Technical Efficiency Measurement in Broiler Chicken Production System:
A Case Study in Epirus, Greece

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Abstract

The aim of this study was to determine the Technical Efficiency (TE) and Scale Efficiency (SE) of broiler farms (DMUs) in Epirus Region of Greece, calculating the margin at which the farms may increase the output based on certain quantities of inputs. The data were gathered by questionnaires and face to face interviews. A representative sample of 110 broiler farms from Arta, Ioannina and Preveza Regional Units randomly selected by using the Neyman's allocation method of stratified sampling. TE and SE of DMUs were determined using an output-oriented Data Envelopment Analysis (DEA) approach. Results showed that the applied broiler meat productive system of Epirus is intensive, large scale and characterized by high capital investment, high quantities of used feeds and high rate of efficiency. Output is significantly affected by the quantity of used feeds and the average working capital. TE under Constant Return Scale (CRS) and Variable Return Scale (VRS) models runs up to 0.79 and 0.85, respectively and SE score rises up to 0.94 meaning that the inefficiency is only 6%. Feeding Cost (FC) and Feed Conversion Ratio (FCR) are highlighted as strongly ($p \leq 0.01$) related variables with the TE and SE. Further increase of TE must be focused on the improvement of FCR and on better utilization of infrastructure and equipment in general.

Keywords: broilers, DEA, CRS-VRS models, production systems, technical efficiency

1. Introduction

The poultry farming is one of the main animal production sectors in Greece and is well developed. The expansion of the poultry meat section began over 60 years ago and shows a stabilized growth potential the last 30 years (Ministry of Rural Development and Food, 2016).

The Region of Epirus (Regional Units of Ioannina and Arta) shows the highest concentration in both poultry farms and large poultry industry firms. The poultry industry is the most organized and fully modernized part of the poultry sector in Greece, with high capital investments in any type of facility installations (broiler & breeder farms, hatcheries, slaughterhouses, feed mills, waste treatment and handling infrastructures).

According to Hellenic Statistical Authority (2016) the bulk of the total Greek poultry meat production was at the region of Epirus, accounting at a rate of 64%, whereas 58% of total broiler population has been slaughtered at the same region. Approximately 41% of the total Greek broiler farms have been located in Ioannina and 20% in Arta Regional Unit, respectively. Finally, in Epirus there are established the 70% of total broiler breeder farms which supplies with eggs for hatching 4 hatcheries.

The broiler production system in the Region of Epirus is modeled as intensive, large scale and industrial according to Camargo-Barros et al. (2003) scaling. Facilities are well equipped and relatively mechanized, including, both semi-automatic and automatic equipment. Housing systems are designed to accommodate feed systems, nipple-enabled water supplies and centralized controls for humidity, ventilation and lighting. Some systems have more extensive automation, including remote monitoring and computerized controls.

Farms with automatic equipment have sizes in the 8,000 to 15,000 bird range. This mode of production is intensive with higher levels of investment in animal health standards, housing maintenance and flock productivity.

According to data from the Association of Poultry Processors and Poultry Trade in the EU countries (AVEC - Annual Report, 2017), during the period of 2011-2016, the average annual consumption of poultry meat per capita in Greece was 20.6 kg and the self-sufficiency in poultry meat was 78.2%, respectively. Therefore, it is very important to increase total production (outputs) improving the efficiency of available resources.

The efficiency is an important factor of productive growth especially in developing economies. The technical efficiency (TE) has a crucial role in increasing agriculture growth of developed countries (Zaman et al., 2018). In Greece where the broiler poultry sector is relatively developed, productivity growth can be achieved by estimating the TE of production indicators such as the feed conversion ratio, the average fattening time and the total number of placements per year.

DEA is one of the most popular approaches used in the literature to appraise the performance of farms (Tosadee et al., 2012). There are few researches regarding on the application of DEA approach on animal farming efficiency (Siafakas et al., 2019). Information concerning on DEA approach in broiler farming is limited. Most of them and in particular in developing countries (Omar, 2014) are input oriented. Unfortunately, there is a lack of DEA studies focused on output in broiler farming sector. Thriftiness and productivity of broiler chicken farming was firstly studied in Greece by Kitsopanidis (1978). The efficiency of Greek poultry industry sector has been studied by Keramidou et al. (2011) with the application of the double-bootstrap DEA, in which the internal company's performance factors of the dominant poultry firms had been investigated. However, there are no known studies that have been done to determine the technical efficiency of broiler farms in Greece.

