth noting that subsidies provide a small improvement. It is recommended to develop a mechanism to control and regulate the use of payments by farmers such as improvements in the use of inputs or farm size, and investments. It is of great importance to increase both the amount of subsidies and the number of farmers who receive these subsidies. Moreover, the results of the study show that the increase is more crucial for farms under 100 cows rather than for larger farms.

It is also noteworthy that the efficiency scores of small and large farms are higher, while lower for medium farms. While small-scale farms try to use their limited resources effectively, large-scale farms have an advantage due to their scale and professional management. The positive effect of subsidies on efficiency is more evident for farms with lower scores. In this context, it is crucial to differentiate subsidies according to farm-scale and to create different supports to maximize the efficiency of all farms. It is recommended that provide subsidies to increase the size of especially small farms that operate at increasing returns to scale. Subsidies such as the donation of livestock or feed, financial aid, and interest rebates on agricultural loans for the purchase of livestock are beneficial policy tools for farmers to increase farm-scale. For larger farms operating with decreasing returns to scale, subsidies to improve mechanization conditions and technology is crucial. In this case, knowledge transfer for the efficient use of technology and digitalization, financial aid, and project-based supports for the modernization of large farms are essential.

According to the results of the Tobit analysis, education, family size, the share of livestock in agricultural income and the tendency to give up dairy farming have a significant effect on efficiency. However, age and experience, membership in a cooperative, non-farm income and loan debt have no significant effect. A higher level of education and better financial status is determinants for the use of modern production techniques, the purchase of various suitable inputs, following developments on the market, and putting emphasis on feeding methods, animal health and welfare. Within this framework, extension activities should be organized to raise both formal and agricultural education levels. These training activities should relay information on the effective usage of inputs and subsidies, financial management and marketing. Cooperative membership has an insignificant impact on-farm efficiency. Therefore, the share of farmers' organizations in the market should be increased, and these organizations should also be encouraged to the establishment of their own milk processing plants. According to the marginal effects of the analysis, the farmer's tendency to abandon dairy farming has the greatest negative impact on technical efficiency. The sustainability of dairy farming in the region requires not only agricultural subsidies for farms, but also social policies such as rural development. Solving structural problems of dairy farming and improving social capabilities in rural areas would support the continuity of dairy production in the region.

As a result, it was concluded that agricultural subsidies in the Thrace Region positively affect the efficiency of dairy farms. The findings of this research are guiding in terms of establishing livestock policies, improving dairy farming in the region, and increasing the efficiency and competitiveness of the farms. Other similar studies should be carried out in different regions to make comparisons. Besides, it is crucial to put into practice the farm accountancy data network and improve the statistical infrastructure for doing policy impact assessments.

Acknowledgements

This study supported by Ege University Scientific Research Projects Coordination Unit (Project No: 2016-ZRF-054), Turkey.

References

Allendorf, J. J., Wettemann, P. J. C. (2015). Does animal welfare influence dairy farm efficiency? A two-stage approach. *Journal of Dairy Science*, 98: 7730-7740.

Álvarez, A., del Corral, J., Solís, D., Pérez, J. A. (2008). Does intensification improve the economic efficiency of dairy farms?. *Journal of Dairy Science*, 91 (9): 3693-3698.

Aras, A. (1988). Tarım Muhasebesi, Ege Üniversitesi Ziraat Fakültesi Yayınları, No:486, Bornova, İzmir.

Bajrami, E., J Wailes, E., L Dixon, B., Musliu, A., & Durand-Morat, A. (2017). Factors affecting the technical efficiency of dairy farms in Kosovo. *Journal of Central European Agriculture*, 18 (4): 823-840.

Banker, R. D., Charnes, A., Cooper, W. W. (1984). Some models for estimating technical and scale inefficiencies in data envelopment analysis. *Management Science*, 30 (9): 1078-1092.

Cabrera, V.E., Solís, D., del Corral, J. (2010). Determinants of technical efficiency among dairy farms in Wisconsin. *Journal of Dairy Science*, 93(1): 387-393.

