Counties performance evaluation of cereal production in Albania

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Abstract

Agriculture is one of the most important sectors of the Albanian economy. Agricultural production occupies for about 1/5 of the country's GDP. Agricultural production includes all realized production in all counties of the country. Cereal constitutes a significant part in agricultural production, which are grown all over the country. The main cereals cultivated in the country are wheat, maize, rye, barley and oats. The highest level of cereal production in Albania is reached in low and coastal counties and the lowest levels of cereal production are reached in mountainous counties. The production potentials of the agricultural sector are bigger than that. For this purpose there is a need of finding ways and manners to increase agricultural production in general, which affects the growth of employment and welfare, economic growth and poverty alleviation in rural areas. In this context, the counties performance evaluation related to cereal production and the identification of their productive opportunities in these agricultural cultures has a big interest. In this paper, the productive performance of the counties has been evaluated by using the Data Envelopment Analysis (DEA) method as a method for performance evaluation and benchmarking.
Keywords: performance, counties, Data Envelopment Analysis (DEA).

Introduction

Cereals are one of the most important agricultural products as they serve as basic food for both humans and animals. Before the 90's, Albania has reached high levels in cereal production, because all the required amount of domestic consumption was produced domestically. Cereal production in the country fell a lot in the early 90's as a result of abandonment of agricultural land due to migration to the cities or immigration to other parts of the population living in rural areas. Another reason for reducing the interest of cereal cultivation in the country was the market's opening and foreign products competition with lower prices than the cost of domestic production. So, the domestic needs of cereals in our country today are supplemented by domestic

production and import. Within a year, our country imports from the other countries about 400 thousand tons of cereals. Imported cereals are mainly wheat, corn and rye. The largest quantity of imported cereals comes from Russia, Serbia, France, Croatia and Italy. Cereals weigh about 10% of total imports of our country's food products.
Cereal production in the country is dominated by two main products, wheat and maize. Maize production has experienced significant growth in recent years, while wheat production that has been increased in recent years, is still in low levels. The increase of maize production is the result of the addition of livestock heads in the country for which maize is one of the basic foods. Also, cereal processors have increased their interest for finding raw materials domestically in more competitive prices. Even, cereal cultivation began to increase as a result of the price increase of wheat in international markets.
Nowadays, as in any other sector, even in agriculture, it is not enough simply to produce, but you need to be efficient in production, to be productive. This, as noted above, takes more importance if we keep in mind the low performance that the agriculture sector has shown consistently but also the income and employment in this sector for the rural population in our country. Various problems related to the lack of financial resources, land fragmentation, and many other problems have led to low levels of agricultural production. The need to find a realistic solution for farmers in order to increase their production for both domestic and foreign markets has become a necessity. This issue is important to be studied, as economic growth that is untapped due to lack of efficiency, can be improved at no extra cost to increase production and improve performance.

Material and method

The performance evaluation in the production of the cereals of the counties in our country, in this study, is based on data related to the level of cereal production in the county basis, as well as the surfaces sown with each of the different types of cereals (wheat, maize, rye, barley, oats) in the 12 counties of Albania. These data are obtained from the INSTAT, agriculture statistics for 2015, and are presented in Table 1.

Table 1. Sown surfaces and cereal production.

No	County	The surface sown with cereals for 2015 (in hectare)						Cereal Production for 2015 (in tone)
		Cereals	Wheat	Maize	Rye	Barley	Oats	Cereals
1	Berat	9,870	4,170	3,665	5	30	2,000	45,984
2	Diber	8,757	2,973	5,173	156	35	420	47,208
3	Durres	7,004	2,402	3,775	-	5	822	42,451
4	Elbasan	21,903	12,467	6,847	100	-	2,489	98,272
5	Fier	31,889	17,765	9,798	-	3	4,323	154,151
6	Gjirokaster	5,351	2,306	1,156	45	6	1,838	19,424
7	Korce	23,482	15,849	4,174	489	2,411	559	86,189
8	Kukes	4,927	1,000	3,133	509	2	283	22,932
9	Lezhe	6,640	2,815	3,815	-	-	10	39,179
10	Shkoder	7,932	1,801	6,131	-	-	-	48,543
11	Tirane	8,374	4,028	3,446	10	-	890	45,766
12	Vlore	6,504	2,042	3,501	-	15	946	45,413
Gjithsej / Total		**142,632**	**69,618**	**54,614**	**1,313**	**2,507**	**14,580**	**695,514**

Source: INSTAT, Statistical Yearbook of Agriculture, 2015

In this paper, the performance of the counties is evaluated using the data envelopment analysis (DEA), through the CCR-input oriented model (CCR-I). The DEA method uses data for inputs and outputs from each DMU – decision making unit (county) to build an efficient frontier, such that all observed DMU-s lie within or below the envelopment frontier. The technical efficiency of each DMU is measured in terms of the technical efficiency of all other DMU-s in the analysis. The model will identify and differentiate efficient and inefficient ones, even when they exhibit optimal value for efficiency. The DEA method defines the production potential of each DMU and the ways of achieving it.