The aim of this study was to determine the Technical Efficiency (TE) and Scale Efficiency (SE) of broiler farms calculating the margin at which the farm may increase the output -in this case the quantity of broiler live weight produced- based on certain quantities of inputs which have already been used in production system.

2. Materials and Methods

2.1. Study area and sampling method

The study was conducted in the most important chicken broiler production area of Greece, the Region of Epirus, Greece, during the year 2016. Epirus is located within 39.40 north latitude and 20.51 east longitude. A representative sample of 110 broiler chicken farms from Arta, Ioannina and Preveza Regional Units randomly selected by using the method of stratified sampling. The Regional Unit of Thesprotia was not included in the sample due to the absolute luck of poultry farms in this area. The Neyman's allocation method was used to calculate the final sample. The total number of broiler farms were divided into two layers, or strata. The first stratum was related with farm size (h1: 5,000-25,000 broilers; h2: 25,001-50,000 broilers; h3: 50,001-75,000 broilers; h4>75,000 broilers) while the second one was represented by the regional unit where farm is operated (n1: Arta; n2: Ioannina; n3: Preveza). The formula of Neyman's allocation is the following:

$$n_h = n \cdot \frac{N_h S_h}{\sum_{h=1}^{H} N_h S_h} \tag{1}$$

where:

$$S_h = \sqrt{\frac{1}{N_h - 1} \sum_{i=1}^{N_h} (y_i - \bar{y}_i)^2}$$

n_h – sample size in stratum h

n – total sample size

N_h – population size in stratum h

y_i – variable of interest in stratum h

2.2. Data collection and analyses

The required data were gathered by questionnaires and interviews with the owners of 110 broiler farms. The software packages MSEXCEL (dataset development), SPSS v.24 (statistical analysis) and R by adds-on benchmarking package (mathematical DEA analysis) were used.

2.3. Data Envelopment Analysis (DEA)

DEA is based on the mathematical theory established by Farrell (1957) and improved by Charnes et al. (1978) and Banker et al. (1984). Its implementation has been proposed for agricultural sector studies because it is simple to use and to interpret the results concerning on the assessment of the efficiency of farms. Most of the non-parametric applications are based on the DEA model as proposed by Charnes et al. (1978). Numerous researches have focused on measuring the relative level of technical and scale efficiency, by using the conventional DEA approach (Omar, 2014). Traditional DEA models usually deal with efficiency of input resources versus output products of associated decision-making units (DMUs) within cross sectional data (Farrell, 1957; Tone and Tsutsui, 2010).

In developing countries, the DEA - input orientation model is more popular to use because the scarce resources (inputs) must be used more efficiently for the production of the same output (Begum et al., 2010). In our study area where the broiler chicken farming is well developed (Ministry of Rural Development and Food, 2016) to calculate the technical efficiency of broiler chicken farms, a DEA - output orientation model was applied, assuming that broiler farmers have higher control on outputs rather than inputs. Efficiency's assessment performed by the construction of a -best practice- efficient frontier. This relays on the potential increase of output keeping unchanged the input level. DEA is a non-parametric method in which the relationships between all inputs and outputs are considered (Keramidou et al., 2011). The DEA method is commonly used to evaluate the technical efficiency of a number of DMUs (Toloo and Nalchigar, 2009). The method compares the studied farms as DMUs (decision making units) and finds out the efficiency score.

As an efficient frontier technique, DEA identifies the inefficiency in a particular DMU by comparing it to similar DMUs regarded as efficient, rather than trying to associate a DMU performance with statistical averages that may not be applicable to that DMU. The efficient frontier envelopes all other data points, thus giving rise to the name data envelopment analysis (Avkiran, 2001).

In Figure 1, it plots the empirical relationship between an input and an output from a set of 7 hypothetical broiler farms, A, B, C, D, E, F, and G. Using DEA will determine that ABCD form an efficient frontier.