Ceyhan, V., Hazneci, K. (2010). Economic efficiency of cattle-fattening farms in Amasya province, Turkey. *Journal of Animal and Veterinary Advances*, 9: 60-69.

Chang, H. H., Mishra, A. K. (2011). Does the Milk Income Loss Contract program improve the technical efficiency of US dairy farms?. *Journal of Dairy Science*, 94 (6): 2945-2951.

Charnes, A., Cooper, W. W., Rhodes, E. (1978). Measuring the efficiency of decision making units. European *Journal of Operational Research*, 2 (6): 429-444.

Chidmi, B., Solis, D., Funtanilla, M., Cabrera, V. E. (2010). Analyzing the determinants of technical efficiency among traditional dairy farms in Wisconsin: a quantile regression approach, *Agricultural and Applied Economics Association 2010 Annual Meeting*, Jully 25-27, Denver, USA.

Coelli, T. J., Rao, D. S. P., O'Donnell, C. J., Battese, G. E. (2005). An introduction to efficiency and productivity analysis. Springer, New York, the USA, p.331.

Curtis, J., Jackson S., Kennedy, V. D. (2016). An evaluation of technical efficiency among heterogeneous dairy farms. *African Journal of Dairy Farming and Milk Production*, 3 (2): 135-140.

Dagistan, E., Koc, B., Gul, M., Parlakay, O., Akpinar, M. G. (2009). Identifying technical efficiency of dairy cattle management in rural areas through a non-parametric method: a case study for the East Mediterranean in Turkey. *Journal of Animal and Veterinary Advances*, 8 (5): 863-867.

DairyNZ. (2018). New Zealand Dairy Statistics (2017), Hamilton, New Zealand, p.52.

Erdal, G., Erdal, H., Yavuz, H., Çallı, A. (2016). The present and future statues of animal presence in Turkey; the declination of TR83 area. *Turkish Journal of Agriculture-Food Science and Technology*, 4 (8): 668-675.

European Union (EU). (2018a). EU Dairy Farms Report. Brussels, Belgium, p.185.

European Union (EU). (2018b). Turkey Report (2018). Strasbourg, p.111.

FAO. (2019). Food and agriculture data, http://www.fao.org/faostat/en/#data (Accessed date: 12.04.2019).

Farrell, M.J. (1957). The measurement of productive efficiency. *Journal of the Royal Statistical Society*, 120: 253-290.

Ferjani, A. (2008). The relationship between direct payments and efficiency on Swiss farms. *Agricultural Economics Review,* 9(1): 93-102.

Galanopoulos, K., Abas, Z., Laga, V., Hatziminaoglou, I., Boyazoglu, J. (2011). The technical efficiency of transhumance sheep and goat farms and the effect of EU subsidies: Do small farms benefit more than large farms?. *Small Ruminant Research*, 100(1): 1-7.

Galluzzo, N. (2018a). A non-parametric analysis of technical efficiency in Bulgarian farms using the FADN dataset. *European Countryside*, 10 (1): 58-73.

Galluzzo, N. (2018b). Analysis of economic efficiency in some Irish farms using the DEA approach. Turkish *Journal of Agriculture-Food Science and Technology*, 6 (2): 156-162.

Gaspar, P., Mesías, F. J., Escribano, M., Pulido, F. (2009). Assessing the technical efficiency of extensive livestock farming systems in Extremadura, Spain. *Livestock Science*, 121 (1): 7-14.

Gelan, A., Muriithi, B. W. (2012). Measuring and explaining technical efficiency of dairy farms: a case study of smallholder farms in Africa. *Agrekon*, 51 (2): 53-74.

Gonçalves, R. M. L., Vieira, W. D. C., Lima, J. E. D., Gomes, S. T. (2008). Analysis of technical efficiency of milk-producing farms in Minas Gerais. *Economia Aplicada,* 12 (2): 321-335.

Guesmi, B., Serra, T. (2015). Can we improve farm performance? The determinants of farm technical and environmental efficiency. *Applied Economic Perspectives and Policy*, 37 (4): 692-717.