In CCR-I model, the goal is to produce the same output level with the possible minimum of input. Also, this model will show opportunities that have inefficiency DMU-s to reduce the amount of unused inputs on them. The CCR-I model, under the CRS assumption, in its envelopment form is given below:

$$\begin{aligned} &Min_{\theta,\lambda,s^+,s^-} && z_k = \theta_k - \varepsilon\vec{1}s^+ - \varepsilon\vec{1}s^- \\ &s.t. && Y\lambda - s^+ = Y_\nu \\ & && \theta_\nu X_\nu - X\lambda - s^- = 0 \\ & && \lambda, s^+, s^- \geq 0 \end{aligned}$$

where:

- n n is the number of $DMU DMU$-s (counties) taken in the study,
- YY is $n\ x\ sn\ x\ s$ output matrix and $X\ X$ is $m\ x\ nm\ x\ n$ input matrix,
- $X_\nu = \{x_{i\nu}\} X_\nu = \{x_{i\nu}\}$ input quantities $(i = 1, \dots, m) i = 1, \dots, m)$ of the $DMU_\nu DMU_\nu, k = 1, \dots, n. k = 1, \dots, n.$
- $Y_\nu = \{y_{rk}\} Y_k = \{y_{rk}\}$ output quantities $(r = 1, \dots, s) r = 1, \dots, s)$ of $DMU_\nu DMU_k$,
- $s^+ s^+$ and $s^- s^-$ vectors of additional variables (slacks)
- $\lambda\lambda$ vector of weight and $\varepsilon\varepsilon$ is an infinitely small constant
- 1 ◎ vector line of dimensions $1\ x\ s 1\ x\ s$ (outputs) and $1\ x\ m 1\ x\ m$ (inputs)
- θ scalar that determines the proportional reduction for all inputs of $DMU_\nu DMU_k$.

$DMU_k\ DMU_k$ (DMU under evaluation) performance is fully efficient only if the conditions are met at the same time: $\theta^* = 1\ \theta^* = 1$ and all slacks are equal to zero. The performance of $DMU_\nu DMU_\nu$ is weakly efficient only when the conditions are met: $\theta^* = 1\ \theta^* = 1$ and $s_i^{-*} \neq 0 s_i^{-*} \neq 0$ and/or $s_{\_}^{+*} \neq 0\ s_{\_}^{+*} \neq 0$ for any $i\ i$ and rr in some alternate optima. Conversely, if $\theta^* < 1 \theta^* < 1$, the $DMU_\nu\ DMU_k$ performance is inefficient. DMU that result with the value of $\theta = 1\ \theta = 1$ are technically efficient and define the efficient frontier according to this model. If $\theta = 1$ $\theta = 1$ no input reduction can be made. In the whole of the DMU-s resulting in the value of $\theta = 1 \theta = 1$ not all are fully efficient. Some of them may have weakly efficiency. In them there is room for improvement, i.e., reduction of the inputs as the value of the corresponding slack variables different from zero. If $0 \leq \theta < 1$

$0 \leq \theta < 1$, the DMU becomes technically inefficient and extend below the efficient frontier. For inefficient DMU-s, which need improvement, optimization is calculated in a two-stage process:

- The proportional reduction of the inputs used by the DMU taking the optimal value of θ as a factor.
- Movement over the efficient frontier through slack variables $s^+ s^+$ and $s^- s^-$.

Also, non-zero elements of the optimal vector λ found by the model identify the reference set for each inefficient DMU. The reference set consists of efficient DMU-s from the range of efficient DMU-s at the efficient frontier, against which the$DMU_{\text{ı}}$ $DMU_{\text{ı}}$ is evaluated. The reference set determines the point of reference for the DMU_k DMU_k. This means that, the projection in the efficient frontier of an inefficient DMU will be the linear combination of the reference set of the respective efficient DMU-s of this inefficient DMU with the optimal vector components. The linear combination of the DMU-s means a linear combination of inputs and outputs with the values of λ-s to obtain the input and output levels that the DMU must achieve in order to be technically efficient. This design will result the same as that gained by the improvement through θ and additional variables.