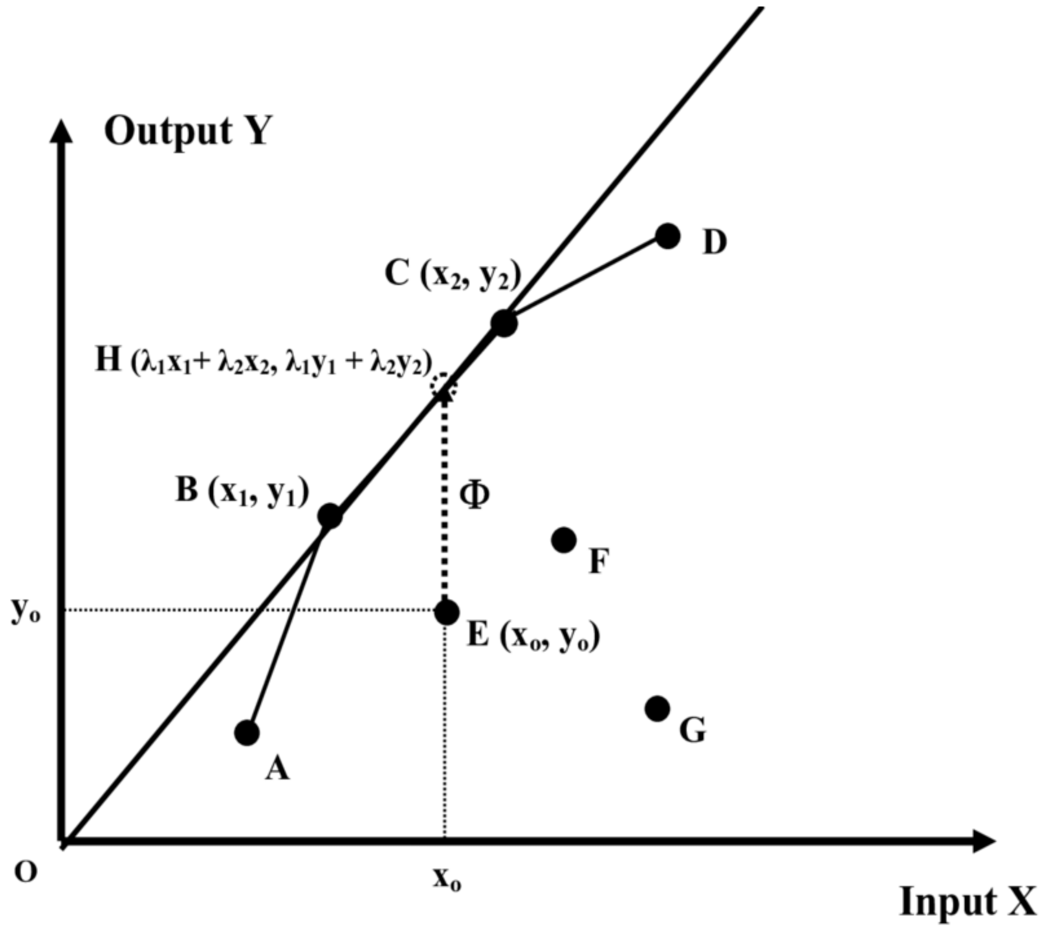

Fig. 1. Output-Oriented Variable Return-to-Scale DEA Model: Input/Output.

The solution of the problem statement was based on two alternatives. Firstly, technical efficiency, as proposed by Charnes et al. (1978), is measured under CRS -Constant Return to Scale-assumption. Secondly, the VRS -Variable Return to Scale-model was applied (Banker et al., 1984).

Production efficiency can be defined in terms of the production function that relates the level of various inputs. Technical Efficiency (TE) is a measurement of a farm's success in producing maximum output from a given set of input; in other words, TE refers to the physical relationship between inputs used in the production process. TE measures output relative to that of the efficient isoquant. Efficient farms produce on the production frontier or, alternatively stated, on the efficient isoquant (Heidari et al.,2011). TE can be calculated by the ratio of sum of weighted outputs to sum of weighted inputs (Cooper et al., 2006).