Gül, M., Yilmaz, H., Parlakay, O., Akkoyun, S., Bilgili, M. E., Vurarak, Y., Hizli, H., Kilicalp, N. (2018). Technical efficiency of dairy cattle farms in East Mediterranean Region of Turkey. *Scientific Papers Series Management, Economic Engineering in Agriculture and Rural Development*, 18 (2): 213-226.

Hadley, D. (2006). Patterns in technical efficiency and technical change at the farm-level in England and Wales, 1982–2002. *Journal of Agricultural Economics*, 57 (1): 81-100.

Hazneci, E., Ceyhan, V. (2015). Measuring the productive efficiency and identifying the inefficiency determinants of dairy farms in Amasya Province, Turkey. *Journal of Agriculture and Environmental Sciences*, 4 (1): 100-107.

Jiang, N., Sharp, B. (2015). Technical efficiency and technological gap of New Zealand dairy farms: a stochastic meta-frontier model. *Journal of Productivity Analysis*, 44 (1): 39-49.

Karakuş, K. (2011). An overview to live animal and red meat imports of Turkey. *Igdir University Journal of the Institute of Science and Technology*, 1(1): 75-79.

Kleinhanß, W., Murillo, C., San Juan, C., Sperlich, S. (2007). Efficiency, subsidies, and environmental adaptation animal farming under CAP. *Agricultural Economics*, 36(1): 49-65.

Kumbar, N. (2015). An Efficiency Analysis of Breeding Farm Enterprises in Trakya Region. (PhD Thesis) Namık Kemal University, Department of Agricultural Economics, Tekirdag, 96p.

Kumbhakar, S. C., Lien, G. (2010). Impact of subsidies on farm productivity and efficiency. In: The Economic Impact of Public Support to Agriculture. Springer, New York, pp 109-124.

Latruffe, L., Bakucs, L. Z., Bojnec, S., Ferto, I, ... Toma, C. (2008). Impact of public subsidies on farms' technical efficiency in New Member States before and after EU accession. *European Association of Agricultural Economists 2008 International Congress,* August 26-29, Ghent, Belgium, 5p.

Latruffe, L., Desjeux, Y. (2016). Common Agricultural Policy support, technical efficiency and productivity change in French agriculture. *Review of Agricultural, Food and Environmental Studies*, 97 (1): 15-28.

Latruffe, L., Guyomard, H., & Le Mouël, C. (2009). The role of public subsidies on farms' managerial efficiency: an application of a five-stage approach to France. *Working Papers Smart–Lereco*, No: 09-05, Rennes, France, 25p.

Madau, F. A., Furesi, R., Pulina, P. (2017). Technical efficiency and total factor productivity changes in European dairy farm sectors. *Agricultural and Food Economics,* 5 (17): 14p.

Mareth, T., Scavarda, L. F., Thomé, A. M. T., Cyrino Oliveira, F. L., Alves, T. W. (2019). Analysing the determinants of technical efficiency of dairy farms in Brazil. *International Journal of Productivity and Performance Management,* 68 (2): 464-481.

Mareth, T., Thomé, A. M. T., Scavarda, L. F., Cyrino Oliveira, F. L. (2017). Technical efficiency in dairy farms: research framework, literature classification and research agenda. *International Journal of Productivity and Performance Management*, 66 (3): 380-404.

McDonald, J. (2009). Using least squares and Tobit in second stage DEA efficiency analyses. *European Journal of Operational Research,* 197: 792-798.

McDonald, J. F., Moffitt, R. A. (1980). The uses of Tobit analysis. *The Review of Economics and Statistics,* 62 (2): 318-321.

Ministry of Agriculture and Forestry (MAF). (2021). Animal Production Statistics.

National Dairy Council. (2019). Milk Sector Statistics in the World and Turkey, p.49.

Newbold, P. (1995). Statistics for Business and Economics. Prentice-Hall International, New Jersey, p.867.