Results and discussions

After processing the above data through the CCR-I model, the performance of each county of our country is characterized by a single summary of the result of the relative technical efficiency. The results of these relative efficiencies are reflected in Table 2.

Table 2. Counties performance results.

DMU No.	DMU Name	CRS Efficiency	Sum of lambdas	RTS	Optimal Lambdas with Benchmarks					
1	Berat	0.88111	0.746	Increasing	0.135	Fier	0.099	Gjirokaster	0.511	Vlore
2	Diber	0.87342	1.098	Decreasing	0.521	Lezhe	0.195	Shkoder	0.382	Vlore
3	Durres	1.00000	1.000	Constant	1.000	Durres				
4	Elbasan	1.00000	1.000	Constant	1.000	Elbasan				
5	Fier	1.00000	1.000	Constant	1.000	Fier				
6	Gjirokaster	1.00000	1.000	Constant	1.000	Gjirokaster				
7	Korce	1.00000	1.000	Constant	1.000	Korce				
8	Kukes	0.87538	0.477	Increasing	0.408	Shkoder	0.069	Vlore		
9	Lezhe	1.00000	1.000	Constant	1.000	Lezhe				
10	Shkoder	1.00000	1.000	Constant	1.000	Shkoder				
11	Tirane	1.00000	1.000	Constant	1.000	Tirane				
12	Vlore	1.00000	1.000	Constant	1.000	Vlore				

Source: Data processed by the authors

Table 2 shows that the counties of Durrës, Elbasan, Fier, Gjirokastër, Korcë, Lezhë, Shkodër, Tiranë and Vlorë have a result of relative technical efficiency equal to 1, which means that in the group of counties surveyed these are technically efficient. So these counties have resulted with the best practice production from all over the country. The relative technical efficiency of these counties implies the production of the given product level (cereals) with the minimum input potential (respective surface of wheat, maize, rye, barley and oats). Namely, these counties have maximized their available resources in the production process. Also, from table 3 it is seen that

additional variables are all zero for all inputs and outputs of these counties. This shows that these counties are fully efficient.

The other counties of Berat, Dibër and Kukës are technically inefficient, as their efficiency results are smaller than one. The county with the lowest result of relative technical efficiency is the county of Dibër. Their inefficiency means the non-using optimal utilization of available resources (cereal sown surfaces) in the production process. In these conditions each of them should proportionally reduce the inputs through θ. Also, they should reduce the inputs to the extent of the corresponding additional variables that are different from zero.

The county of Dibër, the most inefficient from all counties, should proportionally reduce all cereal sown surfaces to the mass $\theta = 0,87342\theta = 0,87342$ and further reduce the sown surface with ray with $136,25305\ 136,25305$ ha and the sown surface with barley with $24,8355124,83551$ ha, without changing the current level of cereal production. In this way the production performance of this county will be improved and in the future will be fully efficient. The same would be justified for Berat and Kukës. The county of Berat, should proportionally reduce all cereal sown surfaces to the mass $\theta = 0,88111\theta = 0,88111$ and further reduce the sown surface with barley with $17,1642317,16423$ ha and the sown surface with oats with $512,09051\ 512,09051$ ha, without changing the current level of cereal production. The county of Kukës, should proportionally reduce all cereal sown surfaces to the mass $\theta = 0,87538\theta = 0,87538$ and further reduce the sown surface with ray with $445,56983445,56983$ ha, the sown surface with barley with $0,718620,71862$ ha and the sown surface with oats with $182,63061182,63061$ ha without changing the current level of cereal production. So it is possible that inefficient counties to improve their technical efficiency score and thereby improve performance in the cereal production and simply just by using their existing maximum surfaces.

		Input Slacks					Output Slacks
DMU No.	DMU Name	*Wheat (ha)*	*Maize (ha)*	*Rye (ha)*	*Barley (ha)*	*Oats (ha)*	Cereals (ton)
1	Berat	0.00000	0.00000	0.00000	17.76423	512.09051	0.00000
2	Diber	0.00000	0.00000	136.25277	24.83546	0.00000	0.00000
3	Durres	0.00000	0.00000	0.00000	0.00000	0.00000	0.00000
4	Elbasan	0.00000	0.00000	0.00000	0.00000	0.00000	0.00000
5	Fier	0.00000	0.00000	0.00000	0.00000	0.00000	0.00000
6	Gjirokaster	0.00000	0.00000	0.00000	0.00000	0.00000	0.00000
7	Korce	0.00000	0.00000	0.00000	0.00000	0.00000	0.00000
8	Kukes	0.00000	0.00000	445.56983	0.71862	182.63961	0.00000
9	Lezhe	0.00000	0.00000	0.00000	0.00000	0.00000	0.00000
10	Shkoder	0.00000	0.00000	0.00000	0.00000	0.00000	0.00000
11	Tirane	0.00000	0.00000	0.00000	0.00000	0.00000	0.00000
12	Vlore	0.00000	0.00000	0.00000	0.00000	0.00000	0.00000