The use of Constant Returns to Scale Model begins with the assumption that there is data on K inputs and M outputs on each of N farms (DMUs). For the i-th DMU technical efficiency there are represented by the vectors x_i and y_i respectively. The K×N input matrix, X, and the M×N output matrix, Y, represent the data of all N farms. The purpose of DEA to construct a non-parametric frontier is introduced via the ratio form (Coelli, 1996). For each farm (DMU) obtained a measure of ratio of all outputs over all inputs, such as $u'y_i/v'x_i$, where u is an M×1 vector of output weights and v is a K×1 vector of input weights. To select optimal weights, we specify the following mathematical programming problem:

$$\max_{u,v} (u'y_i/v'x_i), \quad (2)$$

$$\text{st} \quad u'y_j/v'x_j \leq 1,\ j=1,2,.....,N,$$

$$u, v \geq 0$$

This involves finding values for u and v, such that the TE measure of the i-th DMU is maximized, subject to the constrain that all TE measures must be less than or equal to one. Furthermore, this particular ratio formulation has one problem of infinite number of solutions. To avoid this one, we impose the constraint $v'x_i=1$, which provides:

$$\max_{\mu,\nu}(\mu'y_i), \quad (3)$$

$$\text{st} \quad \nu'x_i = 1,$$

$$\mu'y_j - \nu'x_j \leq 0,\ j=1,2,.....,N,$$

$$u, \nu \geq 0$$

where the notation changes from u and v to μ and ν reflect the transformation. This is the multiplier form of the linear programming problem.

When the DMUs may be given a fixed quantify of resources and asked to produce as much output as possible an output orientation would be more appropriate. Moreover, in many cases the choice of orientation will have only minor influences upon the scores obtained (Coelli and Perelman, 1996). Technical efficiency calculation is expressed by the following output-orientated VRS model:

$$\max_{\varphi,\lambda}\varphi, \quad (4)$$

$$\text{st} \quad -\varphi y_i + Y\lambda \geq 0,$$

$$x_i - X\lambda \geq 0,$$

$$N1'\lambda=1$$

$$\lambda \geq 0$$

where $1 \leq \varphi < \infty$, and $\varphi-1$ is the proportional increase in outputs that could be achieved by the i-th DMU technical efficiency, with input quantities held constant. An output-oriented CRS model is defined in a similar way (Coelli, 1996). The ratio $1/\varphi$ defines a TE score which varies between zero and one (e.g. the output-orientated TE score reported by DEAP).

The VRS DEA model (variable returns to scale) can be converted to the CRS DEA model (constant returns to scale) by waiving the requisite $N1'\lambda=1$.

The DEA method implies statistical correlation between inputs and outputs. In addition, in order to consider the exact method, the following relationship was applied:

$$DMU \geq \max\{m*s, 3(m+s)\} \quad (5)$$

where, DMU: number of farms, m: the number of inputs, s: the number of outputs (Cooper et al., 2006).

The analysis was developed based on measurement of technical efficiency with CRS and VRS for each broiler farm. In cases where there were differences between CRS and VRS efficiency values, there was an indication of size effectiveness. The measurement of the size of SE - Scale Efficiency - is calculated by the math type:

$$SE_i = \frac{TE_{i,CRS}}{TE_{i,VRS}} \quad (6)$$

where:

SE - Scale Efficiency of farm i
TE - Technical Efficiency of farm i
CRS - Constant Return to Scale
VRS - Variable Return to Scale

2.4. Selection of input and output variables

Literature provides some suggestions about screening procedures for the selection of input and output variables. Last decade an increasing interest concerning on efficiency's issues of broiler chicken farms has been demonstrated (Yusuf and Malomo, 2007; Udoh and Etim, 2009; Mahjoor, 2013; Omar, 2014; Tuffour and Oppong, 2014).

The following variables were selected to investigate the level of technical efficiency of the 110 broiler farms:

- Y= total produced quantity of live chickens per farm (kg/year)
- X1= total feed consumption (kg/year)
- X2= number of yearly placements
- X3= average fattening days per breeding
- X4= average working capital in euro (including land)
- X5= labor (hours/year)

As output variable (Y) was chosen the "total produced quantity of live chickens per farm" because this index expresses the productivity of broiler farm (Begum et al., 2010; Mahjoor, 2013). Total feed consumption (X1) is the dominant component of variable cost (Spais and Hatzizisis, 2011) and the ratio X1/Y expresses the ratio of feed conversion (FCR) which significantly affects the productivity of each broiler farm (Florou-Paneri and Christaki, 2016). The number of yearly placements (X2) is a variable which affects the total productive potential of the broiler farm which depends on unit size, facilities and equipment etc. The average fattening days per breeding (X3) affects the number of yearly placements on farm facilities. The variables X4 and X5 that express the average working capital (including land) and labor, respectively, represent the two main factors affecting the total productive cost, the technical efficiency and the viability of farms (Kitsopanidis, 1978).