Özden A. (2016). Analysis of countries agricultural production efficiency by income groups: meta frontier approach, *Journal of Tekirdag Agricultural Faculty*, 13 (3): 121-128.

Özüdoğru, T. (2010). Analysis of economic impacts of Amasya cattle breeders association on the local farmers. (PhD Thesis) Ankara University, Department of Agricultural Economics, Ankara, 250p.

Parlakay, O., Semerci, A., Çelik, A. D. (2015). Estimating technical efficiency of dairy farms in Turkey: a case study of Hatay Province. *Custos e Agronegócio Online,* 11(3): 106-115.

Pfeiffer, L., López-Feldman, A., Taylor, J. E. (2009). Is off-farm income reforming the farm? Evidence from Mexico. *Agricultural Economics*, 40 (2): 125-138.

Semerci, A., Celik, A. D. (2017). Reflections of animal husbandry subsidies on dairy cattle enterprises: A case study of Hatay Province-Turkey. *Journal of Tekirdag Agricultural Faculty*, 14 (2): 92-100.

Siafakas, S., Tsiplakou, E., Kotsarinis, M., Tsiboukas, K., Zervas, G. (2019). Identification of efficient dairy farms in Greece based on home grown feedstuffs, using the Data Envelopment Analysis method. *Livestock Science*, 222: 14-20.

Silva, E., Almeida, B., Marta-Costa, A. A. (2018). Efficiency of the dairy farms: A study from Azores (Portugal). *European Countryside*, 10 (4): 725-734.

Silva, E., Arzubi, A., Berbel, J. (2013). An application of data envelopment analysis (DEA) in Azores dairy farms. In: Efficiency measures in the agricultural sector, Springer, pp 73-81.

Silva, E., Marote, E. (2013). The importance of subsidies in Azorean dairy farms' efficiency. Efficiency measures in the agricultural sector, Springer, pp 157-166.

Skevas, I., Emvalomatis, G., Brümmer, B. (2018). Heterogeneity of long-run technical efficiency German dairy farms: A Bayesian Approach. *Journal Agricultural Economics*, 69 (1): 58-75.

Špička, J., Smutka, L. (2014). The technical efficiency of specialised milk farms: a regional view. *The Scientific World Journal,* Article ID: 985149, p.13.

Terin, M., Kulekci, M., Yildirim, I. (2017). Measuring technical, allocative and economic efficiencies of dairy farms in western Turkey. *Indian Journal Animal Research*, 51: 165-169.

Thrace Development Agency (TDA). (2013). Trakya Bölgesi Mevcut Durum Analizi, Tekirdag, 433p.

Turkish Statistical Institute (TurkStat). (2019). Data Request.

Turkish Statistical Institute (TurkStat) (2020). Regional Statistics. https://biruni.tuik.gov.tr/bolgeselistatistik/ (Accessed date: 10.05.2021).

Uzmay, A. (2017). Determination of farmers opinions about the affects of livestock policies on dairy cattle farms: sample of Izmir province. *Journal of Agriculture Faculty of Ege University*, 54 (2): 167-175.

Uzmay, A., Çınar, G. (2016). The hierarchy of preferences of dairy cattle breeders to supporting policies in Izmir: Fuzzy Pairwise Comparison. *Turkish Journal Agricultural Economics*, 22 (2): 59-67.

Uzmay, A., Koyubenbe, N., Armagan, G. (2009). Measurement of efficiency using Data Envelopment Analysis (DEA) and social factors affecting the technical efficiency in dairy cattle farms within the province of Izmir, Turkey. *Journal of Animal and Veterinary Advances*, 8 (6): 1110-1115.

Uzmay, A., Ozden, F. (2016). A study on the factors affecting the dairy policy opinions of the (2013) Turkey National Dairy Summit Participants. *Journal of Agricultural Science and Technology*, 18 (5): 1163-1172.

Zhu, X., Milán Demeter, R., Lansink A.O. (2012). Technical efficiency and productivity differentials of dairy farms in three EU countries: the role of CAP subsidies. *Agricultural Economics Review*, 1 (1): 66-92.