Table 3. Input and output slack variables

Source: Data processed by the authors

On the other hand, all inefficient counties should be compared to the efficient counties that make up their reference sets. Table 1 shows that Berat county has as a reference set the counties of Fier, Gjirokastër and Vlorë. Dibër county has Lezhë, Shkodër and Vlorë counties as reference set, while Kukës county has the counties of Shkodër and Vlorë. For the Dibër county, if the Lezhë, Shkodër and Vlorë counties inputs are linearly

combined with the values of λ_1 λ_1= 0,521, λ_2 λ_2= 0,195, λ_3 λ_3= 0,382, its projection is achieved in the efficient frontier, which complies with the projection obtained from the above suggested improvements through θ and additional variables. The situation would be also described for other inefficient counties, Berat and Kukës. For the Berat county, if the Fier, Gjirokastër and Vlorë counties inputs are linearly combined with the values of $\lambda_1\lambda_1$= 0, 135, λ_2 λ_2= 0,0999, λ_3 λ_3= 0,511, its projection is achieved in the efficient frontier, which complies with the projection obtained from the above suggested improvements through θ and additional variables. Also, for the Kukës county, if the Shkodër and Vlorë counties inputs are linearly combined in the values of λ_1 λ_1= 0,408, λ_2 λ_2= 0,069, its projection is achieved in the efficient frontier, which complies with the projection obtained from the above suggested improvements through θ and additional variables.
After the improvements mentioned above, the studied counties may change their input and output levels to the boundary levels given in the Table 4.below.

DMU No.	DMU Name	Efficient Input Target Wheat (ha)	Maize (ha)	Rye (ha)	Barley (ha)	Oats (ha)	Efficient Output Target Cereals (ton)
1	Berat	3674.23916	3229.27735	4.40556	8.66915	1250.13451	45984.45523
2	Diber	2596.66338	4518.17682	0.00000	5.73407	366.83438	47208.19169
3	Durres	2402.00000	3775.00000	0.00000	5.00000	822.00000	42451.13965
4	Elbasan	12467.00000	6847.00000	100.00000	0.00000	2489.00000	98272.32150
5	Fier	17765.00000	9798.40000	0.00000	3.00000	4323.00000	154150.60549
6	Gjirokaster	2306.00000	1156.00000	44.50000	6.00000	1838.00000	19424.25319
7	Korce	15849.00000	4174.00000	488.50000	2411.00000	559.00000	86188.67624
8	Kukes	875.38277	2742.57421	0.00000	1.03214	65.09372	22932.34862
9	Lezhe	2815.00000	3815.00000	0.00000	0.00000	10.00000	39179.12086
10	Shkoder	1801.00000	6131.00000	0.00000	0.00000	0.00000	48543.38904
11	Tirane	4028.00000	3446.00000	10.00000	0.00000	890.00000	45765.98544
12	Vlore	2042.00000	3501.00000	0.00000	15.00000	946.00000	45413.38722

Table 4. Target input and output values for each county

Source: Data processed by the authors

Conclusions

For the weight that agriculture makes in the country's total production and the great impact it has on the employment and well-being of the rural population, to improve the performance of agricultural production in general and that one of cereals in particular, counties should orient their productive resources towards improving technical efficiency. And not just for these reasons, but also for the fact that in short-term period when other factors that affectthe performance cannot be changed or improved, such as financing, machinery, etc., maximizing production through improved production efficiency remains the best alternative for improving performance and increasing productivity in the counties taken in the analysis.
But, in order to achieve this, the performance of the counties themselves should be assessed, and in particular their relative technical efficiency should be assessed. As explained above, realistic technical efficiency is the county efficiency compared to other counties of the same kind (having the same inputs and outputs). The measure of relative technical efficiency tells the counties the level at which they are and so

directs them about optimum utilization. This measure is very important and with practical interest to the counties and should be taken in consideration and analyzed to find the causes that led the counties to the levels of production inefficiency. Thus, counties with a low level of relative technical efficiency (inefficiency) should find ways for improving with the purpose of maximizing the use of inputs in function of increasing technical efficiency, which will thus lead to improving performance and productivity growth.

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