3. Results and Discussion

Descriptive statistics of selected variables of 110 broiler farms are shown in Table 1.As shown from Table 1 the mean values of variables Y, X1, X2, X3, X4 and X5 are372,115.97 (kg), 673,423.87 (kg), 5.07, 45.26 (days), 241,619.93 (€) and 2,612.53 (hours), respectively. The mean X1/Y ratio or FCR is 1.81. The above results suggest that in study area are operated broiler farms which characterized by high capital investment, high quantities of annually used feeds and high quantity of produced broiler meat. The average number of annually placements is relatively high while the average fattening days per breeding are more than those proposed by breeding companies which provide Cobb and Ross chicks. On the other hand, the yearly used labor arises up to 2,612.53 hours or 1,244 human working units and is rather low. Finally, the mean FCR (1.81) is considered to be compensatory.

Tab. 1. *Descriptive statistics of selected variables.*

Variables	Type of insert in DEA	Unit	Mean	SD
		DMUs = 110		
Y	Output	kg	372,115.97	304,150.8 2
X1	Input	kg	673,423.87	624,349.7 23
X2	Input	numb er	5.07	0.95
X3	Input	days	45.26	3.50
X4	Input	€	241,619.93	245,929.6 7
X5	Input	hours	2,612.53	1,244.24

Table 2 shows the Pearson's correlations between selected variables. Three statistically significant correlations (0.981, P<0.01; 0.799, P<0.01; 0.755, P<0.01) among X1 and X4 variables with the output (Y) and between X1 and X4 variables were detected. This could be attributed to the fact that in broiler farms, output is strongly linked with feed consumption and capital investments. In study area feeding cost is about the 75% of variable cost while depreciations and interests represent about 82% of firm cost which contributes at a level less than 10% in total cost. On the other hand, no statistically significant correlations (P>0.05) between output (Y) and number of yearly placements (X2), average fattening days per breeding (X3) and labor (X5) were detected. Feeding cost is about the 68% of total cost in the DMUs of study area and in combination with working capital represents the two major factors affecting technical efficiency. The results of this study are in general agreement with the findings of other researches concerning on technical and economic efficiency of broiler farms (Mahjoor, 2013; Omar, 2014).

Tab. 2. *Pearson's correlation matrix.*

Variables	Y	X1	X2	X3	X4	X5
DMUs= 110						
Y	1					
X1	0.981[a]	1				
X2	0.386	0.351	1			
X3	0.190	0.011	0.076	1		
X4	0.799[a]	0.755[a]	0.206	0.001	1	
X5	0.442	0.386	0.260	-0.123	0.425	1

[a]Correlation is significant at the 0.01 level (2-tailed).

Table 3 shows the results of Technical and Scale Efficiency of studied farms. As shown in Table 3, seventeen (17) and thirty-three (33) farms are fully effective in output-oriented DEA approach, according to the results of the CRS and VRS models, respectively. In addition, according to CRS and VRS models, twenty (20) and twenty (20) broiler chicken farms have a technical efficiency ≥0.9 increasing the percentage of technically efficient farms to 33.7% (CRS) and 48.2% (VRS), respectively. Furthermore, according to CRS and VRS models, nineteen (19) and twenty-one (21) broiler chicken farms have a technical efficiency 0.9<TE≤0.8 increasing the percentage of technically efficient farms to 50.9% (CRS) and 67.3% (VRS), respectively. The technical efficiency of the VRS model is greater than the technical efficiency determined with the CRS model. If there is a difference between CRS and VRS technical efficiency scores for a particular DMU, this indicates that DMU has scale inefficiency, which can be calculated from the ratio between the CRS TE score and the VRS TE score (Cooper et al., 2006).

Tab. 3. *Frequencies of Technical and Scale efficiency of studied farms.*

TE	CRS model		VRS model		SE	
	DMUs	%	DMUs	%	DMUs	%
=1	17	15.4	33	30.0	50	46.4
1.0<TE≤ 0.9	20	18.2	20	18.2	40	36.4
0.9<TE≤ 0.8	19	17.3	21	19.1	7	6.4
0.8<TE≤ 0.7	26	23.6	16	14.5	11	10.0
0.7<TE≤ 0.5	23	20.9	17	15.5	2	1.8
0.5<TE≤ 0.3	3	2.7	3	2.7	0	0.0
0.3<TE≤ 0.1	1	0.91	0	0.0	0	0.0
0.1<TE≤ 0	1	0.91	0	0.0	0	0.0

Total	110	100	110	100	110	100
Mean	0.79		0.85		0.94	
SD	0.18		0.16		0.13	

The ratio CRS to VRS indicates the scale efficiency (SE). The scale efficiency of the majority of the sample (108 of 110 farms) ranges from 1 to 0.38 with an average of 0.94 and a standard deviation of 0.13. Thus, it seems that farms could achieve an increase in broiler meat production by improving their technical efficiency. The SE value is used to indicate the extent to which the productivity could be increased if the farm moved to technically optimal productive scale (Romero et al., 2010). The average technical efficiency was 79% (CRS) and the average scale efficiency was 94% and were similar to findings of Karagiannis and Sarris (2005). As a result, the broiler chicken farms in the sample could have on average increased their output by 6% if they had adopted the optimal scale, and they could have further increased their output by 21% if they had used existing inputs more efficiently. In this paper the mean SE value (0.94) was oriented to output, meaning that the farm yield is of high efficiency with the level of scale inefficiency being only 0.06. This result suggests that inputs (variables X1, X2, X3, X4 and X5) should be rationally managed in order to achieve maximum output under the given level of inputs (Madau, 2011 & 2015, Likita and Okonkwo, 2015). Taking into account that total feed consumption and working capital are strongly related to output the effort to maximize SE must be focused on the above mentioned variables, since other inputs such as number of yearly placements, average fattening days and labor have no significant effect on output and consequently on TE and SE of studied farms. Due to the fact that the possibilities to improve working capital are limited more emphasis should be given on feed efficiency (Ullah et al., 2017). Thus, improve on the efficiency of inefficient farms can be achieved through a proportional increase in output that can result from better utilization of feed (FCR) particularly during the final fattening period (29-42 days). Improvement of FCR could be achieved optimizing the management concerning on housing, feeding, veterinary care, hygiene conditions etc. (Leeson and Summers, 1980). Among them improvement and modernization of equipment related to feed distribution and waste, ventilation, lighting and control of humidity are included. Further reduction of mortality below than the average percentage 3% of this study could be another way to improve FCR.

A Spearman's correlation matrix based on the consistency of the technical efficiency of DMUs by the CRS and VRS models and their relationship to SE was created (Table 4).

Table 4 shows that correlation coefficients between CRS-VRS and CRS-SE are positive and statistically significant ($p \leq 0.01$). These results clearly suggest that the broiler farms, given the level of inputs used in model development, could increase the quantity of live weight of broilers produced (output), according to the CRS model, since this model was developed in order to increase the output optimizing the combination of inputs (Farhan et al., 2015; Parichatnon et al., 2018).

Tab. 4. Spearman's correlation matrix of studied DMUs.

	CRS model	VRS model	SE
CRS model	1		
VRS model	0.739[a]	1	
SE	0.509[a]	0.035	1

[a]Correlations are statistically significant at level p≤0.01.

On table 5 are shown means and standard deviations of main variables used in the DEA approach of study area. According to SE score fifty (50) efficient and sixty (60) inefficient DMUs were revealed. Statistically significant differences (p≤0.01) were detected between efficient and inefficient DMUs concerning on the following variables· Feed Conversion Ratio (FCR); Total Production Cost; Technical Efficiency (TE) according to CRS and VRS models and Scale Efficiency (SE). Particularly, FCR was approximately improved by 6% in efficient in comparison to inefficient DMUs. This also suggests that efficient DMUs achieve about 6% increased production of live weight of chicken, consuming the same amount of feed, as compared to inefficient DMUs. The average size broiler farm (n=29,468) of the study area sample with 5.07 annual placements produces an additional 42,530 kg of live chicken weight and thus gross income rises by 47,650 euro per year.

Tab. 5. Means and standard deviations of the main variables used.

	Unit	Efficient	Inefficient	p
DMUs	No	50	60	
Y: total produced quantity	kg/year	426,597.24 ±351,908.66	326,789.20 ±251,908.25	0.087
X1: Total feed consumption	kg/year	756,079.85 ±743,459.96	604,543.88 ±500,498.58	0.206
X2: Yearly placements	No	5.22±0.79	4.95±1.02	0.128
X3: Average fattening days	days	45.59±1.	44.99±4.	0.

		97	39	377
X4: average working capital	€	228,781.08 ±246,187.22	252,318.97 ±247,275.46	0.619
X5: labor	hours	2,587.35 ±455.00	2,650.01 ±1,190.14	0.794
Feed Conversion Ratio	kg/kg	$1.74^{a} \pm 0.19$	$1.85^{b} \pm 0.21$	0.007
Annual turnover per farm	€	474,262.49 ±391,250.22	363,695.72 ±285,726.94	0.253
Total production cost	€/kg	$0.80^{a} \pm 0.07$	$0.84^{b} \pm 0.07$	0.002
CRS model	No	$0.87^{b} \pm 0.16$	$0.72^{a} \pm 0.18$	0.000
VRS model	No	$0.87^{B} \pm 0.16$	$0.83^{A} \pm 0.17$	0.022
SE	No	$0.98^{b} \pm 0.00$	$0.88^{a} \pm 0.15$	0.001

Anova test.

^{a,b}Means in the same row sharing a different superscript are significantly different ($p \leq 0.01$).

^{A,B}Means in the same row sharing a different superscript are significantly different ($p \leq 0.05$).

As previously was reported feeding cost is the main component of variable cost (75%) and represents about the 68% of total production cost. In the present study total production cost in efficient farms was lower by 5% as compared to inefficient ones. Consequently, the two main variables significantly affecting the Technical Efficiency and the Scale Efficiency of the 110 DMUs of study area are Feed Conversion Ratio and Total Production Cost.

Technical efficiency of broiler farms of study area according to CRS model was significantly higher ($p \leq 0.01$) in efficient farms as compared to inefficient ones (0.87 vs

0.72) and this result indicates that a great potential of its improvement exists suggesting that there are wide margins (about 20%) of its improvement. Otherwise, this finding means that the inefficient DMUs could increase their output (chicken live weight) by about 20% if they should use more rationally the same quantity of inputs. Technical efficiency of inefficient DMUs according to VRS model was significantly lower ($p \leq 0.05$) than that of efficient ones. Finally, the scale efficiency of efficient broiler farms rises up to theoretically maximum value (0.98) and the inefficiency is only 2%. On the contrary, the SE of inefficient farms was determined equal to 0.88 and this result suggests that there are significant possibilities for each improvement (about 12%). Since in the study area the producers use the same chick hybrids and compound feeds of similar composition, quality and price in order to improve technical efficiency and scale efficiency of DMUs, a more rational organizing and management of farming system in general and especially in variables feeding and housing is required. This is in agreement with the analyses of Madau (2011 & 2015) for more rational use of disposal resources in order to increase input. The owners of inefficient farms have to reduce the waste of feed, to increase the number of yearly placements and to exploit for more time per year their facilities and equipment whom charges such as depreciations, interests etc. are relatively high.

Unfortunately, as previously mentioned there are not similar DEA approach output-oriented studies on intensive and industrial broiler farming to compare the findings of the present study. Moreover, most of input variables of input-oriented studies are related with the social status of broiler producers such as age, education level, further training etc., while in the present study technical and economic variables were used. So, the potentialities for further correlations and discussion are limited.

4. Conclusions

The broiler chicken productive system of Epirus Region, Greece is intensive, large scale, industrial and is characterized by high capital investment, high quantities of used feeds and high efficiency. Total feed consumption represents the major part of variable cost and is strongly related to average working capital. Quantity of chicken live weight produced (output) is significantly affected by the quantity of used feeds and the average working capital. Variables such as number of yearly placements, average fattening days per breeding and labor have no significant effect on output. Fifty (50) of one hundred and ten (110) DMUs (≈45%) are technically efficient while the inefficient ones rise up to about 55%. Average Technical Efficiency (TE) according to CRS and VRS models runs up to 0.79 and 0.85, respectively and the ratio CRS to VRS or Scale Efficiency (SE) score rises up to 0.94 which is characterized as high meaning that the inefficiency of the broiler productive system is only 6%. Technical efficiency of inefficient broiler farms according to CRS model could be improved about 20% if they use their given level of inputs more rationally. Feeding cost and feed conversion ratio are highlighted as strongly related variables with the technical and scale efficiency of studied farms. Further increase of technical efficiency must be focused on the improvement of feed conversion ratio and more rational management of infrastructure and equipment. Further research is needed to confirm the results of this study.

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